

**SOFS
2022**



SYMPOSIUM ON OCEAN AND FRESHWATER SYSTEMS

“Utilization of aquatic systems for future challenges”

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Abstracts

First Symposium on Ocean and Freshwater Systems

08 December 2022



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University of Ruhuna**



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“Utilization of Aquatic Systems for Future Challenges”

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Foreword

The Research Symposium on Ocean and Freshwater Systems is designed to provide students with opportunities to learn through research findings. Utilisation of Aquatic Systems for Future Challenges is the theme of this year. The Faculty of Fisheries and Marine Sciences & Technology offer two-degree programmes. The B.Sc. Honours in Fisheries and Marine Sciences consists of 50% fisheries-related modules and 50% marine science modules. The BSc Honours in Marine and Freshwater Sciences programme has a weighting of 50% in marine science and 50% in freshwater science. For both programmes, there is a research component consisting of an 8-credit module. Students should be able to conduct scientific research in a chosen area under the supervision of a senior academic and present the research findings in a systematic manner to an examination board.

Undergraduate Research can be considered a learning activity that enriches a student's experience. All students are required to prepare a research proposal based on the knowledge acquired in the first three years of the programme. Incorporating research methodology and the hypothesis-driven scientific process can provide a foundation for developing independent critical thinking skills and oral and written communication skills. Independent thinking can give the student the confidence to form their own opinions based on the available evidence. Thus, the research process has a very positive impact on learning objectives as students prepare for their respective careers.

There was no opportunity to present their study to an academic community and gain wider acceptance for their research. Research symposium organized by the Faculty of Fisheries and Marine Sciences will give students the opportunity to disseminate their findings. The faculty expects that such an event will provide students with the opportunity to develop into responsible, competent professionals with integrity in the fields of fisheries, aquaculture, marine, and freshwater sciences. The faculty anticipates that this event will continue to grow and become a major event of the faculty calendar.

Senior Prof. Tilak P.D. Gamage
Chairperson/ Scientific committee of the SOFS-2022



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Message from the Vice Chancellor

I am pleased to send this message to the first symposium on “Ocean and Freshwater Systems (SOFS) – 2022” of the Faculty of Fisheries and Marine Sciences & Technology of the University of Ruhuna on the theme of utilization of aquatic systems for future challenges.

The common target in the research area of fisheries, aquaculture, oceanography, marine geology, limnology, and water technology should be the generation of knowledge on the use of the resources available in marine and freshwater systems for the upliftment of livelihoods of people. That ultimately should contribute to sustainable development in the economy of the country which remains the major challenge our country is currently facing, especially as an island nation.

Sri Lankans should be equipped with adequate knowledge to sustainably utilize our marine and inland aquatic environments and resources and provide services and products locally and globally for the sake of improving our annual GDP. Various technologies developed using generated knowledge through research and development could be detrimental to the healthy balance of natural ecosystems. Therefore, modern knowledge relevant to marine and freshwater systems must be utilized carefully to achieve sustainability of aquatic system. Similarly, the simultaneous implementation of various knowledge-based experiences related to aquatic systems needs innovative approaches based on good quality research to produce value-added services and products other than basic research on generating knowledge.

Therefore, the theme of this first symposium of the Faculty of Fisheries and Marine Sciences and Technology is timely and important. It would provide an ideal platform to share knowledge the field of marine and freshwater systems and their living and non-living resources. I am extremely happy that the faculty of fisheries and marine sciences and technology has given high priority to research activities. I appreciate the continuous efforts to disseminate their newly acquired knowledge by organizing this biennial symposium to host a wide variety of research in the faculty

While wishing the conference every success, I take this opportunity to congratulate all the authors and the symposium organizers as well as the contributors for making the symposium reality.

Senior Professor Sujeewa Amarasena
Vice-Chancellor
University of Ruhuna



Message from the Dean

I am proud of having this opportunity to issue a message for the first Symposium on Ocean and Freshwater Systems (SOFS) of the Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, scheduled to be held on 08 December 2022 with both physical and virtual platforms.

The Faculty of Fisheries and Marine Sciences & Technology, founded in 2005 has spearheaded fisheries, freshwater, and marine sciences education and research in the tertiary education system of the country. SOFS of the faculty, organized to initiate a faculty activity in the corporate plan of the University 2019-2023 will hereinafter be a routine event in the academic calendar of the faculty to disseminate high-quality research findings. The faculty board recognized the theme of the first symposium; “Utilization of aquatic systems for future challenges”. SOFS-2022 has great importance to the faculty because the research findings of the graduands of the academic year 2016/2017 are disseminated to the public. Proceedings of the SOFS-2022 consist of 25 abstracts, the outcome of the independent research of the graduands. The research findings included in the proceeding are significant as the students conducted the research activities with the COVID-19 pandemic and subsequent restrictions. The students presenting research findings and the respective supervisors of faculty have shown their dedication to academic research in the challenging pandemic situation. I believe the experience that student gain through research in the peri-pandemic period would brighten their path to the challenging future. The quality of the abstracts in the proceeding has been maintained by the peer-reviewing process through expert reviewers, and the panel of the experienced editorial board.

I would like to extend my sincere gratitude to Prof. Tilak P.D. Gamage, Chairperson of the scientific committee, Prof. R.A. Maithreepala, Editor-in-Chief of the SOFS 2022, and all other members of the scientific/ organizing committee, and the editorial board for their tremendous effort for the success of the symposium. I gratefully welcome Prof. Jagath Manatunge, keynote speaker of the SOFS-2022, and highly appreciate the panel of expert reviewers. As the Dean of the faculty, I also wish to convey my sincere gratitude to the academic, academic support, and non-academic staff of the faculty for extending their fullest support and cooperation for the success of SOFS-2022. I also congratulate the graduands of the cohort 2016/2017 for being important stakeholders of SOFS-2022. I further would like to place a special remark on Senior Professor Sujewa Amarasena, the Vice-chancellor of the University of Ruhuna for his moral support and inspiration to complete the event successfully.

I wish the first symposium on the Ocean and Freshwater Systems of the faculty of Fisheries and Marine Sciences & Technology would be a great success.

Prof. K.H.M. Ashoka Deepananda
Professor of Fisheries Biology (Chair)
Dean/ Faculty of Fisheries and Marine Sciences & Technology



Keynote Speech

Controlling Pollution of Aquatic Ecosystems for Sustainable Urban Development

Prof. Jagath Manatunga

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Aquatic ecosystems are continually polluted and degraded by pressures that are directly related to anthropogenic origin and are often a result of urbanization and rapid industrial growth. Such impacts include the loss of biological communities, chemical pollution by excess nutrients and contaminants, and alteration of structural diversity of aquatic systems, their connectivity and process dynamics. Pollution is generally the primary cause of aquatic ecosystem degradation, which directly affects water consumptive patterns, frequently with severe consequences to public health. A broad range of contaminants from the point- and non-point sources have rendered most of the water sources unfit to use as raw water intakes for public water supplies. This paper emphasizes the need to control aquatic pollution in attaining sustainable urban development by highlighting some case studies in the Western Province of Sri Lanka.

Household waste discharges, industrial effluents, and urban/agricultural runoff are detrimental to aquatic ecosystems, including coastal zones, on a scale never seen before. Prevention and/or effective control of aquatic contamination/pollution demands the knowledge of common as well as emerging contaminants, a thorough understanding of natural elemental cycling/treatment processes, and to appreciate the need for advanced waste treatment systems. To make such resources avenues for sustainable development, well-developed monitoring systems of aquatic ecosystems that are (or could be) affected by effluent discharges are essential. Appropriate waste treatment technologies, including nature-based solutions, must be developed to remove pollutants from waste discharges and ensure adequate water pollution control. These technologies need to be further developed to improve efficiency while reducing overall cost outlays – without which adoption of such technologies may not be realized. Recent developments in preventing pollution of aquatic ecosystems, including coastal zones, are highlighted in this paper.

