

ICCES 2023

THIRD INTERNATIONAL CONFERENCE OF THE CENTRE FOR ENVIRONMENTAL SUSTAINABILITY



August 25, 2023



**The Quest for Environmental Management
for Sustainability under Changing Climate**



**Centre for Environmental Sustainability
UNIVERSITY OF PERADENIYA
SRI LANKA**



PROCEEDINGS
of the
THIRD INTERNATIONAL CONFERENCE OF THE CENTRE
FOR ENVIRONMENTAL SUSTAINABILITY (ICCES) 2023

*The Quest for Environmental Management for
Sustainability under Changing Climate*

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UNIVERSITY OF PERADENIYA, SRI LANKA
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Message from the Vice Chancellor



I am pleased to submit this message for the e-proceedings of the third International Conference of the Centre for Environmental Sustainability (ICCES 2023), hosted by the Centre for Environmental Sustainability at the University of Peradeniya.

For the past six years, the ICCES conference has served as an excellent platform for scientific deliberations on environmental sustainability. The current conference's theme, "The Quest for Environmental Management for Sustainability Under a Changing Climate," emphasizes the need for sustainable strategies and approaches to manage and protect the environment. It is of paramount importance to recognize the interplay between human activities, infrastructure development, economic progress, the preservation of nature, and the health of living beings while minimizing and adapting to climate change. Innovative solutions in all these areas are required to ensure the well-being of current and future generations while safeguarding ecosystems and resources.

My sincere appreciation goes to the organizing committee led by Prof. Tilak Hewawasam, Director, Centre for Environmental Sustainability, and all partners for their dedication and expertise in ensuring the success of ICCES 2023.

I anticipate some significant conclusions and recommendations arising from ICCES 2023.

I wish ICCES 2023 the very best.

Prof. M.D. Lamawansa
Vice Chancellor of the University of Peradeniya, Sri Lanka

Message from the Chief Guest



I am pleased and privileged to forward this message of congratulations and best wishes on the occasion of the third international conference organized by the Center for Environmental Sustainability (ICCES 2023) of the University of Peradeniya. The purpose of this conference is to bring together experts, researchers, and leaders to communicate and discuss the results of fundamental and applied research in environmental science, which will ultimately benefit policy makers for successful implementation.

The environment is crucial to both healthy living and the continuation of life on planet earth. Earth is home to various species of life and we all depend on the environment for food, air, water and other requirements. But, if we exhaust these resources too quickly, future generations will not have access to them. In order to truly understand what environmental sustainability means, we must learn how to use resources in a sustainable way. It involves resource management to ensure that we have enough for tomorrow and what we need today. Therefore, it is crucial for each individual to preserve and safeguard our ecosystem and make sustainable use of resources. To improve the management of the environment, environmental science research and knowledge dissemination through scientific forums should be encouraged. Therefore, it is commendable that the University of Peradeniya's Center for Environmental Sustainability organizes this conference every three years while providing a forum for researchers to present their cutting-edge discoveries in the field of environmental science.

Further, I would like to express my warm and sincere gratitude to the organizing committee for their committed effort to make this event a success.

Senior Professor Chandana P. Udawatte
Vice Chairman of the University Grants Commission, Sri Lanka
Project Director/AHEAD Project, Ministry of Higher Education

Message from the Director of the Center for Environmental Sustainability and Chair of ICCES 2023



It is my great pleasure to deliver this message on the occasion of the 3rd International Conference of the Center for Environmental Sustainability (ICCES 2023) of the University of Peradeniya. The Center for Environmental Sustainability (CES) conducts diverse activities in its focus areas of training, consultancy, and, research in environmental management, to ensure the development of an environmentally informed and responsible society. The international conference, an important event in the CES activity calendar and the strategic plan, is organized once in every three years. The aim of the conference is to provide an excellent platform for researchers and policy makers to discuss and to propose actions to combat and mitigate global environmental issues.

Today we live in world where we encounter the negative effects of severe environmental issues and challenges such as resource depletion, pollution, waste disposal, climate change, global warming, the greenhouse effect, etc. It is imperative that solutions for these challenges should be found and implemented by innovative research that should be disseminated and deliberated for effective implementation on time. Therefore, this year's conference is organized under the timely theme of "The Quest for Environmental Management for Sustainability Under a Changing Climate". Fifty papers will be presented at the conference under different thematic areas such as Biodiversity and Conservation, Wetland Ecosystems, Water Quality Management, Pollution Detection and Control, Green Industry towards Environmental Sustainability and Landuse Planning and Environmental Monitoring.

The ICCES 2023 would not have been possible without the commendable contribution of staff of the CES and the University and members of the Organizing Committees. I would

like to take this opportunity to extend my sincere gratitude to the Postgraduate Institute of Science (PGIS), University of Peradeniya, for collaborating with us for this event with the CES and the AHEAD project of the Ministry of Education for providing financial assistance.

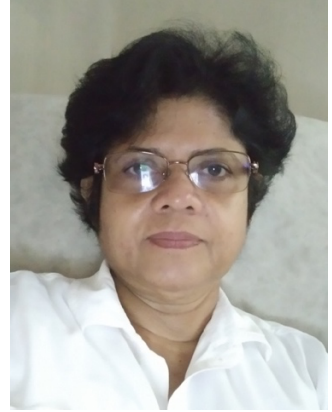
I am confident that this conference will be a great opportunity for researchers in the field of Environmental Science to share their work with the wider scientific community to devise solutions to the key contemporary environmental issues at the national and global level.

Professor Tilak Hewawasam

Director of the Center for Environmental Sustainability (CES)

Chair of the Organizing Committee/ ICCES 2023

Message from the Editorial Chair of ICCES 2023



Environmental degradation or the deterioration of the environment is a serious threat to humans and other biota, as well as to entire biosystems. As responsible and conscientious citizens, it falls upon us to identify environmental issues and develop sustainable solutions for a healthy and sustainable planet for all living beings. The Centre for Environmental Sustainability (CES) of the University of Peradeniya identifies this global necessity and plays a national role in mitigating adverse environmental impacts, mainly through research, consultancies, environmental education, and awareness programs. An instrumental stride taken by CES is the organization of the biannual International Conference of the Centre for Environmental Sustainability (ICCES) that showcases the unwavering dedication and commitment to finding sustainable solutions for environmental problems while encouraging to tackle environmental problems and disseminating research findings to the society.

This is the third International Conference of the Centre for Environmental Sustainability (ICCES 2023) offering researchers in the field of Environmental Sciences to present their work and interact with local and foreign researchers, and share knowledge and experience at an internationally recognized academic forum. We received 75 abstracts from local and foreign researchers, and after a double-blind review process, 51 abstracts were selected for presentation at the ICCES 2023 on August 25, 2023. These abstracts covered a wide spectrum of disciplines in environmental science, including Agronomic, Conservation, Education, Engineering, Geographical, Health, Land Use Planning, Pollution control, Social and Waste Management. The review process involved more than 65 reviewers from several Universities across Sri Lanka, including the University of Peradeniya. I gratefully acknowledge all the reviewers for the excellent service rendered within the stipulated time assigned for the task.

Managing 75 abstracts and compiling them into an *e-book* format within a span of three months presented a significant challenge. The successful completion of this task would not have been possible without the invaluable support extended by the eight Editorial Board members. Their participation in a series of zoom meetings and lengthy in-person meetings, as well as their knowledge, expertise, professionalism, and commitment were the cornerstone of this achievement. These etched yet another pleasant memory to my academic journey, and I sincerely thank all the members of the Editorial Board. I also thank Prof. Sudarshana Bandara of the Department of Fine Arts, University of Peradeniya, for designing the cover pages of the *e-book* of abstracts for ICCES 2023.

Moreover, I gratefully appreciate the advice and support given by Prof. Tilak Hewawasam, the Director of CES and the Conference Chair, from the inception of this endeavor. His leadership significantly facilitated my editorial responsibilities. Also, I acknowledge all the members of the Organizing committee of CES including the Conference Coordinator, Dr G.A.N. Suranjith, for their kind cooperation throughout. Last, but not least, I must also acknowledge the Secretarial assistance provided by Ms. I.K. Wimalaweera, the Administrative Officer of CES and Mr. R.M. Asantha Madhuranga, the Management Assistant of CES for the kind cooperation extended throughout.

I firmly believe that this *e-book* of abstracts will serve a wider academic community, including researchers in their pursuit for updating or applying knowledge, as well as in designing new research. All these efforts will converge in achieving a sustainable living environment and shaping a better future.

Professor Anoma Perera
Editorial Chair/ICCES 2023
University of Peradeniya, Sri Lanka

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Keynote Address

Creating the Pathways for the Low Carbon, Circular Economy by Enriching Organizational Level Environmental Sustainability Roadmap

Samantha Kumarasena, BSc(Eng), MSc, MBA

Chief Executive Officer, National Cleaner Production Centre, Sri Lanka

‘Sustainability’ is the ability to continue a defined behavior indefinitely. If the behavior or practice cannot be continued indefinitely then they are not sustainable. ‘Environmental sustainability’ revolves with three resource flows; water, energy and materials. In order for renewable resources to be sustainable, the rate of harvest should not exceed the rate of regeneration. Regarding the pollution, environmental sustainability is there if the rates of waste generation does not exceed the assimilative capacity of the receiving environment. Likewise, the depletion of the non-renewable resources should require comparable development of renewable substitutes. The solar radiation received to the planet is more than enough to fulfil its energy requirements if feasible technologies are available for the conversion. Photovoltaic (PV) panels is a technical and financially feasible technology to produce electricity directly from sunlight. Similarly, ample of sea water is available to treat and supply if affordable refining technologies are available. Reverse Osmosis (RO) is a proven technology to treat sea water or even sewage to the drinking quality.

In this context, materials going to be the most scare resource in the future as the global recycling rates is still only about 9%. Signifying the anthropological pressure on natural resource base, the Ecological footprint has exceeded the biocapacity since 1987. The Ecological debt day (Earth overshooting day) for the same year was 19th December. Gradually the ecological debt day has moved forward and the same in 2023 was fallen on 2nd August. Meanwhile the material prices are getting escalated day by day. The aim of adopting Circular Economy declaration by European Union (EU) was to increase the levels of materials circulation from the current levels. Hence the EU countries target to move to the so-called sustainability quadrant through reducing the ecological footprint while maintaining the human development index at a higher level.

Sri Lanka being a developing country with low ecological footprint, shall not follow the unsustainable path of development, but must move directly to the sustainability quadrant by picking up the right sustainable development strategies. Decoupling the resource use from economic development is necessary for the businesses in order to curtail the use of natural capital in orders of quantities indicated by the factor theory. Accordingly, the curtailing of resources in making the products and services are expected to be cut down by half (1/2) to one twentieth (1/20).

A green factory with resource efficient cleaner production practices can usually halve the usage of resources. The green apparel factories set up in Sri Lanka and other countries in last two decades has achieved this in water and energy flows. Those factories were set up in responding to the call by the buyers in the global supply chains such as the ‘Plan A’ presented by Mark & Spencer in 2007. NCPC Sri Lanka evaluated one of those factories

under the National Cleaner Production Awards in 2008 and found the company has achieved 53% savings in energy consumption and 47% savings in water consumption after converting into a Green factory.