The City of Colombo has recently been accredited as a Ramsar site, and restoration and conservation of wetland ecosystems have become imperative. With the continuous development of larger population centres in the Western Province, the hydrological properties of urban wetlands have changed, directly impacting the structure and function of wetlands. There is a persistent societal need, especially within urban communities, to reverse the decline of urban wetland systems and restore lost ecosystem functioning and services by promoting active restoration aiming at natural recovery. Despite the benefits that urban wetlands provide, restoration and protection of these spaces occur less often and face more significant barriers compared to other ecosystems. Restoration of some



wetlands in Colombo are highlighted as case studies aimed at contributing to sustainable urban development.

In Sri Lanka, we must recognize the importance of rational water management practices and water security in an environment with ever-increasing competition between water uses. We have to face significant challenges arising from irregular rainfall patterns, likely impacts due to global warming, increasing water pollution scenarios, etc. Notwithstanding many attempts thus far, Sri Lanka has yet to adopt comprehensive national-level policies to regularize aquatic resource conservation, which must be considered an essential requirement for sustainable water resource use and to ensure pollution control. Conservation and restoration of aquatic systems need clearly defined criteria and targets. Such management criteria should primarily follow a process-oriented and stepwise adaptive approach judging the success of restoration against pre-defined reference/control levels. Institutional and societal expectations must be appreciated; restoration targets must not be over-ambitious and promise too much. For instance, small-scale restoration of degraded ecosystems can re-introduce some elements of essential ecosystem services, including improving biodiversity. Every so often, 'marginal' ecosystems are better than nothing, especially in urban settings, and the best can be achieved with proper political will and good governance. A brief review of existing policies and approaches adopted in Sri Lanka are discussed to seek progressive avenues that promote pollution control of aquatic ecosystems, which is again imperative in attaining sustainability.



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Assessment of Freshwater Red Algae *Batrachospermum* sp. for Phytochemicals, Antioxidant and Antibacterial Activity

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Marine red algae have been used in traditional medicine for centuries while the therapeutic and biological properties of freshwater red algae are almost unknown. The present study was conducted with the aim of identifying the phytochemical constituents, the antioxidant and antibacterial activity of freshwater red algae, *Batrachospermum* sp., collected from headwater region of Wathurawa-Ela, in Deniyaya. Methanol and aqueous extracts of *Batrachospermum* were subjected to seven qualitative phytochemical screening tests, and the antioxidant activity for the methanol extract was evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay. Further, their potential antibacterial activity against human pathogenic bacteria, *Bacillus cereus* and *Escherichia coli* were evaluated using Kirby-Bauer disk diffusions test, for both extracts. Qualitative phytochemical analysis identified the presence of flavonoids, steroids and alkaloids in both methanol and aqueous extracts while terpenoids and glycosides were detected only in the aqueous extract. The methanol extract of *Batrachospermum* showed an IC₅₀ (half-maximal inhibitory concentration) of 99.70 µg/mL of antioxidant activity while, the methanol extract of the standard reference, ascorbic acid showed an IC₅₀ of 71.14 µg/mL, indicating its antioxidant activity. The antibacterial activity of methanol extract tested against *B. cereus* was moderately strong compared to the inhibition induced by the solvent (99.8% methanol). The diameter of the inhibition zones was, 10.50±2.12 mm, 11.00±1.41 mm, 7.00±0.00 mm and 10.00±2.83 mm for undiluted (8 µg/mL) and 1:1, 1:2 and 1:4 diluted methanol extracts respectively. For methanol, it was 7.00±0.00 mm. The antibacterial activity of methanol extract against *E. coli* was weak compared to the inhibition induced by the solvent in which the diameter of the inhibition zone for methanol was greater than that of methanol extracts of phytochemicals. The diameter of the inhibition zones was, 0.00±0.00 mm, 7.00±0.00 mm, 10.00±0.00 mm and 8.00±0.00 mm for undiluted (8 µg/mL) and 1:1, 1:2 and 1:4 diluted methanol extracts respectively. For methanol, it was 9.50±0.71 mm. Aqueous extracts did not show any inhibition towards either the bacterial isolates. These results implicate the presence of antibacterial compounds, phytochemicals, and antioxidants in *Batrachospermum* that could be a potential source for medicinal and therapeutic applications.

Keywords: Algae, *Batrachospermum* sp., Phytochemicals, Antioxidant activity, Antibacterial activity



Influence of Urbanization on Surface Runoff: A Case Study in Matara City, Sri Lanka

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Land-use changes due to urbanization influence the surface runoff. Therefore, surface runoff assessment has become crucial in urban areas, since the increment of surface runoff leads to the occurrence of floods, soil erosion, and pollutants transportation. Rapid urbanization is mostly being observed in cities of developing countries. Matara city is one of such cities subjected to rapid expansion which is located in southern Sri Lanka. However, a proper surface runoff assessment for Matara city has not been reported in the literature. Making hypothesis that Matara city has been subjected to surface runoff-related issues, we evaluated the relationship between urbanization and surface runoff in Matara city, Sri Lanka for the period from 1990 to 2020. The Geographic Information System (GIS) based SCN-CN method was used as the tool for the study. Rainfall data, source maps, and satellite images were obtained from primary and secondary sources. It was observed that the urban land area has been increased from 1990 to 2020 by 31.79%, while the land area used for forest, home garden, and water bodies have been declined by -9.52%, -22.35%, and -2.35%, respectively. The results of the SCN-CN method demonstrated a positive change of conversion of runoff area (33.01%) by runoff depths (41-60 mm). However, all the other runoff intervals (0-20 mm, 21-30 mm, 31-40 mm, and 61-70 mm) show a negative change of conversion. The transformation of runoff volume in high runoff potential areas shows a positive change (18.61%) while low and moderate runoff potential areas show a negative change of conversion of volume (-1.60% and -17.01%). Therefore, it can be concluded that due to urbanization, the imperviousness of the land increases leads to high runoff potential area. This trend will not achieve a positive impact because a high runoff potential area leads to destructive phenomena, such as floods and slidings. The results revealed that, change of land usage has led to higher surface runoff over the studied period in the study area. Therefore, assessing the surface runoff which rises with the urbanization is an essential task in the urban planning and development.

Keywords: Land use, SCN-CN method, Urbanization, Surface runoff, Matara city

Predicting Fishing Grounds of the Offshore and High Seas Longline Fishery of Sri Lanka Using Oceanographic Conditions in the Indian Ocean

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The fishing grounds of the multiday longline fisheries of Sri Lanka are identified from the remote sensed satellite data measurements. The fisheries catch rates of longlines relevant to the major commercially targeted fish species (*Thunnus albacares*, *Xiphius gladius* and *Thunnus obesus*) in the Indian Ocean was calculated by the Generalized Additive Model (GAM) and the Empirical Cumulative Distribution Function (ECDF) model. The optimum oceanographic conditions of the sea surfaces including the Temperature (SST), Chlorophyll (SSC), Salinity (SSS), Height (SSH), Eddy Kinetic Energy (EKE) and the Mixed Layer Depth (MLD) relevant to the target fish species were analyzed to ascertain the relationship between the catch rates and spatiotemporal distribution of Potential Fishing Zones (PFZ). The Catch Per Unit Effort (CPUE) varied in the South–West and North- East monsoon seasons. Four main regions; Bay of Bengal, Exclusive Economic Zone (EEZ) of Sri Lanka, Eastern and western margins of the Maldives island EEZ, and the East-Central Arabian Sea in the Indian Ocean were observed as highly aggregated PFZ. The best fitting models in the GAM analysis indicates that all the oceanographic parameters influence in different proportions for the abundance of the fish species. It can be concluded that SST is the primary driving force of the fish distribution in the ocean. The SSC and SSS indicate that the fluctuating sensitivities considerably impacts on the fish distribution. Results suggest that the optimum oceanographic conditions derived for the fish species can be useful for tracking and predicting the potential fishing grounds in the Indian Ocean. However, the reliability of model results strictly depends on the fisheries catch data recordings that can cause errors related to the catch rates and the prediction of fishing grounds.