Nevertheless, eco-innovative, novel business models are required to achieve the resource productivity and conservation in multiple orders such as 10 to 20. Those novel business models shall be supplement with tools such as Eco-design and sustainable product innovation. 'Eco-innovation' is a term used to indicate novel business models developed predominantly by European companies from 2000 to 2010 period. Those business models have sustainability in core business strategy as well as in all business functions and operations. United Nations Environmental Program (UNEP) developed a methodology to convert the existing businesses into Eco-innovative business models and documented the same into Eco-innovation manual and the toolkit in 2012. Hence Eco-innovation is a tool today applicable in business organizations in order to convert those into more sustainable business models. Eco-innovation has been implemented in Sri Lanka in industrial sectors such as Agri-food, Dairy and chemicals etc. according to the UNEP methodology.

Systematic integration of environmental considerations into design and development process of products with the purpose of reducing the environmental impacts throughout the life cycle is known as Eco-design. The established methodologies are Design for Environment (DfE) and Design for Sustainability (DfS). The companies in Sri Lanka implement the eco-design process according to those methodologies and ISO 14006 standard on 'Environmental management systems – Guidelines for incorporating eco-design'. Life cycle assessment (LCA) becomes a fundamental tool to facilitate the application of above tools. The capacity of conducting the life cycle assessments has enhanced in Sri Lanka in last decade and the demand for commercial level LCA assessments also in an upward trend. The results of a multi-impact category LCA can be used as the basis for implementing the tools such as Eco-design and Eco-innovation. Yet, a semi-quantitative level life cycle mapping itself may be sufficient to identify the environmental impacts in applying the tools.

Buying back the products after its life time and recovery of resources from those products can be a key strategy in an eco-innovative business developed for the supplier to the local market. The market-based instruments such as Extended Producer Responsibility (EPR) which are currently given prominence by authorities can be easily linked to those activities at organizational level. As the conducive environment is getting created for EPR, the revolutionary changes can be expected in rates of resource circulation leading to the circularity. Arranging such proactive environmental management tools with a strategic choice into an environmental sustainability roadmap at organizational level creates the pathway for a low emission, circular economy. Those proactive environmental management tools have been recognized in national environmental policies and action plans as the choices for the pathways towards sustainable development. The national policy on Sustainable Consumption and Production and the national environmental action plan has encompassed Cleaner Production, Eco-design, Eco-innovation, EPR and Eco-industrial parks as suitable tools for achieving the Sustainable Development Goals at national level.

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Session A

Biodiversity and Conservation I

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A – 01

A Preliminary Investigation of Non-Breeding Season Behavioral Patterns and Taxonomic Status of Indian Peafowls (*Pavo Cristatus*) in Wellamadama Premises of the University of Ruhuna, Sri Lanka

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Indian peafowl (*Pavo cristatus*) is one of the top agro-pests in Sri Lanka and is increasingly becoming an invasive species in many ecosystems, including the central hills, posing a threat to native fauna. To date, there is limited ecological and taxonomic information on Indian peafowls in Sri Lanka. Thus, this study aimed to address this knowledge gap by investigating the abundance, activity patterns, and taxonomic status of Indian peafowls in the Wellamadama premises of the University of Ruhuna (UOR), Matara, Sri Lanka. The abundance of Indian peafowls in UOR was determined monthly for three months from 7:30 to 8:30 a.m. Direct observations of behavioural patterns (*i.e.*, feeding, preening, resting, walking, *etc.*) for 20 phenotypically selected individuals (10 males and 10 females). The observations were made from 6:00 a.m. to 6:00 p.m. under natural conditions for 20 days during their nonbreeding season during the last two weeks in July and the first two weeks in August 2022. The average duration of each behaviour was calculated to determine the most common activities of peafowls. Individual behaviours were plotted against time to identify the peak hours for each behaviour. The taxonomic status of the peafowls was determined by analyzing the *mitochondrial Cytochrome b* gene region (210 bp) of freshly fallen feathers. The average number of Indian peafowls recorded during the study period was 28 ± 2 individuals (12 males and 16 females). During the daytime, both males and females spent most of their time feeding. In addition, several other dominant behaviours were observed during the daytime, including preening, resting, walking, and calling. However, there was a significant difference ($p < 0.05$) in the times utilized by males and females for dominant behaviours including feeding. The diet of Indian peafowls consisted of both plant and animal materials including rice, vegetables, fruits, insects, reptiles, *etc.* Phylogeographically Indian peafowls in Sri Lanka were separated as a distinct group from the common south Indian peafowls with an average P-distance of 2.8%, indicating that Sri Lankan peafowls tend to be a subspecies of the common Indian peafowl rather than a haplotype. The findings will serve as a foundation for further studies on Indian peafowls in Sri Lanka and aid in understanding their biology and ecology.

Keywords: *Cytochrome b*, diurnal activities, Indian peafowls, phylogeography, taxonomic status

A – 02

Butterfly Fauna in the Wellamadama Premises of the University of Ruhuna, Matara, Sri Lanka

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Butterflies are one of the most noticeable species of Earth's biodiversity. They are recognized as useful bioindicators due to being exceptionally sensitive to any changes in their environment including temperature, humidity, light, and rainfall. They have diverse requirements for different habitat types for mating, breeding, and nectaring and are, thus, in sync with the diversity and quality of their habitats. The present study was carried out from November 2022 to April 2023 to examine the diversity and distribution of butterflies across three different habitats, namely, grasslands, aquatic ecosystems, and building areas of the Wellamadama premises of the University of Ruhuna (UOR). Data collection was done twice-a-month (first and third week) between 09:00 a.m. and 03:00 p.m. along two line transects each (2 × 100 m) in the three habitat types. Temperature and humidity were recorded at each sampling event using HOBO® data loggers. All encountered butterfly species and their abundance were recorded. Species were identified using standard photographic field guides. Shannon's diversity index (H') and Magalef's Index (D_{Mg}) were calculated to compare the similarities of habitats. Minitab (v.17) software was used for statistical analysis. A total of 1030 butterflies belonging to 36 species and five families (*i.e.*, Hesperidae, Pieridae, Papilionidae, Nymphalidae, and Lycaenidae) were recorded. The highest species richness was recorded in the building areas (64.70 %) while it was lowest in aquatic ecosystems (41.17 %). The diversity indices further confirmed that building areas have a higher butterfly diversity ($H'=0.9968$, $D_{Mg}=0.5856$) than in aquatic ($H'=0.6422$, $D_{Mg}=0.4971$) and grassland habitats ($H'=0.4191$, $D_{Mg}=0.3977$). *Ypthima ceylonica* of Family Nymphalidae (90%) and *Catopsilia pyranthae* of Family Pieridae (1.26 %) were the most abundant and the rarest encountered species, respectively, found in the UOR. The findings of this study highlight UOR as a butterfly-rich locality that provides diverse habitats for these environmentally sensitive winged creatures.

Keywords: biodiversity monitoring, butterfly assemblages, butterfly diversity index

A – 03

**Distribution of the Critically Endangered Spotted-billed Duck
(*Anas poecilorhyncha*) in the Northern Province of Sri Lanka**

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The Spotted-billed Duck (*Anas poecilorhyncha*) is a critically endangered breeding resident bird of Sri Lanka, with a range restricted to the Northern Province. Hence the objective of this study was to determine the distribution of this species within the Northern Province. We assessed the distribution of this species using data from our long-term study on the waterbirds, carried out from 2014–2018 (inclusive). The study was conducted monthly during this period, with two sampling days per month. Point counts with unlimited distance or the variable circular plot method were used to assess the abundance of waterbirds, including the present species. A total of 772 points were sampled during the study period, and the Spotted-billed Duck was observed at 41 points. A total of 333 individuals were recorded during the study period, with approximately half (181) recorded from a single point at Saravanai in June 2018, forming a single flock. As the average number of individuals in a flock in other areas (per point) was about 4, we suspect that this large flock resulted from migratory individuals. Apart from Saravanai, other major areas included the Giant's Tank Sanctuary at Mannar (mean population size 10), as well as Araly Junction (3), Mankumban (3), Karainagar (3), Mandaitivu (2), Anthanathidal (6), and Allaipiddy (2) in the Jaffna peninsula. Minor areas included Kaludaipiddy in Pungudutivu (3) and Vallai (2) and Nagar Kovil (1) in the Jaffna peninsula. During the five-year study period, we did not observe major fluctuations in population size of this species. Currently, only the Giant's Tank and Nagar Kovil are designated as protected areas. Hence, we recommend declaring as many other areas as possible for the conservation of this critically endangered species.

Keywords: critically endangered breeding resident, distribution, Northern Province, Spotted-billed Ducks

Financial assistance from the University of Peradeniya (Grant Nos. RG/2014/41/S and URG/2016/57/S) is acknowledged.

A – 04

**Influence of Environmental Conditions on Odonates in the Sarasavi Oya,
Peradeniya, Sri Lanka: A Case Study**

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Dragonflies and damselflies (Odonates) are representative of freshwater environments, and their high diversity, straightforward identification process, and conspicuousness have rendered them highly valuable in biodiversity studies. The existence of species of Odonata in freshwater environments can indicate the condition of the water body and hence used as bioindicators. This study aimed to determine the Odonate diversity in relation to selected environmental conditions in the Sarasavi Oya, Peradeniya, Sri Lanka. Sampling was carried out twice a month from February to June 2022 for both adult and larval Odonates in three sites: a village area, a forested area, and an area near the university premises. Diversity, richness, and evenness of Odonates in the three sites were compared using Simpson's (1-D), Shannon-Wiener (H'), Margalef Species Richness (D_{Mg}), and Shannon Evenness (E) indices. Temperature, elevation, Dissolved Oxygen (DO), pH, electrical conductivity, Total Dissolved Solids (TDS), percent canopy cover, stream substrate, and anthropogenic activities were measured at each location. The study yielded 13 species of odonates belonging to ten families. The area close to the University was more diverse ($H'= 1.842$, $1-D=0.805$) with a higher Odonate species richness ($D_{Mg}=1.603$) than the forested area ($H'=1.554$, $1-D=0.825$, $D_{Mg}= 1.473$) and village area ($H'=1.788$, $1-D= 0.718$, $D_{Mg}= 1.199$). However, Odonate species were more evenly distributed in the village area ($E=0.919$) than in the forested area ($E=0.747$) and the area close to university premises ($E=0.799$). Canonical Correspondence Analysis (CCA) indicated that substrate characteristics were the most important environmental condition explaining the Odonate species distribution in the Sarasavi Oya. In addition, temperature, TDS and conductivity were identified as other important factors in determining the species distribution. Therefore, the composition of these invertebrates can indicate the type and quality of the aquatic habitat.

Keywords: diversity, environmental conditions, odonates, species richness

A – 05

Assessing Fish Species and Ecosystem Health in Negambo and Puttlum Lagoons, Sri Lanka

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The biodiversity in coastal lagoons is generally high as well as unique compared with other inland ecosystems. Among the Sri Lankan lagoons, the Negambo lagoon in the western and Puttlum lagoon in the north western coastlines are important for fisheries. However, the surrounding areas of these lagoons are densely populated and hence subjected to high anthropogenic pressures resulting in the degradation of lagoon ecosystem. The present study was undertaken in the Negombo and Puttalam lagoons for assessing lagoon fish species and basic physio-chemical parameters. Lagoon fish samples were obtained from fish landing sites. These samples were brought to the laboratory and stored at 4 °C for identification to the species level using available guides. GPS coordinates and basic physico-chemical parameters for lagoon water, including salinity, water temperature, pH and Dissolved Oxygen were recorded from 17 sites in Negambo and 13 sites in Puttalam. Thus far, 19 species of fish were identified from the Negombo lagoon and 35 species from the Puttalam lagoon. In Negombo, the mean pH was 6.35, while in Puttalam it was 7.81. Water temperature ranged from 27-31.2 °C in Negombo lagoon and 25-32.8 °C in Puttalam lagoon. Salinity showed a larger range in fluctuation in Puttalam from 11.55 ppt to 25.68 ppt while the salinity in Negambo varied between 11.93 ppt and 22.71 ppt. During field visits, it was observed that both lagoons, especially the Negombo lagoon, was highly polluted due to discharge of household and commercial waste, unauthorized developmental activities and destruction of mangroves. These may have an adverse effect on the fauna of the lagoons. In addition to the preliminary data gathered above, additional samples were also collected for ensuing environmental DNA (eDNA) studies. These included fin tissue from each species for DNA barcoding and filtered lagoon water samples for eDNA metabarcoding analysis. The fauna in these lagoons act as indicators of the health of the ecosystem and hence this study will help highlight the species composition that could be used in lagoon biodiversity conservation and fisheries management.

Keywords: eDNA, fish, lagoon, water samples, Negambo, Puttalam

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A – 06

Relationship between the Vegetation Structure and Butterfly Diversity in the Peradeniya Campus and adjacent Forested Areas

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Despite the significant habitat loss due to urbanization, numerous butterfly species have demonstrated an increase in population sizes. Therefore, it is important to analyze urban butterfly diversity while considering the preferred vegetation characteristics. Butterflies were sampled at seven point count stations each in the suburban campus and adjacent forest. Vegetation parameters, including diameter at breast height, tree height, and understory height, were measured using the point-centered quarter method. Tree density and understory density were calculated. The Shannon-Weiner diversity index (H'), Simpson's diversity index (1-D), Brillouin's diversity index (H), Smith and Wilson's evenness measure (E_{var}), and the Modified Nee index of evenness (E_Q) were used to compare the diversity of butterflies in the two habitats. Pearson's correlation was employed to identify relationships between vegetation parameters. Relationships between measured vegetation characteristics and butterfly species abundance were revealed using canonical correspondence analysis (CCA). Campus area exhibited higher diversity ($H'=4.685$, $1-D=0.946$, $H=4.567$) compared to the forest ($H'=3.923$, $1-D=0.908$, $H=3.595$). This may be due to the presence of a wider range of habitat types adjacent to one another, resulting in a mass effect that boosts species abundance at places with high connectivity. The distribution of species were more even in the forest ($E_{var}=0.250$ and $E_Q=0.116$) than in the campus ($E_{var}=0.414$ and $E_Q=0.145$). Tree height exhibited a significant positive correlation with tree density ($r=0.583$, $p=0.029$), while understory height showed a significant negative correlation ($r=-0.901$, $p\leq 0.01$) with the understory density. According to the CCA, preferences for vegetation parameters were species specific, and the first four axes explained 92.54% of the cumulative variation in abundance, suggesting that the measured variables are critical determinants of butterfly diversity.

Keywords: butterfly, diversity, urban, vegetation



Session B

Biodiversity and Conservation II

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B – 01

A New Locality of Guppy, *Poecilia reticulata* (Cyprinodontiformes: Poeciliidae) on the Border Zone of Knuckles Forest Reserve, Sri Lanka

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Poecilia reticulata Peters, 1859 is recognised as one of the potential invasive freshwater fish in Sri Lanka, which was first introduced to the island in 1928 as a mosquito controlling measure. This study describes a new locality of a well-established natural breeding population of *P. reticulata* from Heel Oya sub-river catchment area (tributary of the Mahaweli River) at Thangappuwa, a border zone of Knuckles Forest Reserve [KFR] on the southern flank of the Knuckles Mountain Range [KMR] at an elevation of 1160–1270 m above sea level. During a preliminary survey of KFR in November 2022, a population of guppies was recorded. The current study examined the status of this population from November 2022 to April 2023. The fish were sampled with hand nets and underwater videos, and the species were identified using field guides. Presence of juveniles confirmed that it was a natural breeding population distributed along several interconnected streams of Heel Oya (7° 21' 11.5632" N, 80° 49' 36.1266" E; 7° 21' 28.6230" N, 80° 49' 20.5176" E; 7° 21' 07.0698" N, 80° 48' 51.4008" E), in KMR. The presence of a breeding population of guppies at Thangappuwa close to KFR raises concern about the potential invasion and its ecological impacts. Therefore, further studies on this guppy population and its impact on native species such as *Garra ceylonensis*, *Schistura notostigma* and *Plesiopuntius bimaculatus* are required in order to implement conservation measures for the native ichthyofauna.

Keywords: biodiversity, conservation, distribution, fish, invasive, Knuckles Mountain Range

B – 02

Habitat Preferences and Foraging Behaviour of two Bulbul Species in two Landscapes in the Dry Zone of Sri-Lanka

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The Red-vented bulbul (*Pycnonotus cafer*) (RVBB) and White-browed bulbul (*Pycnonotus luteolus*) (WBBB) are two common bird species found in Sri Lanka. Despite their widespread distribution, there is limited knowledge regarding their habitat preferences, foraging behaviour, and ecology. Hence, this study aimed to understand habitat preferences, foraging behaviour, and ecological variations of RVBB and WBBB, in the dry zone of Sri Lanka. The research was conducted from October 2022 to February 2023 in the Mihintale Sanctuary and in the premises of the Faculty of Applied Sciences, Rajarata University of Sri Lanka. Data were collected using focal sampling, opportunistic observations and mist netting. Both species exhibited significant differences in habitat preference ($p < 0.05$). The WBBB showed a strong preference for water-hole-associated habitats (99.00%), while RVBB had no specific preference. The RVBB population significantly outnumbered the WBBB population in both the habitats ($p < 0.05$). Foraging behaviour was more noticeable in the morning than in the afternoon and gleaning was the major food-handling technique observed in both species (for RVBB, 70.00%; WBBB, 73.63%). RVBB spent most of its time on tree tops (70.78%) while WBBB seems to prefer mid branches of trees (76.08%). During feeding, RVBB foraged at an average height of 7 ± 0.21 m, while WBBB foraged at an average height of 5 ± 0.2 m above ground. Major food type of both species were fruits (for RVBB, 93.17%; WBBB: 98.18%) and twigs were the preferred foraging substratum in both species. The standardized habitat niche breadths (for RVBB, 0.9402 and for WBBB, 0.7857) indicated that both species were habitat generalists in the study areas. Although a strong habitat overlap was evident from the pairwise habitat niche overlap value (0.9800), the results indicate that both bulbul species exhibit distinct habitat preferences, foraging behaviours, and ecological characteristics within the region.

Keywords: foraging behaviour, habitat preferences, niche breadth, *Pycnonotus cafer*, *Pycnonotus luteolus*

B – 03

**Visiting Frequency, Colour Preference and Resource Collection by
Tetragonula praeterita and *T. iridipennis* (Hymenoptera: Apidae) Visiting
Portulaca grandiflora (Portulacaceae)**

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The study of floral colour preferences is important to attract bees to crop fields for pollination. The present study investigated the visiting frequency, colour preference, and resource collection by stingless bees visiting the moss rose, *Portulaca grandiflora*. Three separate flowerbeds were prepared for yellow, orange, pinkish-yellow, and pink flowers. Anther dehiscence and nectar availability were identified by observing the time of pollen release by anthers and nectar gathering by bees, respectively. The beginning of stigma receptivity was determined by checking the stickiness using a needle tip. Bee visiting frequency during 30 min intervals from 07:00-12:00 hours until the flower withers was determined for five randomly selected flowers from each colour flower-bed for five sunny days. Two stingless bee species, *Tetragonula praeterita* and *T. iridipennis* visited the flowers. Though the anther dehiscence and stigma receptivity for all colours were between 08:00 and 08:30, the nectar availability period varied. The highest visiting frequency of *T. iridipennis* in orange flowers was 4 bees/5 min/5 flowers between 08:00–08:30 and 09:30–10:00 h, while that of *T. praeterita* was 3 bees/5 min/5 flowers in yellow and orange flowers between 08:00 and 08:30 h. A one-sample t-test showed a significant difference between flower colour and bee visits for both *T. praeterita* ($p < 0.001$) and *T. iridipennis* ($p = 0.014$). A paired t-test revealed a significant difference in *T. iridipennis* ($p = 0.004$) visits between yellow and orange flowers at a given time. A two-sample t-test showed a significant difference between each bee species and resource collection in yellow and orange flowers ($p < 0.001$). Stingless bees show high visiting frequency in the morning since the resources are abundant. Due to their trichromatic vision, bees prefer yellow and orange colours and the study concludes that yellow and orange *P. grandiflora* flowers help create stingless bee-friendly habitats.

Keywords: Moss rose, *Tetragonula iridipennis*, *Tetragonula praeterita*, yellow and orange colour

B – 04

Allelopathic Effects of Plants Used in Reforestation Programs in Sri Lanka

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Selection of appropriate plant species is one of the crucial steps in reforestation programs and knowing the allelopathic effects (both positive and negative) of plants that are commonly used in restoration programs would be beneficial. Present study aims to examine the allelopathic effects imposed by eleven plant species (*Artocarpus nobilis*, *Bauhinia racemosa*, *Cassia auriculata*, *Cassia fistula*, *Macaranga peltata*, *Madhuca longifolia*, *Neolitsea cassia*, *Pterospermum suberifolium*, *Salvadora persica*, *Symplocos cochinchinensis*, *Tamarindus indica*, and *Terminalia arjuna*) that are commonly used in reforestation programs in Sri Lanka, based on Mustard (*Brassica juncea* (L.) Czern.) seed germination bioassay. Seed germination and early seedling growth of mustard in 1% aqueous extracts of healthy fresh leaves, fallen senesced leaves, and roots of the test species were examined (5 replicates; 20 mustard seeds in each replicate) in a complete randomized experimental design. Results revealed that 1% extracts of fresh leaves and roots of the examined species did not significantly inhibit the germination of mustard seeds ($p>0.05$), however, the senesced leaf extract of *C. fistula* significantly reduced seed germination ($p=0.027$). Further, the senesced leaf extracts of *B. racemosa* ($p=0.007$) and *C. fistula* ($p=0.023$), and fresh leaf extract of *M. peltata* caused a significant decline in radicle growth of mustard seedlings. Similarly, the senesced leaf extracts of *T. indica* ($p=0.007$) and the root extract of *P. suberifolium* resulted a significant decline in hypocotyl growth ($p<0.001$). Allelochemicals in roots or in senesced leaves gathered on the forest floor could easily reach the germinating seeds or seedlings of other forest plant species, making adverse impacts. Plant extracts of the rest of the species except *M. peltata* imposed either positive or neutral effects on seed germination and early seedling growth. Although young leaves of *M. peltata* possess allelochemicals, these might degenerate with leaf maturity, and therefore, may not have a significant impact on germination and establishment of other species. Further research is required to reveal the magnitude of allelopathic and competitive effects of above forest species under field conditions, prior to recommending them for reforestation programs.