Keywords: Fishing grounds, Longline, Catch data, Oceanographic conditions

Reasons for the Sudden Fish kills in Uyanwewa Reservoir, Sri Lanka: A Remote Sensing Approach

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Sudden large-scale fish kill incidents have been reported in Uyanwewa reservoir located in Hakmana area in Sri Lanka during last few years and the last fish kill incident was recorded on the 17th July 2020 and the reason for such events have not been revealed yet. According to fishermen, the majority of the reported dead fish were bottom dwellers including *Cirrhinus mrigala*. This reservoir has not been subjected to any previous scientific study and therefore, the baseline information is also lacking. The main objective of this study was to investigate the possible reason for the sudden fish kill in 2020 incident in Uyanwewa reservoir. Sampling was carried out on 25th January, 09th and 25th February 2021. Water quality parameters; Nitrate, Total Phosphate, Dissolved Oxygen (DO), Total suspended solid (TSS) and temperature were measured in water samples collected from the surface, middle, and bottom layers of the water and Chlorophyll-a (Chl-a) was determined in 12 surface water samples collected using a Rutner sampler. Landsat 8 satellite data were retrieved for the dates of sampling as well as the date nearest to that of the past fish kill (14th July 2020). Chl-a is an indicator of the mass of phytoplankton and is a reference for estimating the eutrophication in an aquatic ecosystem. The past Chl-a concentrations of the reservoir were determined by using the regression model, which was developed using the band ratio and Chl-a concentrations in 2021, using ArcGIS 10.6.1. For the development of the Chl-a retrieval algorithm, the most suitable band ratio was received for (B3+B4)/B5 with an R² value of 0.7277 (p = 0.000). Results indicated that during the last sudden fish-kill of Uyanwewa in 2020, the mean Chl-a concentration was 5.64±0.86 µgL⁻¹ which is quite higher than the values obtained in sampling days (4.13±2.25, 5.13±1.28, 4.65±0.72 µgL⁻¹). Based on TSI (Chl-a) = 41.71, the reservoir was in mesotrophic condition on the 14th July 2020. One-way ANOVA was used to compare the water quality data between the layers at the sampling dates. Mean water temperature and DO levels showed a significant difference between the water layers and the mean DO concentration was lowest in the bottom layer (3.05±0.46 mg/L). Mean Chl-a (4.13±2.25, 5.13±1.28, 4.65±0.72 µg/L) and phosphate results (0.044±0.03, 0.058±0.03, 0.064±0.03 mg/L) of Uyanwewa were characteristic of being in the mesotrophic and eutrophic range respectively according to Nürnberg, 1996. DO levels in the middle and bottom layers (4.48±0.46, 3.05±0.46 mg/L) also indicated that the algal bloom formation may be a probable cause of fish kills in Uyanwewa reservoir through the depletion of DO concentration in middle and bottom layers.

Keywords: Landsat 8, Uyanwewa, Chlorophyll-a, Remote Sensing, Algal bloom

Enumeration, Isolation and Antibiotic Sensitivity of *Vibrios* in Post-Larvae of *Macrobrachium rosenbergii*

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In Sri Lankan reservoirs, culture-based fisheries of the *Macrobrachium rosenbergii*, Giant Freshwater Prawn (GFP) have been established, making the inland fishery an economically important component. Scientists are investigating the reason for the low *M. rosenbergii* production comparison to its stocking density. This reduced output might be due to associated bacteria and their pathogenicity. This study focused on enumeration of total bacteria and total *Vibrios* count and isolation *Vibrios* present in the *M. rosenbergii* postlarvae collected from five different larval rearing tanks (PL-S1, PL-S2, PL-S3, PL-S4 and PL-S5) at Freshwater Prawn Breeding Centre, Kahandamodara and investigating the sensitivity of selected *Vibrios* to commonly used antibiotics viz Chloramphenicol (30 µg), Ciprofloxacin (30 µg), Tetracycline (30 µg), Gentamicin (30 µg), and Ampicillin (30µg). Five postlarvae samples, each comprising 30 individuals, were obtained from five separate tanks and all the samples were homogenized separately. Samples were inoculated on standard plate count agar (PCA) plates and Thiosulfate Citrate Bile Sucrose (TCBS) plates respectively to estimate the total plate count (TPC) and total *Vibrio* count (TVC) by spread plate method. Bacterial colonies grown on TCBS were isolated and confirmed as *Vibrio* sp using a battery of biochemical tests and according to the methods and keys given in Alsina and Blanch, (1994) and Bergey's manual of determinative bacteriology. Then the antibiotic sensitivity of bacteria associated with postlarvae was investigated using the Kirby- Bauer disk diffusion technique. The study revealed that the total bacterial count and the total *Vibrio* count varied among different tanks. TPC ranged from 10.61Log CFU/g±0.24 to 6.25Log CFU/g ±0.18. Furthermore, the significantly highest number of bacteria was present in PL-S1 (10.61LogCFU/g±0.24) and the lowest number of bacteria was present in PL-S5 (6.25 Log CFU/g ±0.18), whereas the TVC ranged from 3.29 LogCFU/g ±0.01 to 2.41 LogCFU/g ±0.06 and the significantly highest total *Vibrio* count was observed on PL-S3, PL-S4 and, PL-S5 (3.21 Log CFU/g ±0.02, 3.14 Log CFU/g ±0.09, 3.30 Log CFU/g ±0.01) whilst the lowest *Vibrio* abundance was recorded in PL-S1 (2.41 Log CFU/g ±0.06). Further, it revealed that out of the total bacteria, *Vibrios* consisted of a considerable percentage. All isolated colonies were identified and confirmed as *Vibrio* sp. Antibiotic sensitivity testing experiment revealed that all the isolates were 100%



resistant to Ampicillin followed by 67.5% intermediate resistance to Gentamycin. Isolates were sensitive to Chloramphenicol, Ciprofloxacin and Tetracycline. This study concluded that post-larvae of *M. rosenbergii* have various abundances of total bacteria and *Vibrio*. Also, concluded that some of Vibrios developed resistance against some commonly used antibiotics as therapeutics whereas some of the antibiotics are effective against the isolated Vibrios.

Keywords: Antibiotic resistance, Post larvae, Total plate count, Total Vibrio count



Projecting Land Use Changes and Its Impacts on Flooding: An Analysis of Remote Sensing Images of Kalu River Basin in Sri Lanka

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Floods are one of the most common natural disasters worldwide, leading to economic losses and loss of human lives. There are 103 rivers in Sri Lanka and some of these rivers make severe impacts on the natural and built environment during the rainy seasons due to floods. Characteristics of the flood is decided by a combination of factors such as rainfall and land use. Although the Kalu river made significant impacts during flooding, hydrological effects driven by the multi-temporal land use changes on flooding in the river basin is yet to be studied. To fill this research gap, the present study generated land cover maps of 1995, 2014 and 2019 using Maximum Likelihood Algorithm of Supervised Classification, and subsequently a Land Change Modeler (LCM)-Markov was implemented to predict the land use of 2019. The model was validated with three-map comparison which consists of two components of agreement and three components of disagreement. Overall accuracy of the validated model was good with a value of 77%, and it was used to predict the land-use maps of the years 2030, 2050 and 2100. Eventually, an event based hydrological HEC-HMS model was developed to study the impacts of land-use changes on hydrological response and runoff processes of the three major sub-basins (Horana, Ellagawa and Millakanda) of Kalu river basin. The model was calibrated and validated for the flood events occurred in April and May 2008, and May 2003 respectively. Finally, curve number (CN) values were generated for the predicted land use maps of the year 2030, 2050, and 2100. Calculated CN values were then incorporated to the validated HEC-HMS model and impacts of land use on hydrological responses and runoff processes were assessed. The projected results indicated that the natural vegetation areas will continue to decrease from 84.8% of the whole study area in 1995 to 73.7% by the year 2100 followed by an increase in both agricultural (from 14.1% in 1995 to 22.3% in 2100) and urban areas (from 0.8% in 1995 to 3.4% in 2100 respectively). The CN values have also increased with the projected land use. As a result, despite the same rainfall prevailing, the peak discharges will continue to rise in all three major sub-basins with respect to the predicted land use changes. Moreover, according to the predicted run-off simulation using HEC-HMS, Horana (Kalutara) and Ellagawa sub-basins are projected to be more vulnerable in near future. The results of this study can be used as a road map for taking necessary actions to achieve sustainable water resources management in Kalu river basin in future.