Keywords: hypocotyl growth, radicle growth, restoration, root extracts

B – 05

Invasion of *Alstonia macrophylla* Wall. ex G.Don in Tropical Lowland Rain Forest at Kurulu-Kele Forest Reserve, Sri Lanka

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Invasive species are considered as one of the primary threats to biodiversity and ecosystem function. *Alstonia macrophylla* Wall. ex G.Don is an aggressive invader in lowland rainforest ecosystems of Sri Lanka, especially in secondary forest habitats. Invasion of *A. macrophylla* in the Kurulu Kele Forest Reserve (KKFR) has been reported, but the potential threat of this invasion has not yet been scientifically assessed. Present study aims to reveal the changes in the vegetation, seedling bank and in the soil seed bank of KKFR due to invasion of *A. macrophylla*. Standing vegetation in both invaded and uninvaded areas of the forest was enumerated in randomly established ten 10 m × 10 m plots following stratified random sampling protocol. The seedling bank was surveyed in a 2 m × 2 m quadrat established in each plot. For the soil seed bank survey, three pooled surface soil samples were collected from each plot, spread on sterilized sand beds, and the emerging seedlings were counted over a period of three months. Results showed that the species richness of the forest vegetation in uninvaded areas was slightly higher, but stem density, endemism, and threatened plant species were more or less the same in both sites ($p > 0.05$). However, seedlings of *A. macrophylla* were observed in both uninvaded and invaded areas, and the soil seed bank in both areas contained live *A. macrophylla* seeds. These findings indicate the possibility of *A. macrophylla* invading currently uninvaded forest areas of KKFR. This could pose a significant threat to this unique flora of this forest. Therefore, it is essential to take measures to control the spread of *A. macrophylla* in KKFR, as early as possible.

Keywords: aggressive invader, seed bank, seedling bank, vegetation

B – 06

Preliminary Investigation on Genetic Diversity and Population Genetic Structure of *Aedes aegypti* and *Aedes albopictus* in Three Localities of Sri Lanka

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High prevalence of vector mosquitoes is one of the major reasons for severe dengue outbreaks in Sri Lanka. The disease outbreaks can be effectively managed by controlling the vector populations. Proper understanding of the genetic diversity and population genetic structure of dengue vectors, *Ae. aegypti* and *Ae. albopictus* mosquitoes is vital in successful vector controlling programmes. This study was conducted to determine the genetic diversity and population genetic structure of both dengue vectors in three localities: Panama, Peradeniya, and Nikeweratiya from Ampara, Kandy, and Kurunegala districts, respectively, using the mitochondrial gene *Cytochrome c oxidase subunit I (COI)*. From each locality *Aedes* eggs were collected using ovitraps. Ten adults from each species from each locality (one adult emerging from each ovi-trap) were subjected to DNA extraction using the Livak buffer protocol. PCR amplification was conducted using forward and reverse primers that have been used in previous studies. A total of twelve 444 bp *Ae. aegypti* (Peradeniya-6, Panama-6) and thirteen 458 bp *Ae. albopictus* (Peradeniya-5, Nikeweratiya-8) partial *COI* sequences were used in the analysis. The results indicated the presence of six and five haplotypes for *Ae. aegypti* and *Ae. albopictus*, respectively. Haplotype (*Ae. aegypti* 0.848±0.074 and *Ae. albopictus* 0.808±0.077) and nucleotide diversity indices (*Ae. aegypti* 0.008±0.002 and *Ae. albopictus* 0.007±0.003) showed that both species have high genetic diversity, except for *Ae. albopictus*, collected from Peradeniya, which had a zero diversity. The mean intraspecific distance (using Kimura 2-parameter distance algorithm) of *Ae. aegypti* was higher (0.392±0.009) than that of *Ae. albopictus* (0.099±0.024). Non-significant neutrality test values for both species indicated the absence of apparent population expansion or contraction. Genetic structures (AMOVA using Arlequin software) between the populations were not significantly different for both species ($p>0.05$). This preliminary study suggests the possible gene flow between populations. Spread of resistant genes between populations may affect the effectiveness of mosquito control programmes. However, future studies using much faster evolving genomic regions, increased sample sizes, and sampling sites are needed to confirm the gene flow among dengue vector populations in Sri Lanka.

Keywords: *COI*, genetic diversity, haplotypes, intraspecific distance, population genetic structure



Session C

Wetland Ecosystems

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C – 01

Existing Challenges to Implementing an Environmental Management Plan in Attanagalu Oya River Basin

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Effective environmental management plans (EMPs) are needed for areas with environmental problems and this has been often highlighted in the recent past. The success of the EMP depends on the ability to overcome existing environmental challenges. Attanagalu Oya River Basin can be identified as an area with a large number of environmental problems. This research aimed to identify and analyse the main environmental issues that exist in Attanagalu Oya River Basin and make suggestions to overcome these issues. A literature survey and field observations were used to identify the existing environmental challenges. Interviews were conducted to rank the key environmental challenges. Root Cause Analysis (RCA) was used as the main data analysis method in this study, and identified challenges under the RCA were ranked using the ranking method. Seven key challenges were identified for the Attanagalu River Basin, including anthropogenic, development and construction, government and institutional, climate and weather-related, pollution and waste management challenges together with challenges in achieving National Sustainable Development Goals (NSDGs), and international organization and partnership framework. Suggestions to overcome those identified environmental challenges in the study area include, enhancing socially responsible behaviors, implementing nature-based solutions or different environment management approaches, enhancing institutional coordination and linkage, increasing public-private and community partnerships, conducting updated research and investigations, awareness building through incentives and enforcement, and climate action. Further, proper NSDGs achieving techniques were identified to overcome existing environmental challenges. This theoretical study will help to a profound understanding of the environmental challenges in implementing EMP in the Attanagalu Oya River Basin Area.

Keywords: environmental challenges, national sustainable development goals, nature-based solutions, root cause analysis

C – 02

Occurrence and Characteristics of Microplastics in Coastal Sediments along Southeast Coast of Sri Lanka

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Microplastics (MPs), plastic particles smaller than 5 mm in size, are one of the most significant emerging environmental threats to marine environments across the globe. Despite the number of recent research on MP pollution in the western and southern coastal environments of Sri Lanka, only a few studies have been conducted to unravel MP pollution along the southeastern coast of Sri Lanka. The current study aimed to investigate the spatial distribution, sources, morphology, and composition of the MPs in the coastal sediments of the southeast coast of Sri Lanka. Sediment samples were collected from straight beaches (23) and lagoon areas (8) along the southeast coast extending from Kalmunai to Panama. At each sampling site, approximately 5 kg of surface sediments were collected from the wrack line to berm zone. The MPs in the representative fractions of sediment samples were isolated by density separation using 1.20 g/ml NaCl solution. The amount, shape, and colour of isolated MPs were analyzed using a petrographic microscope. Scanning Electron Microscope (SEM) and Fourier Transform Infrared (FTIR) Spectroscopy were employed to investigate their morphology and chemical composition respectively. The results highlighted the presence of five shape types of MPs, namely fibers (86.77%), flakes (6.61%), fragments (3.58%), foams (1.93%), and films (1.10%). Additionally, these MPs appeared in nine different colours in these beach sediments. The five shape types of MPs indicated different weathering surface morphologies such as scratches, pores, protrusions, grooves, pits, and scales, possibly due to mechanical abrasion, chemical reactions, photodegradation, and microbial degradation. The FTIR analysis revealed that the main polymer compositions of MPs are polyethylene and polystyrene. The distribution of MPs varied from 0 to 45 per 500 g. The highest number of MPs were recorded from lagoon environments (>20 MP per 500 g) indicating land-derived sources of MPs. This study lays the foundation for the investigation of MPs along the southeastern coast of Sri Lanka and to predict the possible sources of MPs based on the results.

Keywords: coastal sediments, microplastics, surface morphology

C – 03

Nature-Based Solutions for Urban Flood Mitigation in the Jaffna City

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Increasing urbanization and climate change leads to higher frequency and intensity of hydro-meteorological extremes. Flash floods are a serious urban challenge in many cities. The objective of the study was to identify the factors associated with flash floods and recommend appropriate nature-based solutions for mitigation in the Jaffna City. The study was conducted in 2019 for a period of 12 months using a combination of both quantitative and qualitative research methods. Quantitative data were collected through self-administered questionnaire survey and secondary data sources. Qualitative data were collected using key informant interviews and focus group discussions. For the questionnaire survey, 150 participants were randomly selected. The study identified that 80% of the flash floods occur in the urban and the coastal zone of the city. The key factors identified as contributing to flash floods in Jaffna city were construction of water bodies and drainage systems, mechanized agriculture in low-lying areas, inadequate knowledge about sustainable agriculture production methods, and lack of proper planning and regulation. This study recommends the application of nature-based solutions, such as creation of stormwater harvesting areas and establishing permeable pavements to increase infiltration.

Keywords: disaster management, flash flood, nature-based solutions, urban flood mitigation

C – 04

Changes in the extent of Wetlands in the Colombo Metropolitan Region Over the Period from 1992 to 2021, using Satellite Remote Sensing and GIS

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Wetlands play a crucial role in enhancing human well-being within urban environments. However, they are encountering increasing pressures due to population growth and development activities. Similarly, the wetlands in Colombo metropolitan area in Sri Lanka have experienced rapid changes since the introduction of the open economy in the 1970s. The region undergoes an annual loss of approximately 1.2% of wetland area due to human activities. The present study aims to assess the change of wetland area in the Colombo metropolitan region, identify the primary reasons for loss of wetlands and develop strategies to mitigate these changes. The main data sources employed in this study were electronic documents, articles, and book chapters. In addition, the satellite images obtained from the USGS Earth Explorer were used to develop the study area's land use land cover maps. The study employed a supervised classification method to monitor the wetland changes using Landsat images from 1992, 2001, 2011 and 2021. Post-classification wetland change detection was conducted in three periods: 1992-2001, 2001-2011, and 2011-2021. A change detection matrix analysis was performed to identify the specific conversions from one land type to another. The study revealed a decrease in the extent of wetland in the past 29 years: an annual change of -2.57 % (in 1992) to 1.87 % (in 2021) of the total study area. The change detection matrix analysis identified significant wetland to urban conversion, approximately 1155.1, 1467.09, and 4492.44 ha in the three periods, respectively. Urban expansion was identified as the primary reason for reduction in the wetland cover. These findings have implications for future urban policymakers and responsible authorities, providing valuable insights to support the conservation of the wetland system in the wetlands in the Colombo metropolitan area.

Keywords: change detection, Landsat images, matrix analysis, wetlands

C – 05

**Assessment of Heavy Metal Concentrations in Two Mangrove Ecosystems
in Sri Lanka**

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Mangroves are well-known heavy metal accumulators and play an important role in replenishing natural ecosystems. In this study, heavy metal concentrations in the standing water, soil at 10 cm depth, and in selected mangrove plants (true mangroves: *Rhizophora apiculata* and *Sonneratia caseolaris* and associated mangroves: *Acrostichum aureum* and *Acanthus ilicifolius*), collected from *Kirala kele* and *Unawatuna lagoon* in Sri Lanka were evaluated. The collected samples were analysed for heavy metals (Cr, Mn, Co, Ni, Cu, Zn, Pb and Cd) using inductively coupled plasma-optical emission spectrometry (ICP-OES). The results were statistically analyzed using PAST 4.03. The heavy metal concentrations in water were higher in samples collected from Unawatuna than those from Kirala kele. Mn was reported in high concentrations in water samples in both *Kirala kele* (34.3 gL⁻¹, SD=1.002, p=0.02) and *Unawatuna lagoon* (71.2 gL⁻¹, SD=8.71, p=0.02). Further, Mn (14.6 mgkg⁻¹, SD=1.277) and Zn (22.8 mgkg⁻¹ SD=3.16) concentrations were high in soil samples from both *Kirala Kele* and *Unawatuna*, respectively. The concentration of heavy metals in plant species varied according to the plant organs in the following order: stems>roots>leaves. However, Ni concentration was high in the leaves of all plants (39.9 mg/kg, SD=37.2, p=0.05). According to the scatter plot, the leaves, roots and stems of all tested plant species have the same accumulation pattern. *A. aureum* had the highest potential to accumulate heavy metals. The study presents potential of using mangrove species in phytoremediation.

Keywords: environmental pollution, heavy metal contamination, mangrove ecosystems, phytoremediation

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C – 06

**Anthropogenic Activities in Urban Wetlands and Community Perceptions
on Wetland Conservation: A Case Study of the Thalangama Wetland**

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Wetlands are considered as one of the most productive ecosystems with diverse floral and faunal species, and provide high socio-economic and ecological services to humankind. Urban wetlands are significant in protecting the natural ecosystem balance in man-made environments, but these are very fragile and their environmental quality is often being subjected to rapid degradation due to accelerated human activities. *Thalangama* Tank, a man-made wetland located in *Madiwela* catchment area, in the *Kelani* river basin is an urban biodiversity refuge surrounded by densely populated human settlements. It also includes the Colombo flood detention area which used for paddy cultivation. This research aimed to identify anthropogenic activities in *Thalangama* urban wetlands and to suggest possible conservation methods. The main objective of this research was to identify the nature and impacts of anthropogenic activities in the wetland and the conservation methods that can be implemented. The study utilized mixed research methodology including both primary and secondary data. Primary data was collected from 50 respondents by using a questionnaire. In selecting the study respondents, the probability sampling method was used in the community who reside within 100m of the lake. In-depth interviews were conducted among the older adults who were aware the history of the lake, farmers, the *Grama Niladhari*, Agricultural officers, office bearers of farmers' associations and Irrigation officers. The study revealed that 77.4% of the respondents perceive the lake has agricultural and recreational importance. Another 56.5% recognized the importance of wetland's flood management potential while only 24.6% perceived its ability to reduce urban heat. Although, 52.9% of respondents believe that they have a close interaction with the lakes, they do not have sufficient understanding of the lake as a fragile ecosystem with a rich biodiversity. As the study findings indicate, the ecosystem is severely threatened by unsystematic waste disposal in the wetland area (79.1%), illegal land encroachment on the wetland boundary, influenced by political and social powers (71.5%) and road kills of animals due to collision with vehicles (30.2%). When the use of the lake is considered, 58.5% expressed that the lake is crucially important to their livelihoods. Despite, 59.6% of the respondents were found to be engaged with lake-related income sources. Further, this research identified road kill prone areas, wetland encroachment, waste, and dumping sources where a specific intervention is needed in protecting the ecosystem. Moreover, this research recommends the importance of establishing wildlife corridors, underground passes, and community-based mechanisms to overcome above mentioned issues.

Keywords: anthropogenic effects, conservation, Thalangama, wetland, urban



Session D

Water Quality Management I

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D – 01

Water Table Elevation and Groundwater Quality in Jaffna City, Sri Lanka

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Information related to hydraulic and hydro-meteorological parameters and their chronological trends is a prime requirement for city planners and policymakers to manage water resources in urban settings. Jaffna city faces various problems related to the quantity and quality of water resources and water-related hazards. Lack of information on hydraulic parameters is a hindrance in alleviation of these problems. The town depends solely on the availability of groundwater for drinking, domestic and livelihood needs, in the absence of surface waters. However, groundwater is saline in most of the areas within the city. Water scarcity is high in coastal Jaffna due to its high population (population density of 22,579 per km²). Jaffna town has low surface elevations above the msl ranging from 0.1 m on the coast to 5.49 m inland. It is underlain by brown or grey calcareous sands. Aquifers in the said formations are unconfined in nature with shallow water tables ranging from 1-15 meters from the ground surface. Salinisation of groundwaters in Jaffna is believed to be a consequence of natural and anthropogenic activities such as leaching from calcareous sands and evaporation returns, mixing of saline waters, sea salt sprays and water table fluctuations. As a result, the majority of the areas in Jaffna city require freshwater supplies and water pricing has become a dominant scenario. The present study aims to analyse groundwater salinity levels against groundwater table elevations (msl). A systematic approach was adopted using a 0.25 km² grid covering the entire town (20.2 km²) and one sampling locality was selected from each grid. Depth to the groundwater table, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were determined using a digital portable EC meter in 285 dug wells. Water table elevations (msl) against water salinity were mapped with the aid of Arc Map 10.3. Groundwater table elevations (msl) vary from -3.1 m to 2.9 m in Jaffna, whereas groundwater salinity is found along the South, Southeast and Western coasts exemplifying a strong correlation with lower water table elevations. High groundwater salinisation however matches with that of water in the presence of calcareous sands in selected locations but no strong patterns were found. Groundwater salinisation in Jaffna town was probably due to fluctuations of water tables due to natural loss of groundwater discharge, over-extraction, leaching of salts from calcareous formations and needs to be monitored to arrive at better decisions with regard to urban supplies of water.

Keywords: groundwater table elevation, Jaffna city, salinity, water table fluctuations, spatial patterns

D – 02

Impact of Carbon Storage on the Water Quality of the Upper Walawe River Basin

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The upper Walawe River basin, which ranks as the fourth largest in Sri Lanka, has emerged as a key area of interest for the management of water quality due to its substantial size and population density. There has been a dearth of comprehensive research aimed at evaluating the impact of land use in the catchment on water quality, particularly during the months of November and December. The objective of this investigation is to explore the interrelationship between the storage of carbon in the catchment and the quality of surface water in the upper section of the Walawe River basin. The study utilized the InVEST Carbon storage model to assess carbon storage across nine micro-catchment areas in the upper Walawe River basin. Water quality parameters were measured in nine different streams that flowed through these micro-catchments, and the association between carbon storage and water quality was analyzed using the Pearson correlation test, with a significance testing carried out at 0.05. Additionally, several factors related to carbon storage were examined, including pH, temperature, total dissolved solids, conductivity, dissolved oxygen, biochemical oxygen demand, alkalinity, total hardness, as well as the presence of elements such as Zinc, Cadmium, Sodium, Potassium, Copper, Magnesium, Chromium, Nickel, nitrate, and phosphate. The overall carbon pool ranged from 0 to 257 t ha⁻¹ yr⁻¹, with an average annual value of 121.84 t ha⁻¹ yr⁻¹. The study focused on investigating the correlation between carbon storage and various water quality parameters. A notably strong negative correlation was observed between carbon storage and Magnesium levels ($r = -0.712$, $p=0.031$). In conclusion, this investigation highlights the significant potential for carbon storage in the upper Walawe River basin and its interrelationship with water quality.

Keywords: Carbon storage, InVEST model, upper Walawe river basin, water quality

D – 03

Soil Erosion in the Middle Walawe River Basin, Sri Lanka and it's Impacts on Surface Water Quality

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Soil erosion (SE) is one of the important environmental issues which affects the soil fertility, catchment water quality and aquatic ecosystem health. This study aims to estimate the rate of soil erosion and the quality of the surface water of the Middle Walawe River (MWR) basin and to determine the correlations between the rate of soil erosion and physico-chemical parameters of the surface water. The SE rate of 8 sub-watersheds within the study area were calculated using the Sediment Delivery Ratio (SDR) model of Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) Software. The input variables land use-land cover (LULC), rainfall (RF) and soil erodibility (K) data of the sub watersheds were used in the model. Water samples were collected monthly from each tributary of the 8 sub-watersheds for 2 months. Water quality parameters pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), alkalinity, hardness, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), conductivity, nitrate, phosphate and major and trace metal (K, Na, Mg, Cr, Cd, Zn, Cu and Ni) concentrations were assessed. The variation of water quality parameters among the sub watersheds were compared using one-way ANOVA and the relationships between water quality parameters and soil erosion rate were evaluated using the Pearson correlation test. The comparison of water quality parameters among the sub watersheds indicated significant differences ($p < 0.05$) in temperature, TDS, alkalinity, nitrate, Ni and Na concentrations. The soil erosion of the sub-watersheds ranged from 0 to 49 t/ha/yr with an annual average of 18.8 t/ha/yr, possibly due to the LULC and intensity of the RF variations within sub watersheds. Correlations between catchment water quality and soil erosion indicated a linear relationship; pH ($r=0.50$), TSS ($r=0.57$), phosphate ($r=0.45$), BOD ($r=0.49$) and cations of K ($r=0.51$) and Mg ($r=0.42$). The findings of the study suggested that the soil erosion within the MWR basin has an important implication on the catchment water quality.

Keywords: InVEST SDR Model, middle Walawe watershed, surface water quality, trace metals

D – 04

**Microbiological Quality of Groundwater Self-supply Wells at
Vadamarachchi Sand Dune Aquifer in the Jaffna Peninsula, Sri Lanka**

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Groundwater is an extremely valuable resource and pollution of groundwater resources is of serious concern. More than 80% of people in the Jaffna region rely on groundwater self-supply wells. However, the delivery of safe water and associated risk factors due to fecal contamination of these wells remain unclear. Present study assesses the microbiological quality of water in groundwater self-supply wells at Vadamarachchi sand dune aquifer in the Jaffna Peninsula, Sri Lanka. Microbial contamination status in 77 groundwater self-supply wells were assessed. Samples were collected during October to November 2022, and analyzed for total coliform and *Escherichia coli* as per the Sri Lankan Standards 1461 Part I: 2015. Membrane-filtration was employed with Chromogenic Coliform Agar and each set of analyses was conducted with a positive and negative control with specific reference strains for quality assurance purposes. Total coliform and *E. coli* were detected in 97% and 85% of well waters respectively. In a 100 ml sample, total coliforms ranged from 12 to 2000 colony forming unit (cfu) with an average of 1772 cfu/100 ml. This indicated the heavy coliform contamination. The presence of *E. coli* with an average of 403 cfu/100 ml further confirmed heavy fecal contamination. Seventy nine percent of these wells were located within 20 m radius from the septic tanks, and remaining was in the range of 20 m to 30 m. Thirty-eight percent of the wells were without walls surrounding the wells. This study recommends to clean and disinfect wells using chlorine on a regular basis, improve the well structures, implement sealed type septic tank to households and raise awareness regarding proper household water treatment such as boiling and safe storage.

Keywords: *Escherichia coli*, microbiology, self-supply wells, septic tank, total coliform

D – 05

Investigation of Suitable Pre-treatment to Improve the Performance of Sea Water Reverse Osmosis Treatment Plant at Ninathivu

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Effective pre-treatment is required to increase the efficiency and life expectancy of the reverse osmosis membrane elements by minimizing fouling. The membrane used in Sea water Reverse Osmosis (SWRO) plant at the Nainativu Island has been replaced two times within an eighteen-month period, due to the ineffective pre-treatment. Laboratory records indicate the presence of high concentration of Ferrous in the feed. This study aimed to identify suitable pre-treatment technique to improve the quality of the feed water to the SWRO membrane to improve its durability. The study was conducted during the dry season from May to September, 2022. It was found that the iron removal efficiency increases when aeration combined with the pre-chlorination. Aeration with 5 ppm pre-chlorine showed the maximum iron removal of 63.4% but high dosage of pre-chlorination cannot be practiced as free chlorine can cause severe damages to the membrane. The results obtained from filtration using a cation resin indicates that the iron removal efficiency decreases with the increasing number of filtrations. Eventually the removal capacity of the cation resin become exhausted as raw water total hardness is increased. The total iron concentration in water was determined by the APHA (3500-Fe B) standard method. Results revealed that filtration using iron removal resin enhanced iron removal by 100%. Coagulation flocculation study indicates that effective turbidity removal range of the coagulant, polyaluminium chloride, was 25-40 ppm while iron removal efficiency was more than 80% at the optimum speed and time. In conclusion, coagulation flocculation and filtration using iron removal resin were very effective pre-treatment methods for the Nainativu SWRO plant.