Keywords: LCM-Markov (Land Change Modeler-Markov), HEC-HMS, Curve Number, Peak discharge

Application of Selected Floating Aquatic Plants for Phytoremediation of Textile Dye Effluent from Batik Industry

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Batik industry in Sri Lanka releases a large volume of waste effluent containing toxic chemicals to the aquatic environment. Such chemical compounds negatively affect the physicochemical properties of water such as the color, pH, Electrical Conductivity (EC), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and concentration of total, dissolved and suspended solids (TS, TDS and TSS). Thus, it is highly important to treat effluent generated from the batik industry before being released into the aquatic environment. This study aimed to find out the possibility of applying aquatic floating plants *Azolla pinnata* (mosquito fern), *Salvinia molesta* (giant Salvinia), and *Lemna minor* (common duckweed) for the phytoremediation of initially treated effluent from a dyeing plant of batik industry. The Batik effluent samples released from the “Leka Batik Center” Matara were collected from the effluent outlet of the treatment plant. Experiments were conducted in the laboratory using diluted and pH adjusted wastewater in glass tanks separately using known biomass of floating aquatic plants open to the indoor light condition at room temperature. During the experiment process, physicochemical parameters of water were recorded at 05-day time intervals. Totally 12 glass tanks in three series where each series consisted of three replicates of plants (separately for three species) system and 01 control set without adding plants were used. Three plant species showed clear evidence in colour removing, and decreasing EC, TS, TDS, TSS, COD, BOD, and NO_3^- , PO_4^{3-} concentrations. *Salvinia* sp. showed the drastic decline in above parameters occurred during 20 days with the efficiency of 94.19% of color removal, 78.81% of EC, 71.58% of TS, 66.67% of TDS, 64.80% of TSS, 81.53% of COD, 62.367% of BOD, 94.62% of NO_3^- , and 80.41% of PO_4^{3-} . There are some reported evidence for treatment of domestic waste and other type of waste water in using *Salvinia* sp., but no clear evidence is available for treatment of batik dye wastes using that aquatic plants. This study clearly shows that *Salvinia* sp. is the most suitable floating aquatic plant comparing with *Azolla pinnata* and *Lemna minor* in remediation of textile dye effluent released from Batik industry. As a one practical problem it was found that all three types of plants grown in the laboratory system without adding nutrients during study period have limited their growth in wastewater. However, the results of this study would be useful to design giant Salvinia grown in constructed ponds to further treat effluent released from wastewater treatment plants in Batik industries.

Keywords: Wastewater, Phytoremediation, *Azolla pinnata*, *Salvinia molesta*, *Lemna minor*

Rainfall Variations and Land-use Pattern Change the Floods in MahaOya River Basin, Sri Lanka

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Flood behavior and possible driving factors (land use and rainfall) responsible for flood hazards of the Maha Oya were studied. Discharge data over the last 28 years were collected and analyzed to identify disaster management precautions and the driving factors affected flooding in Maha Oya. Previous studies suggest that the river basin had been subjected to serious erosion due to increased soil digging, clay mining, and high flood vulnerability over the last three decades. HEC-HMS rainfall-runoff modeling techniques were employed to develop previous (1992-1995) and present (2016-2019) conditions of the Maha Oya basin to compare the changes in discharge with respect to the variations in land-use and rainfall. These two periods were selected to represent the 28 years of duration. Land-use variations of the river basin for the relevant period were obtained from a supervised classification using Landsat images. Classified land-use maps were subjected to an accuracy assessment by calculating Kappa Coefficient. Delineated maps for the year 1990 and 2019 were validated with an overall accuracy of 92.5% & 96% and Kappa estimate value of 0.90 & 0.95, respectively. Two models were calibrated and validated with observed data until the Nash Sutcliffe function reach the acceptable range. Model-01 was calibrated for the period of 1992-1994 with a 0.60 Nash value and validated for the period of 1994-1995 with a Nash value of 0.507. Model-02 was calibrated for the period from 2016 to 2018 with a Nash value of 0.613 and validated for the period from 2018 to 2019 with a 0.553 Nash count. Developed models were used to run the controlled simulation by changing the rainfall data of the two models. Hydrographs of Model 01 & Model 02 and two controlled simulation hydrographs (Controlled Simulation 01 & Controlled Simulation 02) were derived and compared to assess the impact of land-use change and the rainfall variation on the river discharge. The comparison revealed that the river discharge level has depleted over the period of 1992 – 2019 due to the land-use variation. The rainfall variation has reduced the flood frequency during 1992-1995. And old river basin condition generates peak discharge of 200cms excess volume than the present condition. The base-flow of the Maha Oya basin has reduced over the study period, affecting the river discharge during dry months which was the major influence on the river discharge depletion. Land-use classification indicates changes in river channel over the study period augment by sand mining over the riverbank which may be the major influence on the base-flow depletion. The discharge level depletion is affected by other minor alterations and agricultural expansions in the sub-basins of the Maha Oya River basin.

Keywords: HEC-HMS, Land-use variation, Arc GIS, Rainfall variation, Baseflow, River discharge

Microplastics in Sediment, Water and Giant Freshwater Prawn (*Macrobrachium rosenbergii*) in Ridiyagama and Muruthawela Reservoirs of Sri Lanka

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Abundance of micro plastics (MPs) in sediment, water and *Macrobrachium rosenbergii* from Ridiyagama (R) and Muruthawela (M) dry zone reservoirs in Sri Lanka was studied. Gills, gastro-intestinal tract (GIT), and hepatopancreas of prawns were acid digested using nitric acid and analyzed for the abundance of MPs. Sediment samples of reservoirs were acid digested using hydrogen peroxide. MPs were detected in gills, GIT, and hepatopancreas of prawns from both reservoirs. MPs were abundant in hepatopancreas compared to gills and GIT. The occurrence of MPs was 18.4 ± 7.4 MPs/individual in Ridiyagama reservoir, significantly higher than the Muruthawela reservoir (8.4 ± 1.6 MPPs per individual). The abundance of MPs in the sediment of Ridiyagama reservoir was 97 ± 20.8 MPs/kg, being significantly higher than the Muruthawela reservoir (39 ± 7.4 MPs/kg). However, the occurrence of MPs in water was not significantly different between the reservoirs. The mean abundance of MPs in water of Ridiyagama and Muruthawela reservoirs were 26.3 ± 5.8 MPs/L, and 17.7 ± 7.4 MPs/L respectively. MPs were mainly in the form of fibers and the rest was as fragments in both reservoirs. Common colours of MPs were identified as blue, red, and black whereas the white colour fibers, and fragments could only be found in *M. rosenbergii*, sediment, and water from the Ridiyagama reservoir. The study suggests that, even in un-urbanized freshwater habitats intensive agricultural and fisheries activities lead to MPs pollution. However, further studies are required to evaluate the potential pathways, sources, and impacts of MPs and their affiliates within these freshwater systems.

Keywords: Microplastic particles, *Macrobrachium rosenbergii*, Gills, Gastro-intestinal tract, Hepatopancreas

Feeding Preference of Sea Urchin, *Stomopneustes variolaris* in an Intertidal Rocky Reef of Sri Lanka

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Sea urchins are well-known grazers and bioeroders in marine benthic habitats. *Stomopneustes variolaris* that play a key role in controlling macroalgae, is the most abundant sea urchin species in the shallow waters of Sri Lanka. The studies on *S. variolaris* is restricted to few studies on distribution and reproductive biology. Yet, studies on feeding preference is scarce. Thus, present study was carried out to investigate the feeding preference of *S. Variolaris* during January to April 2021 at Ahangama inetrtdal rocky reef (5° 96'N 80° 37'E). Benthic algae cover of the reef was recorded. Sea urchins (n=20), collected from the rocky intertidal reef were transported to the laboratory, and dissected to preserve 1 cm of gut. Contents in the remaining gut was analyzed for proportions of inorganic and organic components. Further, contents of the preserved gut section were observed under dissecting microscope and percentage frequency of dietary components were recorded. Gut contents of sea urchins consisted of calcium carbonate, organic materials, and siliceous materials 48.06±3.74%, 46.24±3.74%, and 5.66±0.47 % (mean±SE), respectively. The organic component of gut composition included plant (85.4 ±.04 2.83%) and animal materials (14.767±1.57%). The most abundant dietary component of urchin was green fleshy algae (57.81±5.22 %), of which *Caulerpa racemosa* was the dominant green macroalgae (9.80±2.89%). Foraminiferan shells were the dominant animal dietary component (14.13 ± 5.62%). The presence of animal and plant material in the gut contents indicates that *S. variolaris* is an omnivorous species. Even though *Sargassum* sp. and *Halimeda* sp. were highly abundant in the study area, these species were not observed in the urchins' gut possibly due to unpalatability. Areas dominated by crustose coralline algae indicate the extensive grazing of sea urchins. Impacts of seasonal changes in the macroalgae cover on the food preference of *S. variolaris* is reccomended for further studies.