Keywords: pre-treatment, reverse osmosis, fouling, coagulation, flocculation



Session E

Water Quality Management II

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E – 01

Floating Treatment Wetlands for Cu and Zn Removal from Secondary Industrial Effluents in Retention Ponds

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Floating treatment wetlands (FTWs) can be a practical and affordable phytoremediation method. The air-filled rhizomes and gas bubbles that are trapped by the intertwined roots, which can be further supported by rafts providing buoyancy to the wetland. Floating wetlands are now recognized as a cost-effective viable ecological option for the treatment of different types of wastewater and reducing water pollution. This study aims to improve treated wastewater quality in an existing retention pond at Horana Export Processing Zone. FTWs were prepared by planting *Cyperus iria*, *Heliconia psittacorum*, *Canna indica* for removing copper (Cu), and zinc (Zn) from treated industrial wastewater. Floating wetlands of the three species were anchored in 90 L treatment tanks and in a control tank (n=3). After eight weeks, water samples were analyzed by atomic absorption spectroscopy to determine copper and zinc concentrations. Results revealed that a high Cu adsorption was recorded in tanks with *Canna indica* (66.67±11.54%) while high Zn adsorption was reported from tanks with *Heliconia psittacorum* (81.71±2.29%). However, the reduction of Zn and Cu by *Cyperus iria* was as low as 48.21±0.28% and 24±1.49% respectively. *Heliconia psittacorum* can be suggested for extracting Zn metal and *Canna indica* can be suggested for extracting Zn metal in industrial effluents in retention ponds. These results also supports the fact that treating industrial wastewater with floating treatment wetlands is a feasible alternative to improve wastewater quality.

Keywords: constructed floating wetlands, phytoremediation, retention pond, water pollution

E – 02

***Cryptosporidium* species contamination in waters treated at selected treatment plants along the Mahaweli River**

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Contamination of water sources with pathogenic protozoans from infected humans and animals *via* sewage from hospitals, livestock farms, and domestic drainage systems is a threat to human health. Mahaweli River is the main drinking water source in Kandy City and its suburbs. This study focused on the presence of selected pathogenic protozoans in both source and treated water in 14 water treatment plants (WTPs) of the National Water Supply and Drainage Board (NWSDB), along the Mahaweli River from Kotagala to Balagolla. Five liters of raw and treated water samples from each station were collected and filtered through 0.45 µm membrane filters and placed in phosphate buffer saline solution followed by a vigorous mixing to elute the spores to the buffer. Samples were then concentrated to a 1 ml solution using sucrose flotation method. To detect the presence of *Giardia*, 100 µl of the concentrated sample was stained with a drop of Lugol's iodine and 200 µl of the concentrated sample was stained using modified Ziehl-Neelsen technique and observed under oil immersion microscopy to detect *Cryptosporidium*. DNA extraction and nested PCR were performed on microscopically tested positive samples for further confirmation. *Giardia* was absent in all the water samples tested. However, three samples from Haragama (raw water) and Balagolla (raw and treated water) were positive for *Cryptosporidium* by microscopy, and nested PCR further confirmed the presence of *Cryptosporidium* in these samples. Water intakes at Haragama and Balagolla WTPs are located in the Victoria reservoir. Accumulation of pollutants in stagnant water pose concern for potential cryptosporidial contamination. It is crucial to note that *Cryptosporidium* oocysts are resistant to the dosage of chlorine used for disinfection during the water treatment process. Further identification of the source and the species of *Cryptosporidium* is recommended for delivering safe drinking water and also to identify the epidemiology of water contamination at these intakes.

Keywords: *Giardia*, *Cryptosporidium*, Mahaweli river, drinking water

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E – 03

Investigation of the Efficiency of Red Soil-Sand Mixture in the Removal of Fluoride from Drinking Water

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Natural and artificial fluoride contamination in water has been identified as a major issue around the world. In general, dental, and skeletal fluorosis occurs when the daily intake of fluoride exceeds 4 mg/L or 10-20 mg/L per day over several years. Developing effective and practical technologies to remove excess fluoride from water is important. Present study examined the fluoride removal efficiency of red soil using 3 different fluoride solutions that represent excess limits of fluoride in water. In this study, locally available red soil from Tissamaharama area was used for adsorption method. The red soil was mixed with sand in a ratio of 4:1 to improve the void space and permeability of the medium. The experiment was conducted for 300 minutes. Fresh standard fluoride solutions were used in the batch test, after preparing them using sodium fluoride (NaF) and deionized water. The final concentrations in the samples were measured using the SPADNS Spectrophotometric method. We found that fluoride solution with 2 mg/L initial fluoride concentration was completely adsorbed by red soil-sand mixture within 90 minutes. The fluoride solution with 5 mg/L initial fluoride concentration was reduced to 0.17 mg/L and obtained 96.6% removal efficiency in 90 min. Moreover, the fluoride solution with 15 mg/L initial fluoride concentration was reduced to 1.15 mg/L after 120 min and achieved 92.3% removal efficiency. It was further observed that more than 90% of fluoride was removed between 90-120 min by the soil-sand medium. Red soil is effective in removing fluoride due to its high iron oxide and aluminum oxide contents. Therefore, red soil can be considered as an efficient adsorbant to remove fluoride in water.

Keywords: defluoridation, fluoride removal, red soil, removal efficiency, SPADNS method

E – 04

**Evaluation of the Use of Peels of Sri Lankan Banana Variety (*Puwalu*)
to Remove Cadmium (II) from Simulated Wastewater**

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Cadmium (II) is a non-biodegradable, toxic heavy metal ion which persists in the environment for a long time, causing harmful effects on living organisms. In this research, peels of Sri Lankan banana variety (*Musa acuminata* Colla var. *puwalu*), were used to remove cadmium (II) from water. Fourier Transform Infrared spectroscopic analysis of dried ground *Puwalu* peel (particle size $\leq 300 \mu\text{m}$) revealed the presence of functional groups of hydroxyl, carboxyl and amine in the biosorbent. The peaks of the elements K and Ca were prominent in X-Ray Fluorescence spectrum of ground *Puwalu* peel. Scanning Electron Microscope image of ground *Puwalu* peel indicated irregular shape porous surface which can enhance the biosorption of Cd (II) to ground *Puwalu* peel. Experiments for the optimization of parameters such as particle size ($\leq 300 - 1000 \mu\text{m}$), adsorbent dosage (0.100-1.500 g), contact time (5-60 min), and pH (2.0-9.0) were carried out for the removal of Cd (II) (10.0 mgL^{-1}) using ground *Puwalu* peel. Flame Atomic Absorption Spectrometer was used to measure the concentration of residual Cd (II) ions in the solutions. Langmuir and Freundlich adsorption isotherm models were used to evaluate the nature of adsorption. Under the optimum conditions (particle size $\leq 300 \mu\text{m}$, adsorbent dosage: 0.500 g, contact time: 30 min, and pH=5.0), the maximum Cd (II) removal percentage by ground *Puwalu* peels was 72.59%. The correlation coefficient (r^2) for Langmuir and Freundlich isotherm models for removing Cd (II) by ground *Puwalu* peel were 0.994 and 0.987, respectively, and the maximum adsorption capacity for cadmium (II) was 23.70 mgg^{-1} . Present work suggests that ground *Puwalu* peel can be used as an environmentally friendly, efficient biosorbent to remove Cd (II) ions from wastewater.

Keywords: banana peels, biosorbent, Cd (II), isotherm

E – 05

Identifying Potential Oil-degrading Bacterial Genera by Analysing Raw Gene Sequencing Data on Deepwater Horizon and Northwest Coast of the Iberian Peninsula Oil Spill Sediments

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With increasing usage of petroleum, accidental release of petroleum oils to marine environments has increased over the years due to marine oil spills. These oil spills pose a multitude of threats to the biosphere and negatively impacts the socio-economy. Bioremediation is one of the most preferred techniques as a treatment of oil degradation and is often carried out using oil-degrading organisms. According to literature, the most prominent oil-degrading bacterial genera are *Arthrobacter*, *Brevibacterium*, *Brachybacterium* and *Mycobacterium*. Present study examined bacterial genera in two raw data sets from gene sequencing studies of oil spill sediments from Deepwater Horizon (January, 2022) and Northwest coast of the Iberian Peninsula (April 2021). The data were analysed by pairing with genomes of known bacteria using the Kraken database for gene sequencing, and calculating their absolute abundances. Metagenomic analysis of marine microbes isolated during the Global Ocean Sampling Expedition (2013) were utilised to compile a baseline marine microbe profile for oceans. It was found, that the most abundant bacterial genera in the sediments were *Sphaerisporangium* and *Pseudomonas*. However, many variables in the oil spills, such as type of hydrocarbon, concentration, ambient temperature, presence of oxygen, and supporting minerals can affect bioremediation. Further analysis of *Sphaerisporangium* and *Pseudomonas* bacterial genera in bioremediation must be investigated.

Keywords: bioremediation, marine oil spill, crude oil, oil degradation, biodegrading microbial communities, oil degrading bacteria



Session F

Pollution Detection and Control

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F – 01

An Assessment of distribution of Airborne Microplastic using Epiphytic Crustose Lichens in Surrounding Areas of an Open Dumpsite of a Plastic Crusher Plant at Kanadola, Sri Lanka

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Airborne microplastics (AMPs) have gained significant global attention due to their presence in the atmosphere and potential risks to human health and the environment. This study focuses on the assessment of microplastic contamination in the air originating from an open dumpsite of a plastic crusher plant in Kanadola, Sri Lanka. Epiphytic crustose lichen samples were collected from trees using stratified random sampling. The study area was divided into three sampling zones based on the distance from the plastic crusher plant: a proximate zone (n=4, 50 m), an intermediate zone (n=3, 50-100 m), and a distant zone (n=3, 100-200 m). In addition, epiphytic crustose lichen samples (n=3) were collected from an undisturbed forest patch at Kumbalgama, as the background control experiment. The acid-digestion method was employed to release the accumulated microplastics from the lichen thallus. Microscopic analysis and a hot needle test were used for microplastic visual inspection and identification, respectively. The total number of microplastics per 1 g of dry weight of lichen in each sampling zone was statistically analyzed using one way ANOVA and the results revealed a significant difference ($p=0.003$) in AMPs distribution among the sampling zones. Post-hoc pairwise comparisons using the Tukey test indicated no significant difference in AMPs distribution between the proximate zone and the intermediate zone, but it significantly differed from the control site. In conclusion, this study highlights substantial plastic pollution in the proximate zone and the intermediate zones of the plastic crusher plant site compared to the forest (control) site. The findings underscore the potential of lichen as a biomonitoring agent for qualitative and quantitative analysis of airborne microplastic pollution.

Keywords: airborne microplastics, biomonitoring, epiphytic crustose lichens, hot needle test, stratified random sampling

F – 02

Post Combustion Carbon Dioxide Capturing Techniques: A Critical Analysis of Recent Developments on Modified Zeolites, Algae and Metal Organic Frameworks

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The world is experiencing catastrophic effects of climate change caused by global warming. Extreme weather events such as flash floods, wildfires, droughts, and heat waves resulting in loss of lives are seen more frequently. Destruction of ecosystems, sea level rise, and food shortages are some foreseen long-term effects that the world will have to face if the anthropogenic carbon dioxide (CO₂) accumulation in the atmosphere continues at the current rate. Therefore, the need for the application of effective CO₂ capture techniques is critical. As a result, more research is being done on zeolites, Metal-Organic Frameworks (MOFs), and algae, producing novel materials. In this work, a review study was done to select three such materials for applications of CO₂ capture in Sri Lanka by considering cost-effectiveness and high throughput. Thus, binder-free 13X-LiCl zeolite, Mg-MOF-74, and the algae *Chlorella* sp. were selected and quantitatively and qualitatively compared based on techno-economic feasibility, resource availability, capturing capacity, deliverable capacity of the captured CO₂, and re-usability of the materials. The analysis was done with a heavy focus on techno-economic feasibility and resource availability, while considering the sustainability aspects. Visual PROMETHEE II was used as the multi-criteria decision-making tool. From the complete ranking, zeolite was chosen as the most suitable material for applications in Sri Lanka, followed by MOF and algae. The results obtained had a stability interval of 16.47% to 29.59% for the given weights. Further, the results showed that zeolite gained an advantage through the criteria of techno-economic feasibility, resource availability, and deliverable capacity, while MOF showed an advantage in reusability. Further investigations should be conducted to develop zeolite based CO₂ capturing devices and to develop methods to utilize the captured pure CO₂ to produce valuable chemicals such as synthetic fuels, which is a net zero carbon energy source.

Keywords: carbon dioxide capture and utilization, zeolites, metal organic frameworks, algae, multi-criteria decision making

F – 03

Effects of Discarded Baby Diapers as a Self-Curing Agent on Concrete Characteristics in the Dry Zone of Sri Lanka

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The use of traditional curing procedures is not economically viable due to high labor costs and other factors, especially in places with severe water shortages in dry zones. Additionally, the increasing amount of waste from disposable baby diapers poses a significant problem in landfills and society as a whole. In response to these challenges, this study explored the use of highly absorbent polymer substances found in used baby diapers as an internal self-curing agent in concrete. The main objective was to evaluate the feasibility of self-curing techniques compared to traditional curing methods. The ultimate goal is to determine the appropriate amount of diaper material that should be incorporated into concrete structures in Sri Lanka's dry zones to achieve self-curing. Baby polymer diapers were mixed with concrete in three different ratios: 1%, 4%, and 7%. Workability, strength, and durability of the concrete were investigated through slump, compressive strength, and drying shrinkage tests. These tests were conducted at 7, 14, and 28 days after the concrete was prepared. Concrete samples S1 (1%), S2 (4%), and S3 (7%) showed larger dimensional changes compared to the control samples CM1 and CM2. It was evident that increasing the baby diaper polymer content led to increased shrinking. The values of the polymer-added samples exhibited an inverse correlation with the amount of linear drying shrinkage. Consequently, minimizing the volume percentage of polymer particles contained within the concrete framework is imperative to mitigate shrinkage during subsequent hydration processes.

Keywords: internal curing, self-curing, super absorbent polymer, sustainability

F – 04

Soil Contamination by Heavy Metals in e-Waste dumping sites at *Ginigathpitiya* and *Koulwewa* villages in the Kurunegala District, Sri Lanka

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Electronic waste has become a global environmental concern, and Sri Lanka is no exception to this growing issue. People in *Ginigathpitiya* and *Koulwewa* villages in the Kurunegala District, Sri Lanka rely on e-waste collection as a source of income. Different electronic and electrical devices contain various heavy metals, and improper disposal of such devices in these areas may lead to soil contamination, posing risks to both human health and the environment. The present study examined the concentration of heavy metals in the soil near e-waste dumping sites at *Ginigathpitiya* and *Koulwewa* villages, by collecting twenty soil samples each collected within a 200 m radius and the heavy metal (Cu, Cd, Cr, Ni, Pb and Zn) concentration of digested and filtered soil samples were measured using Atomic Absorption Spectrophotometry. The analysis revealed that the topsoil (0-15cm depth) at both sites are contaminated with several heavy metal types. *Koulwewa* major e-waste generating site was contaminated with Cu (0.62-110.16 mg/kg), Zn (0.76-56.66 mg/kg), Pb (0.24-64.50 mg/kg), Cd (0.00-1.84 mg/kg), Cr (0.49-4.37 mg/kg) and Ni (0.14-4.12mg/kg). *Ginigathpitiya* e-waste dumping site was also contaminated with Cu (1.89-67.56 mg/kg), Zn (2.05-24.27 mg/kg), Cd (0.05- 1.70 mg/kg), Pb (0.00-14.96 mg/kg), Cr (0.44-1.71 mg/kg), and Ni (0.09-5.09 mg/kg). The study found that the Cd, Cu, Zn, and Pb contents in soil samples taken within a radius of 50 m at both dumping sites exceeded the European Community standards, 1986. To mitigate metal contamination, e-waste collectors should adopt proper e-waste management protocols. It is essential to conduct social awareness programs and update policies and regulations by the relevant government agencies to address this environmental issue.

Keywords: electrical equipment, electronic equipment, environmental impact, soil contamination, trace metals

F – 05

Improvement of Flammability of Coconut Shell Charcoal Briquettes using Different Waste Materials as Fire Starters

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Biomass, being the third renewable energy source in the world, plays an important role in the production of eco-friendly fuels and as a substitute for non-renewable energy source. The longer fire-starting time is a considerable obstacle, especially for commercially available charcoal briquettes. Although there are separate fire starters available in the market, most of them are unsustainable or harmful to health due to the chemicals present and toxic gas emissions. This research attempted to find a sustainable solution by producing a unique biomass charcoal briquette with different improved attributes. In this study, waste materials (rice husk charcoal, sawdust charcoal and waste cooking oil) were combined with coconut shell charcoal separately, aiming to reduce the ignition time while enhancing other properties. The charcoals of selected materials were used here instead of their respective 'raw' form, considering less emission of smoke and the durability of the biomass briquettes. The effect on properties due to the physical state of the additive was compared using both solid and liquid as well. The best combination was selected by evaluating fire starting time, gross calorific value, burning rate, and proximate analysis as the properties of the briquettes. The study found that the mixture of coconut shell charcoal and waste cooking oil at 85:15% and 80:20% ratios were the most effective, resulting in a significantly low fire starting time ($P < 0.05$). The respective results for the selected compositions were the fixed carbon content ($63.9 \pm 2\%$ and $66.6 \pm 2\%$), gross calorific value (25.1 and 27.6 MJ kg^{-1}), fire starting time (2 ± 0.2 and $2.5 \pm 0.2 \text{ min}$), and the burning rate (0.08 and 0.05 g/min). The prepared samples complied with the EN 1860-2-2005 standard for barbecue charcoal briquettes is an indication of their quality, which could make them a potential product for many tropical and agricultural countries while valorizing waste.

Keywords: biomass briquettes, renewable energy, rice husk, sawdust, waste cooking oil, waste valorization

F – 06

Economic Analysis of Battery Energy Storage Systems Used in Low Voltage Distribution Systems

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In the face of the persistent challenge of maintaining an instantaneous balance between power generation and demand in electrical systems, the integration of Battery Energy Storage Systems (BESS) has emerged as a promising solution. This study focuses on the economic analysis of BESS implemented in Low Voltage (LV) distribution systems, with a specific case study in the Sri Lankan power system. During peak demand, the currently available installed capacity struggles to meet requirements, particularly in dry seasons when major hydro power plants operate below nominal capacity. This research evaluates the economic viability, technical benefits, and environmental impacts of employing BESS in the LV distribution feeder. The study analyzes the optimum BESS capacity by considering capital investment, battery costs, and potential savings achieved through peak energy reduction. The methodology involves a comprehensive cost-benefit analysis that compares BESS installation and maintenance costs with the savings obtained from peak shaving. By charging the BESS during off-peak hours and discharging it during peak periods, the study demonstrates substantial cost savings through a reduction in peak demand charges. Additionally, the BESS's ability to perform load shifting optimizes solar energy utilization and reduces strain on the distribution infrastructure, contributing to enhanced system stability and efficiency. The results of the case study on the Sri Jayewardenepura Kotte LV distribution feeder reveal a proposed optimum BESS capacity of 300 kWh. The analysis confirms a positive Return on Investment of 8.786%, affirming the economic feasibility of integrating BESS into the feeder. Moreover, voltage and frequency regulation are effectively managed, further improving distribution system performance. Therefore, this research emphasizes the economic viability, technical advantages, and positive environmental impacts of incorporating Battery Energy Storage Systems into LV distribution systems. The findings will contribute to overcoming peak demand challenges and promoting a more sustainable and resilient power grid in the future.

Keywords: battery energy storage systems, peak shaving, conomic analysis, time of use pricing structure, Solar PV.



Session G

**Green Industry Towards
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G – 01

Use of Key Performance Indicators to Evaluate the State of Environmental-Friendliness of Research and Development in the Commercial Agriculture Sector

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Research and development work targeting improvements to the productivity of the Sri Lankan commercial agriculture sector (CAS) demands optimal allocation and better utilization of the scarce resources available at hand to guarantee the ‘best possible’ outputs/outcomes. Yet, the level of adherence to the principles of sustainable development concerning research outputs is also considered to be of paramount importance in setting such targets, especially to avoid irreversible harm to the earth's natural systems. On this rationale, the level of awareness of the top-level decision makers of any institution on concepts like Social Responsibility in the arena of research is essential to bring up an environmentally friendly research culture. A set of valid and reliable Key Performance Drivers/Indicators (KPDs/KPIs) is a potential tool that can evaluate such aspects within a Performance Management System (PMS). A program of research characterized by two phases was carried out, where a systematic literature review was completed to identify the KPDs/KPIs towards managing research innovations in the CAS (Phase I), followed by exploring the relationships amongst the KPDs/KPIs in place, where 32 in-depth personal interviews supported by a semi-structured interview schedule containing 15 inquiries were performed with the participation of top administrators of research institutes working on CAS (Phase II). Through the Thematic Analysis carried out, two ‘most valued’ KPDs operationalized by respective KPIs were identified, including Commercialization, and Research for Society. The analysis through the MAXQDA software revealed that codes like ‘Environmentally friendly Research Outputs’ did not prominently co-occur with codes like ‘Environment Impact’ or ‘Environment Aspects in KPI’. The study revealed that institutional-level KPDs/KPIs were not purposefully assigned to measure the environmental aspects of research in this sector. As a remedy, a digitally enabled PMS is proposed to facilitate such KPDs/KPIs.

Keywords: commercial agriculture, environmental sustainability, key performance indicators, KPIs, Performance management

G – 02

Food Security within Vulnerable Communities: Balancing Social and Economic Concerns in Plantation Agriculture

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The plantations sector in Sri Lanka plays a significant role in the country's economy, but remains both socially and environmentally vulnerable system. The challenge of food security and sustainable food value chains has peaked in the plantation community during the COVID pandemic. This study investigates the food (in)security in Sri Lankan plantations through the lens of social and environmental sustainability. It explores the various dimensions of food security, including accessibility, availability, affordability, and utilization, and examines how these dimensions are influenced by the existence of constraints in production. The production constraints considered include 8 factors including climate and environmental degradation. Food security and insecurity indices are calculated for random sample of workers among the plantation labor community. Mean comparisons of food availability, food access, food utilization and food stability were carried out in the presence of constraints and the absence of constraints. The data collection included a focused group discussion and independent enumeration of 34 cases within Hatton and Atabage plantation regions. Both food security and food insecurity indices were calculated with respect to food availability, food access, food utilization and food stability and each of these indices were assessed separately in the presence and absence of production constraints. Of the non-parametric mean comparison tests conducted, the food availability score displays a significant difference in the presence and absence of production constraints ($p= 0.0577$). In other words, food access, food utilization and food stability appear not to be significantly differently affected by the presence of food production constraints. The results indicate that food availability, the primary aspect of food (in)security, plays significant bottleneck in the plantation agriculture system. The implications of local food production constraints towards food availability can worsen the social welfare concerns that already burdens the plantation labor community.