Keywords: Feeding preference, Gut contents, *Stomopneustes variolaris*, Macroalgae, Foraminifera

Effect of Different Substrates on the Growth of Water Trumpet (*Cryptocoryne wendtii*)

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The effect of different substrate compositions on the growth performance of micro propagated ornamental aquatic plant; *Cryptocoryne wendtii* ‘Water Trumpet’ under submerged conditions was investigated. River sand (R), Topsoil (T), Coconut coir dust (D) and Cattle manure (M) were used to prepare the substrates. Plastic containers (20.4 cm diameter, 19.2 cm height) were filled with one of four substrate compositions; S (R:T 1:1), C (R:D 1:1), SM (R:T 1:1 with 10% M) and CM (R:D 1:1 with 10% M). Individual plants (9.60 ± 1.47 cm and 0.13 ± 0.01 g) were potted in each container and each treatment had four replicates. Plants were cultured for 35 days under ambient temperature and light conditions, and the water level was maintained at 10 cm above the substrate. Plant growth parameters and environmental parameters were measured once in every two weeks. One-way Analysis of Variance and Duncan’s multiple range test in post-hoc analysis was employed to test the effect of different substrates on the experimental plants. Water temperature (26.8 ± 0.08 °C) was not significantly different among the four treatments. Water pH value was significantly higher in S (7.78 ± 0.32) than that in C (7.58 ± 0.26), SM (7.69 ± 0.29), and CM (7.51 ± 0.18). Plants grown in C and SM exhibited significantly higher total plant wet weight (0.19 ± 0.03 g and 0.23 ± 0.03 g), shoot wet weight (0.14 ± 0.01 g and 0.17 ± 0.04 g) and the %weight gain (44.71 ± 8.94 and 77.68 ± 20.32) respectively compared to other treatments. SM showed significantly the highest total plant dry weight (19.53 ± 2.05 mg) and shoot dry weight (12.63 ± 2.15 mg) compared to S, C and CM. It can be concluded that the application of river sand and topsoil (1:1) with 10% cattle manure mixture (SM) is suitable for the propagation of the ornamental aquatic plant “water trumpet” under submerged conditions.

Keywords: Ornamental Aquatic plants, Cattle manure, Water trumpet, Light conditions

Evaluation of the Diversity of Benthos and its Relationship to Water and Sediment Quality in Headwater Streams: Case Study Bambarakanda Stream, Sri Lanka

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Sediment properties and benthos diversity can be used to evaluate the quality of aquatic systems. Bambarakanda is one of the most popular destinations with tourism interest in Sri Lanka that consists of a unique headwater region. Hence, the anthropogenic activities are being prominent but hardly any proper studies have been carried out in this area. As such, aiming to fulfill the baseline data gap, we investigated the status of the headwater region of Bambarakanda using benthos diversity, sediment properties together with the water quality. Five sampling sites were selected in a 3 km stretch along the stream. Sites were visited once in every month for a three-month period consecutively from January to March 2021. Physicochemical parameters of water (temperature, pH, conductivity, salinity, water velocity, dissolved oxygen (DO), biological oxygen demand (BOD), total suspended solids (TDS), total solids (TS), channel width, phosphate concentration, nitrate concentration, total hardness, total coliform, oxygen redox potential (ORP) and sediment properties (pH, nitrate, phosphate, conductivity, organic matter (OM), particle size) were measured. Benthos samples were collected at each site using the Surber sampler. Benthos diversity was assessed by calculating Shannon-Weiner Diversity Index (H), while water quality was assessed using the Water Quality Index (WQI) and EPT (Ephemeroptera, Plecoptera, and Trichoptera) index. There were significant differences in sediment quality ($p \leq 0.05$) in terms of particle size, while WQI was similar among study sites. According to the WQI, water quality of the stream was 'good' in quality. The coefficient of gradient (Cc) and uniformity coefficient (Cu) indicate that the substrate in site-2 was well-graded, and the others were uniformly graded ($p < 0.05$). There were significant differences in physicochemical parameters of water and sediments among the study sites ($p < 0.05$). Nevertheless, there was not any significant correlation between WQI and H ($R^2 = 0.0003$, $p > 0.05$). Nine taxonomic orders of benthic organisms belong to seven families were identified during the study period. Family *Glossomatidae* was the most predominant order. Family *Leptoceridae* and family *Helicopsyidae* were also significantly dominant in the area. The diversity index (H) was relatively greater (ranges from 1.37 to 1.60), indicating that this area is still rich in benthic diversity. According to EPT index (> 27) and their corresponding water quality ratings, the water can be categories as 'Excellent'. Physicochemical parameters of water, sediment quality, and nutrient content at the Bambarakanda area were optimum for the rich diversity of benthos. The results indicate that this aquatic ecosystem was healthy yet, amid increasing anthropogenic pressure.

Keywords: Benthos Diversity, Water Quality, Sediment Quality

Effects of Total Hardness on Growth Performances, Survival and Feed Utilization Efficiencies of Platy Fish (*Xiphophorus maculatus*)

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The effects of total hardness on growth performance, survival, and feed utilization efficiencies of platy fish (*Xiphophorus maculatus*) were studied. Twenty-one days old 180 juvenile fish with initial mean weight of 0.11 ± 0.04 g and mean total length of 1.82 ± 0.21 cm were exposed to three different hardness levels as, 50, 150, 250 mg/L and 0.00mg/L as the control. Fish were randomly assigned to three treatments and the control each with three replicates. All the fish were kept in 50 L glass tanks at initial stocking density of 15 fish/tank. Total hardness of the water was maintained by adding CaCl_2 & MgCl_2 into the water. Fish were fed with commercial prima diet (39% crude protein) twice per day to near satiety and experiment was lasted for 06 weeks. Water quality of each treatment was maintained below the lethal levels. The percentage survival of fish in each treatment was observed and recorded daily. Total length and body weight of fish in each treatment was measured every two-weeks, while amount of feed consumed was recorded daily. At the end of the experiment, % Average Daily Gain (%ADG), % Specific Growth Rate (%SGR) and Food Conversion Ratio (FCR) were calculated to evaluate the growth performances and feed utilization efficiencies of platy fish. At the end of the experiment, significantly greatest ($p < 0.05$) mean weight gain (0.54 ± 0.01 g), mean total length gain (1.57 ± 0.05 cm), %ADG (11.62 ± 0.21), %SGR (4.20 ± 0.04) and significantly lowest ($P < 0.05$) FCR (1.54 ± 0.05) were observed in 150 mg/L hardness level. Among tested three levels, the growth performances were significantly highest in the hardness level of 150 mg/L followed by 50 mg/L. Final percentage survival was not significantly ($p > 0.05$) different among treatments. According to the overall results, significantly highest and lowest growth performances were observed in 150 mg/L and 250 mg/L hardness levels respectively, while moderate growth performances were observed in 50 mg/L. Correlation coefficient between the total hardness and %SGR of fish was 0.818 and it clearly showed that, around 150 mg/L total hardness level is more favorable for the growth of platy fish. Results of this study revealed that, 150 mg/L total hardness level is the best tested levels for the growth performances and feed utilization efficiencies of *Xiphophorus maculatus*. However, above, and below 150 mg/L total hardness levels are negatively affected the growth performances & feed utilization efficiencies.

Keywords: CaCl_2 & MgCl_2 , Growth performances, Percentage survival, FCR, Specific growth rate

Antioxidant Potential of Common Sea Weeds, *Ulva lactuca* and *Sargassum* sp. in Dickwella Bay, Southern Sri Lanka

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A significant number of bioactive compounds extracted from marine plants acts as free radical scavengers. Such compounds have pharmaceutical value since many diseases are associated with oxydative stress caused by free radicals. The present study investigated the antioxidant properties in phytochemicals extracted from *Sargassum* sp. and *Ulva lactuca* collected from Dikwella bay, Southern Sri Lanka. Methanolic extractions were obtained to perform the phytochemical screening which indicated the presence of flavonoids, terpenoids, tannins, steroids, glycosides, and saponins in both samples. Following the extraction of phytochemicals, antioxidant activities were tested using DPPH (2,2-diphenyl-picryl-hydrazyl) radical scavenging activity, total phenolic content (TPC) and phosphomolybdenum assays. To determine the DPPH activity, light absorbance was measured at 517 nm and ascorbic acid was used as the standard reference solution. The TPC was determined by Folin-Ciocalteu colorimetric method using gallic acid as standard reference. Phosphomolybdenum assay was conducted to evaluate the total antioxidant activity by measuring the absorbance at 695nm. The crude concentrations of the *Sargassum* sp. and *Ulva lactuca* were 40.20 ± 7.62 mg/mL and 41.76 ± 3.95 mg/mL respectively. The DPPH radical scavenging activity of *Sargassum* sp., *U. lactuca* and ascorbic acid showed the IC₅₀ (half minimal inhibitory concentration) values of 8.41 ± 0.01 mg/mL, 5.01 ± 0.01 mg/mL and 71.15 ± 0.01 mg/mL respectively. Extract of *U. lactuca* gave the highest IC₅₀ ($p < 0.001$) value than that of ascorbic acid and *Sargassum* sp. showed significantly higher TPC (106.78 ± 0.36 mg GAE/g) than *U. lactuca* (84.75 ± 0.35 mg GAE/g). In phosphomolybdenum assay, *Sargassum* sp. (113.016 ± 1.47 mg) indicated a significantly higher antioxidant value ($p < 0.05$) than *U. lactuca* (62.769 ± 1.78 mg AAE/g). Results indicated the presence of high DPPH radical scavenging activity of plant extracts than the standard ascorbic acid reference. *Sargassum* sp. exhibits the highest DPPH radical scavenging activity, total phenolic content and total antioxidant activity compared to the *U. lactuca*. Present study highlights the potential application of *U. lactuca* and *Sargassum* sp. as possible sources of natural antioxidants in pharmaceutical and food manufacturing industries.

Keywords: Seaweed, Antioxidant, Phytochemicals, DPPH, Reducing power

Green Synthesized Silver-Soda Lime Glass Nanocomposite, Made by *Neolitsea Cassia* Leaf Extracts Inhibits *Microcystis* sp. Under Aquarium Conditions

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Microcystis sp., one of the most common cyanobacteria releases cyanotoxins which cause severe ecological consequences to both aquatic organisms and human. There is a high demand for developing an eco-friendly safer methods to control harmful algal blooms. Medicinal and antibacterial properties of silver nanoparticles (Ag NPs) has gained a prominent role in developing such methods. Green synthesis of Ag NPs is eco-friendly and cost effective than that synthesized by conventional chemical methods. Therefore, the objectives of the study were to; (1) produce green synthesized AgNPs using 80% methanol extract of *Neolitsea cassia* leaves and produce a nanocomposite by overlaying Ag NPs on soda lime glass beads, and (2) incorporate nanocomposite into an aquarium tank trickling filter to evaluate its performance as an anti-algal agent against *Microcystis* sp. Three concentrations of AgNO₃, 0.1, 0.2 and 0.3 mol dm⁻³ were chemically reduced to elemental Ag by the plant extract and the synthesized NPs were coated on soda lime glass beads (4 mm diameter). Ultraviolet-visible spectroscopy, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDXA) and Fourier Transform Infrared (FTIR) analysis techniques were used in characterizing green synthesized Ag NPs. An experiment was conducted for a period of three weeks and at the end of the experiment, Ag NPs synthesized using 0.3 mol dm⁻³ AgNO₃ were found to be more efficient in inhibiting *Microcystis* sp. with a percentage of 62.27. There was a significant difference in the mean chlorophyll content of controls and the three treatments ($p < 0.05$). Morphological variations of *Microcystis* colonies depend on Ag NP concentration while showing the most significant variations in treatments with 0.3 mol dm⁻³ Ag NPs. Disk diffusion test indicates the highest zone of inhibition (approximately 18 mm) with respect to 0.3 mol dm⁻³ Ag NPs, affirming the anti-algal activity of green synthesized Ag NPs. Study conclude that the anti-algal activity remarkably increased with the increasing concentration of AgNO₃ used to synthesize Ag NPs.

Keywords: *Microcystis* sp., Silver nanoparticles, *Neolitsea cassia*, Anti-algal activity

Coconut Shell Charcoal and Eggshell Charcoal Mixture is Effective for Water De-Fluoridation

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Consumption of potable water with high concentrations of fluoride causes serious health issues. Fluoride ions are released into groundwater primarily as a result of rock erosion. Among several methods for removal of fluoride from water, adsorption method receives much attention because of its simplicity. In this context, amongst various materials, calcium containing minerals and animal bones have been used. The present study is to remove fluoride from water using a blend of coconut shell charcoal and eggshell powder in a packed continuous flowing column system and in a simple batch system. The fluoride removal efficiency (FRE) was determined as a percentage of the ratio of removed concentration to the initial fluoride concentration. The effect of several factors such as the ratio of the mass of coconut shell charcoal to the eggshell in the mixture, the flow rate of fluid in the column system and contact time of water with adsorbents in batch system were studied. Adsorbing materials in powder-form were prepared by breaking down pre-cleaned shells and heating in the oven at 105⁰ C for 3 hours and sieving through a 2 mm sieve separately. The mixture of coconut shell charcoal and eggshell was prepared with different mass ratios. Fluoride concentration in water was determined by colorimetric method by measuring the colour intensity reduction of SPANDS reagent by Fluoride ions. Calibration curve was prepared for known concentrations. The results demonstrate that the continuous system is excellent for removing low initial fluoride concentrations from water, whereas the batch method is best for removing high initial fluoride concentrations. Different ratios of eggshell and coconut shell powder were prepared separately. The eggshell Charcoal system's 3:1 ratio shows that approximately 97% and 65.5% of the initial concentration (0.5 ppm) of Fluoride ions could be removed in the continuous flow and batch systems, respectively, in 8 hours. However, when the initial concentration of Fluoride ions was increased to 4.5 ppm, only 51% of the initial concentration was taken from the water, indicating that defloration is limited by the eggshell surface. Results demonstrate that only the high efficiency of the eggshell powder technique removes a high concentration of fluoride from water. Furthermore, Batch system and column system effectively remove fluoride from potable water.

Keywords: De-fluoridation, Continuous system, Batch system, Fluoride, Charcoal, Eggshell

Impact of the River Plume on Physicochemical Parameters of Near-Shore Water of Nilwala River Mouth, Sri Lanka

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Organic matter, nutrients and suspended particles from terrestrial sources are transported to near-shore waters through rivers, and at the river mouth water meets the Ocean forming a plume. River plumes play a major role in nutrient dynamics, maintaining the biodiversity and, productivity of near-shore waters strongly influence the distribution of phytoplankton, zooplankton, pelagic & benthic fishes. The objective of this study was to determine the influence of river plume on the near-shore water quality of Nilwala river mouth. Sampling was carried out on monthly basis at eleven random sampling points within 1.5 km² of study area covering four monsoon periods (from May 2016 to April 2017). Temperature, pH, salinity, conductivity, and dissolved oxygen (DO) were measured onsite whereas total suspended solids (TSS), nitrate and phosphate concentrations were measured in the laboratory. River discharge varied from 6.82 to 25.18 m³s⁻¹ and direction and distribution of the river plume were interpreted using the variation of surface water salinity. Salinity values of the study site varied between 4.30 and 33.05 ppt during the study period. The mean temperature and mean DO were within the range of 26.48-29.30°C and 5.86-6.18 ppm respectively whereas mean pH values were varied from 7.8 to 8.78. Nitrate and phosphate concentrations were fluctuated between 0.28 to 2.23 mg/L and 0.00 to 0.04 mg/L respectively. Temperature ($r = 0.517$; $p < 0.01$) and TSS ($r = 0.710$; $p < 0.01$) showed significant positive correlation whereas phosphate ($r = -0.318$; $p < 0.05$) showed a negative correlation with river discharge within the study site. However, no significant relationship was recorded between DO and the river discharge. The TSS value positively correlated to the sediment load carried by river water. Further, negative correlation between salinity and phosphate concentration suggests that most of the phosphorus in the river waters are adsorbed by suspended solids and mixing process of both sea water and freshwater masses at the river mouth caused abrupt changes to the chemical composition of near shore waters.

Keywords: Nutrients, Nilwala River, Physicochemical parameters, River Plume

Determination of Optimum Level of Commercial Probiotic, BioGaia™ on Growth Performance, Feed Utilization Efficiencies and Stress Resistance of Freshwater Angelfish, *Pterophyllum scalare*

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The present study was conducted to evaluate the effects of commercial probiotic, BioGaia™ on growth performance, feed utilization efficiencies and stress resistance of freshwater angel fish, *Pterophyllum scalare*. Relevant amount of probiotic for each diet was mixed with the ingredients before the pelleting process. Three levels of commercial probiotic as 0.1% (1ED), 0.3% (3ED), 0.5% (5ED) were incorporated into the basal diet and their dietary effects were compared with the diet containing zero probiotic (CD-Control). Thirty days old *P. scalare* purchased from a private ornamental fish farm at Kudawella were acclimatized to the experimental condition for one week. Twelve glass tanks (60x30x30 cm) were used as experimental units and this experiment was conducted as a static research system at a freshwater aquarium. Tanks were well cleaned and filled with dechlorinated tap-water up to 20 cm height and continuously aerated. Each treatment had three replicates were randomly assigned to the tanks and initial stocking density was 10 fish per tank (initial mean body weight of 0.29 ± 0.00 g, initial mean body length of 2.50 ± 0.00 cm and initial mean body height of 1.80 ± 0.00 cm). Fish in all treatments were fed to near satiety twice a day and experiment was lasted for 35 days. Proximate composition of feed ingredients and prepared diets including moisture content, ash content and lipid content were analyzed separately. Final mean total length, final mean body weight, Percentage Specific Growth Rate (%SGR), Percentage Average Daily Gain (%ADG) and Feed Conversion Ratio (FCR) of angel fish (*Pterophyllum scalare*) fed experimental diets were analyzed to assess the growth performance and feed utilization efficiencies of fish. Results showed that, significantly higher final mean body weight of 0.99 ± 0.05 g and final mean body length of 3.77 ± 0.07 cm were observed in fish fed the diet containing 0.5% probiotic (5ED). Similarly, growth performance of angel fish in terms of %SGR of 3.46 ± 0.15 and %ADG of 6.77 ± 0.51 were significantly higher in 5ED. Significantly better feed utilization efficiency with lowest FCR value (2.65 ± 0.24) was also observed in fish fed the diet containing 0.5% of probiotic (5ED). Significantly lowest %SGR and %ADG and significantly highest FCR value were observed from the fish in the control treatment. The survival rate of fish in all the treatments were high (90-100%) and it was not affected by the probiotic. At the end of the experiment, salinity stress test was conducted on eighteen fish from each treatment in duplicate by exposing them to a



20ppt salinity solution for two hours and Cumulative Mortality Index (CMI) was calculated for each treatment. Significantly lowest Cumulative Mortality Index (CMI) was observed in 5ED treatment. Therefore, the results revealed that the diet with 0.5% of BioGaia™ probiotic can be used as a feed supplement to enhance the growth performance and feed utilization efficiency of freshwater angel fish.

Keywords: Probiotic, growth performance, feed utilization, stress-resistant

Applicability of Graphite–Copper Electrode System for Electrolytical Removal of Rhodamine-B dye in Textile Effluents

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Industrialization around the world increases wastewater discharge, causing environmental issues with great concern. Wastewater treatment and management is the major problem in the textile industry. Although there are many traditional methods to remove color from wastewater, the electrochemical process could be a promising alternative for efficient and eco-friendly treatment. In this study, Rhodamine B (Rh-B) dye was used as a model textile dye to determine the optimum conditions in the electrolytical removal with electrochemical cell. In the presence of the chlorinated electrolyte, the efficacy of the dye degradation is described by the electro-oxidation that leads to the generation of strong oxidizing chlorine active species besides the graphite anode. On the copper cathode, reduction of water activates as the cathodic reaction. The effect of concentration of electrolyte (NaCl), pH, current density, temperature, Rh-B dye concentration and contact time on the degradation of dye were examined by assessing the color removal efficiency, Chemical Oxygen Demand (COD) under the optimized conditions. It was observed that highest color removal efficiencies were reached at 30 °C, pH 7.0 at the 0.075 M NaCl concentration, 80 mA cm⁻² current density. And these optimized conditions were suitable for below 100 ppm of Rh-B dye concentration. The 91.62±0.14% color removal efficiency after 60 minutes of electrolysis for 50 ppm dye solution and 77.07±0.15% of color removal efficiency after 90 minutes for 100 ppm dye were achieved at the optimal conditions. After 180 minutes of experiment, 52.70±4.42% and 50.65±2.13% of COD removal efficiencies were achieved for 50 ppm and 100 ppm of Rh-B dye respectively. Under the optimized conditions, the percentage weight loss values of graphite (0.97±0.01%) and copper (0.94±0.73%) electrodes were obtained for 50 ppm dye treatment. The electro-oxidation was found to be highly effective in the treatment of textile effluents containing Rh-B dye, without forming any sludge.

Keywords: Electro-oxidation, Colour removal, Wastewater treatment, Electrochemical process

Effect of Imported and Locally Produced Fishmeal Incorporated Feed on Growth Performance, Feed Utilization and Survival of Guppy (*Poecilia reticulata* Peters, 1859)

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The present study was conducted to evaluate the effect of imported and locally produced fishmeal incorporated feeds on the growth performance, feed utilization and survival rate of guppy, *Poecilia reticulata*. A commercial feed (CD- 40% Protein (P) and 3% Lipid (L)) was used as the Control. F1 diet (42.9% P, 10.7% L) contained imported fish meal (38.0%) while F2 diet (34.9% P; 7.5% L) contained local fish meal (32.0%). Male (0.28±0.02 g; 2.55±0.16 cm) and female (0.27±0.02 g; 2.71±0.11 cm) guppy fingerlings were separately introduced to 18 glass tanks (27 L) and fed respective diet for 56 days. Fish fed with CD showed significantly higher growth performance in terms of Total Length, Specific Growth Rate (SGR) in both male and female guppy compared to fish fed with F1 and F2. Also, fish fed with F1 and F2 diets did not show a significant difference in growth performance. Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER) were significantly higher in males fed with CD compared to males in other two treatments. However, FCR or PER in females was not significantly different in three treatments. All fish showed more than 80% survival. The cost (LKR/kg) of CD, F1 and F2 were 450.00, 310.00 and 180.00 LKR respectively. The cost per unit production (LKR/kg) of F2 diet for both males and females were significantly lower than F1 diet and the cost per unit production of CD was significantly higher than formulated diets. Therefore, F2 diet which contained locally produced fishmeal is a cost-effective diet among the tested diets for guppy fingerlings.

Keywords: Guppy, Growth performance, Specific Growth Rate, Cost per unit production, Cost-effective feed



Prediction of the yield of Skipjack Tuna (*Katsuwonus pelamis*) Using Remote Sensing Techniques

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Analysis of relationship amongst sea surface temperature (SST), chlorophyll-a (Chl-a) and fish catch help understand the productivity of the ocean. Satellite images provide reliable important information on oceanographic conditions and, at the same time support marine environmental monitoring and assessment. SST and Chl-a are the key indicators in determining the presence of fishes, especially the pelagic fishes. To describe the short-term relationship between oceanographic conditions and distribution of skipjack tuna, and visualize their distribution and catch, remotely sensed satellite based-oceanographic sea surface temperature and chl-a together with fisheries data were used to check the distribution of *Katsuwonus pelamis*. In this context, monthly images of Moderate Resolution Imaging Spectroradiometer satellite (MODIS-Aqua) derived Chl-a, and SST from January 2015 to December 2018 were used. Also, monthly fish catch data in 2018 were used to perform statistical modelling for predicting the catchable yield of *K. pelamis* in 2019 around in the Indian ocean, south to Sri Lanka. Data were processed and analyzed using ArcGIS 10.7.1, Minitab 19 and SPSS 25. Results indicated that there was a negative correlation between SST and Chl-a ($r = -0.724$, $p = 0.000$). A Positive correlation was found between Chl-a, and catch of *K. pelamis* ($r = 0.431$, $p = 0.035$) and a negative correlation was found between SST and catch of *K. pelamis* ($r = -0.547$, $p = 0.006$). Prediction of 2019 yield of *K. pelamis* indicated the 27.4% accuracy ($r^2 = -0.274$). The present study indicates that integration of remote sensing technology, statistical modelling, and geographic information systems (GIS) could be used to determine the relationship between sea surface temperature (SST) and chlorophyll-a (Chl-a), as well as to predict the yield of Skipjack Tuna and their distribution in the Indian ocean south of Sri Lanka. In addition, use of GIS, satellite remote sensing and statistical analysis are the effective instruments for fishing activities, and useful in fisheries management. Thus, the present findings contribute to the decision-making for management of fisheries and reduce costs incurred for search hunting in offshore fisheries of Sri Lanka.

Keywords: Chlorophyll-a, Sea Surface Temperature, GIS, Indian Ocean, Satellite data

Morphological Variation and Species Identification of Leaping Blenny Fish (Family Blenniidae) in Western Coast, Sri Lanka

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Leaping blenny fish which belongs to the family Blenniidae exhibits amphibious behaviors and are common inhabitants in the rocky intertidal zones throughout the world. But there is no adequate data available to show their presence in many parts of the tropics including the Northern Bay of Bengal region. In this study, morphological and molecular methods were used to identify leaping blenny fish species on the Western coast of Sri Lanka. Samples were collected from Negombo, Panadura, and Beruwala beaches to represent the Western coastal belt of Sri Lanka. Thirty blennies were collected from each site. All collected fish were analyzed morphologically by considering twelve morphometric characters and five meristic characters. Condition factor of fish at each site was also calculated. Five fish randomly selected from each site were subjected to do molecular analysis. When considering morphometric characters, there was a significant difference between the fish collected from the three sites in terms of body weight, standard length, total length, head length, maximum body depth, head depth, mouth gape, orbital length, predorsal length, length of the dorsal base, length of anal fin base and length of pectoral fin base. When comparing the mean values of each morphometric measurement for three sites, fish collected from the Panadura site showed a higher mean value than that of Negombo and Beruwala. Condition factor of fish at Negombo (0.97 ± 0.20) and Panadura (1.14 ± 0.35) showed a well-conditioned habitat, while the fish in Beruwala ($K = 0.59 \pm 0.08$) were quite lean. Overall, four different species on the Western coast of Sri Lanka were identified using molecular methods. *Entomacrodus striatus* and *Alticus monochrus* were recorded from the Beruwala site and *Istiblennius dussumieri* was recorded from Negombo. From the Panadura site, *Entomacrodus epalzeocheilos* and *Alticus monochrus* were identified. The phylogenetic tree shows that the two species belonging to the genus *Entomacrodus* are very similar to each other even though they have been found in different locations. This study shows that though the species are living in different locations they have not genetically diverged.

Keywords - Morphology, Morphometric, Meristic, Molecular, Diversity

Effects of Locally Available Carbon Sources on the Growth and Survival of Guppy (*Poecilia reticulata*) Fingerlings in a Biofloc System

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BioFloc Technology (BFT) is based on *in-situ* microorganisms that recycle nutrition by assimilating the toxic nitrogenous waste to improve the water quality in aquaculture facility. This study was conducted to identify the effects of locally available Carbon (C) sources on water quality management and growth of Guppy (*Poecilia reticulata*) fingerlings in a BFT system. Six BFT treatments with three C sources were checked as Rice Bran (RB), Molasses (MOL), Wheat Flour (WF), 1:1 mix of RB: MOL (RBMOL), 1:1 mix of WF: MOL (WFMOL), and 1:1 mix of RB: WF (RBWF). Control (CON) was maintained without any carbon source. Male Guppy fish (0.25 ± 0.02 g and 2.23 ± 0.09 cm) were cultured in fiber-reinforced plastic tanks (30 fish/80 L tank) for 42-days and fed with a commercial diet (3 % BW/day) once a day. C/N ratio was maintained at 15:1 by adding relevant carbon sources. Growth performance and feed utilization of fish and water quality (Temperature, DO, pH, Ammonia, Nitrite and Nitrate) were evaluated. Feed Conversion Ratio in all the BFT treatments (0.99 ± 0.08 to 1.31 ± 0.18) were significantly lower than that of CON (2.27 ± 0.41). The final weight of fish in all BFT treatments were significantly higher than CON (0.46 ± 0.09 g) except for MOL (0.56 ± 0.10 g). RBWF (0.74 ± 0.14) and RB (0.71 ± 0.13) treatments showed significantly higher weights than the MOL. The final length of fish in RB (3.07 ± 0.22 cm), RBWF (3.02 ± 0.19 cm) and WF (2.97 ± 0.27 cm) were significantly higher than the CON (2.75 ± 0.24 cm) and MOL (2.76 ± 0.19 cm). Percentage Average Daily Gain and %Specific Growth Rates of RBWF (4.66 ± 0.23 and 2.58 ± 0.08) and RB (4.60 ± 0.49 and 2.56 ± 0.16) treatments were significantly higher than CON (1.64 ± 0.43 and 1.24 ± 0.25). Survival rates were between 42% (RB) and 69% (RBWF). Temperature (27.87 °C), DO (7.72 mg/L), and pH (7.81) were within the favorable range. Total Ammonia Nitrogen (TAN) levels of all the treatments were below 1.09 mg/L without any significant differences with CON. Nitrite levels of BFT treatments were lower than 0.53 mg/L. The use of BFT systems with a 1:1 mix of Rice Bran: Wheat Flour (RBWF) as the carbon source has increased the growth performance, survival, feed utilization, and floc quality in terms of inhabited microorganisms of Guppy reared in biofloc system. Therefore, it can be concluded that 1:1 RBWF mixture is the best carbon mixture among the tested carbon sources for maintaining BFT systems for Guppy culture tanks.

Keywords Biofloc technology, Guppy, *Poecilia reticulata*, carbon sources



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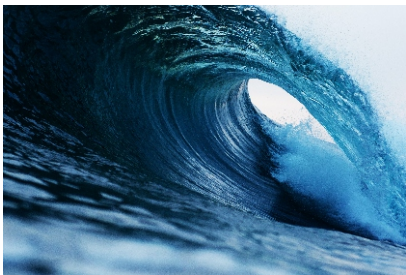
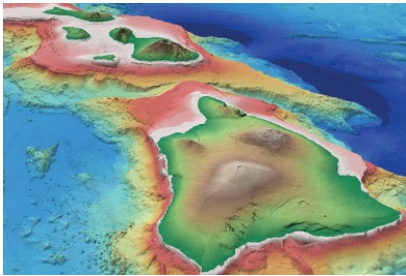
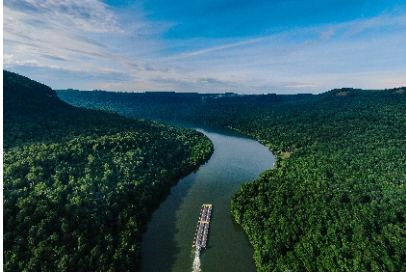
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