Keywords: access, availability, food production, stability, social responsibility, utilization

G – 03

Effect of Reduced Fertilizer Rate, Increased Plant Density and Extended Irrigation Interval on Hybrid Fodder Sorghum Yield in Lowland Paddy Fields

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The study investigated the impact of reduced fertilizer application rate combined with increased plant density and extended irrigation intervals on the yield of hybrid fodder sorghum varieties (SX-17 and Dairygreen) in lowland fallow paddy fields in the dry zone during the *Yala* and third seasons. Various agronomic practices were examined, including four basal fertilizer (Urea:TSP:MOP) rates (BD1; 100:90:65, BD2; 150:62:37, BD3; 75:68:49 and BD4; 113:47:28), two top-dressing urea fertilizer rates (TD1; 150 kg/ha and TD2; 112.5 kg/ha), two plant spacing configurations (WS; 45×30 and NS; 45×15 cm), and two irrigation intervals (SI; 5-day interval until 30 days, and then changed to an 8-day interval and LI; a 7-day interval until 30 days). These practices were combined into four agronomic management packages; AMP1 (BD1, TD1, WS, SI), AMP2 (BD2, TD1, NS, SI), AMP3 (BD3, TD2, WS, LI), and AMP4 (BD4, TD2, NS, LI). The AMPs were arranged in a split-plot design with three replicates. Harvesting of the initial sorghum crop and the first ratoon crop was performed when 50% of the panicles reached dough grain stage. The diameter of the first internode, plant dry weight, leaf area index (LAI), number of tillers, and fodder yield were measured. Data were analysed using ANOVA and DMRT. The initial crop exhibited significantly higher dry weight ($p<0.05$) in plants with greater stem diameter when cultivated with increased fertilizer rates, wider plant spacing, and shorter irrigation intervals in AMP1. Regardless of the fertilizer rate and irrigation interval, the initial crop had higher LAI ($p<0.05$) under narrow plant spacing in AMP2 and AMP4. In the ratoon crop, wider plant spacing in AMP1 and AMP3 resulted a greater number of tillers ($p<0.05$) and a higher plant dry weight ($p<0.05$). The ratoon crop also exhibited higher LAI ($p<0.05$) with narrow plant spacing in AMP2 and AMP4. The total fodder dry matter yield (DMY) in AMP2 and AMP4 with narrow plant spacing was significantly greater ($p<0.05$) for both hybrid fodder sorghum varieties. Importantly, the DMY was not affected ($p>0.05$) by the fertilizer rate and irrigation interval. When SX-17 and Dairygreen varieties were cultivated with low fertilizer rate, along with increased plant density and extended irrigation intervals (AMP4), they produced comparable fodder yields (21.1 and 26.1 MT/ha, respectively) to those grown with higher fertilizer rate, increased plant density, and shorter irrigation intervals (AMP2) (*i.e.*, 24.6 and 28.1 MT/ha, respectively) in lowland paddy fields during drier seasons.

Keywords: dry matter yield, leaf area index, plant dry weight, stem diameter

G – 04

Evaluation of Leather Quality Manufactured from Goat Skin with Selected Vegetable Tanning Materials

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Vegetable tanning agents could reduce chrome pollution in leather making. The current study was conducted to determine the properties of goat leather tanned using locally available plant material: mahogany (*Sweietenia macrophylla*), goraka (*Garcinia spp*), pine (*Pinus caribaea*), refused tea (*Camellia sinensis*) and two commercial vegetable tanning materials (mimosa powder and black wattle solid). Plant tannins were extracted by high pressure water extraction method (121 °C, 15-20 Psi about 20 min). Extracted tannin amounts were measured by ultraviolet spectrophotometry. Tanning was performed according to the pit method, however, re-tanning was not conducted. Physical properties of the treated leathers were evaluated using the International Union of Leather Technologists and Chemists Scarcities. The sensory evaluation was done using a three-point hedonic scale. The extractions resulted percentage tannins of 6.04±0.12%, 3.34±0.06%, 2.98±0.01% and 3.47±0.11% from mahogany, goraka, pine, and refused tea, respectively. The highest tannin absorption level was observed in goraka tanned leathers. The physical properties of leather treated with different tannins were not significantly different (P>0.05). The highest thickness (2.68±0.19 mm) was reported in Wattle-tanned leathers, the highest apparent density (0.75±0.12 gcm⁻³) and the highest tensile strength, both parallel (29.61±8.77 Nmm⁻²) and perpendicular (30.01±14.93 Nmm⁻²) to the backbone were reported in refused tea-tanned leather. The highest elongation at break parallel to the backbone (19.70±1.39 %) was obtained by the mimosa-tanned leather while that of perpendicular to the backbone (23.33±3.44%) was demonstrated by the wattle-tanned leather. Mimosa tanned leather showed the highest percentage of water absorption per day (171.33±33.42 %). Goraka, mimosa and wattle tanned leathers tolerated more than 10,000 flexes compared to others. Goraka-tanned leathers had the highest overall preference in sensory evaluation. According to International Commission of Illumination, the highest lightness value was observed in mimosa-tanned leather while redness and yellowness were highest in mahogany-tanned leather. In conclusion, all the vegetable tanning materials tested resulted leathers with different favorable properties which can be industrially used to produce various leather products.

Keywords: goat skin, leather, tannin, vegetable tannings

G – 05

Impact of the Choice of Packaging Size by Consumers on Waste Generation: A Case Study from Southern Sri Lanka

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Packaging is an integral component of consumer product marketing. Packaging material used vary depending on the product and it is generally discarded as a waste after product consumption. Trash generated from plastic packaging is the most problematic due to its widespread use, inability to degrade naturally, and extremely low global collection and recycling rates. The study objectives were to detect disparities in packaging size choices among different income groups and to assess the impact of packaging size choice on waste generation. For the study, three types of consumer goods (milk powder, tea and washing powder) with varied packaging sizes (milk powder – 18 g, 400 g and 1 kg; tea – 50 g, 100 g, 200 g and 400 g; washing powder 50 g, 250 g, 500 g and 1 kg) were chosen. Consumers were asked to provide household income, packaging size preferences, and the number of packages purchased over a period of one month. The packaging waste generated per month was estimated based on packaging weight. An online survey on packageing size choice was used to collect information from 418 families in the southern province of Sri Lanka. The study revealed that larger packaging sizes were favoured by families who were regular users (65%), whereas small packaging sizes are preferred by families who were non-regular users. In contrast to findings presented in marketing research which often linked low-income families with small packaging sizes (*i.e.* sachets), the current study found no significant influence of family income on the packaging size choice (Kruskal-Wallis rank sum test, $P>0.05$). The study findings further emphasized that use of smaller packaging sizes by households could increase the waste generation by 50-60%.

Keywords: consumer choice, package, sustainability, waste reduction

G – 06

European Green Marketing Strategies: Best Practices for Small and Medium Enterprises in Sri Lanka

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The government of Sri Lanka has recognized the vital role of Small and Medium Enterprises (SMEs) in the economy, contributing 52% to the GDP. However, economic growth was associated with increased CO₂ emissions globally, exacerbating industrialization, urbanization, and deforestation. In the global context, adopting green marketing practices by SMEs in Europe has been identified as a way to mitigate environmental degradation. Thus, the main research objective of this study was to explore the potential of green marketing strategies to mitigate the negative environmental impacts associated with the growth of SMEs in Sri Lanka, by examining the green marketing practices implemented in Europe. The methodology of this study consisted of a semi-systematic review of analyzing relevant articles, research papers, and other relevant literature from the period 2013 to 2023. The results revealed that urban manufacturing SMEs in Sri Lanka have adopted European green marketing practices within their supply chains with slow progress. The review recognized the importance of governmental support, customer awareness, and expanded research efforts in further enhancing the effectiveness of green practices. Further, the review indicates that the sustainability of the application of European systematic green marketing practices in Sri Lanka can be promoted through innovative rainwater collection systems, bulk email services to reduce carbon footprints, product take-back programs, circular energy systems recovery, heat energy using wastewater properties, and developing trash recycling centers. In conclusion, this study emphasized the importance of careful adoption of green marketing practices employed by European SMEs, while considering the socio-economic and environmental factors specific to Sri Lanka. Suggestions include highlighting the need for future research that assesses the current level of adoption of green marketing practices among Sri Lankan SMEs and come up with mitigates to negative environmental impacts associated with the growth of SMEs in Sri Lanka.

Keywords: green marketing, small medium enterprise, environmental degradation, sustainability, consumer behaviour

G – 07

Assessment of Heavy Metal Contamination in Tea Infusions: Implications of Chemical Contaminants in Dambetenna Estates, Sri Lanka

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Tea is a globally renowned and widely consumed beverage due to its distinctive flavor profile and pleasant aroma. Hence, chemical contaminants in tea have drawn much attention due to their potential impact on human health. The current study aimed to assess the levels of Cu, Zn, Ni, Cr, Mn, Pb, and Cd concentration in both green and black Tea infusions. Tea infusions were prepared using fresh leaves from two distinct tea plantations in Dambetenna, Sri Lanka. In both plots, soil type, average annual rainfall, and fertilizer application are similar. The weed control method was the only difference between the two plots. One plot represented an herbicide free (control) environment, while the other plot represented an herbicide applied environment. The heavy metal levels were determined by using Atomic Absorption Spectrophotometer (AAS). The data were statistically analyzed using student's t-test (95% confidence interval) to compare the difference in metal concentrations between the tea plots. The findings indicated that Cu, Zn, Pb, Ni, and Mn concentrations in black tea infusions did not vary significantly ($p > 0.05$) between herbicide applied and control plots. However, Ni and Mn concentrations of green tea infusions from the herbicide applied plot were significantly higher ($p < 0.05$) than that of the control plot. In addition, the Pb concentration in green tea infusions from herbicide applied plots (3.20 mg/kg) exceeded the Sri Lanka Tea Board standard acceptable limit (2 mg/kg). However, Cd and Cr concentrations of both green tea and black tea infusions remained below the detection limits of the AAS. Overall, this study provides insights into lead contamination in tea infusions in herbicide treated plots in Dambetenna Estates in Sri Lanka, offering valuable insights into the potential impact on tea quality and human health.

Keywords: atomic absorption spectrophotometer, black tea, green tea, heavy metals, tea infusions

G - 08

Adsorption of Methylene Blue by Manganese Dioxide and Reduced Graphene Oxide (MnO₂-rGO) Nanocomposite

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Textile dyes are considered as one of the significant groundwater pollutants emitted by apparel industries. These textile dyes cause numerous health concerns to humans and animals due to their toxicity and carcinogenicity. Methylene blue (MB) is a synthetic textile dye, frequently released in high quantities into natural water sources. Novel nanotechnological approaches to remove MB include nanoabsorbents, nanocomposites, nanophotocatalysts, nanofiltration, and nanomembranes. The study aimed to demonstrate the MB dye removal efficiency of MnO₂-rGO nanocomposite. The nanocomposite was characterized using Fourier transforms infrared spectroscopy, X-ray diffraction, and thermogravimetric analysis. Further, the effects of the dosage of the nanocomposite (1-2 gL⁻¹), pH (4, 7 and 10), dye concentration (10-50 ppm) for the dye removal and reusability of the nanocomposite were investigated. The optimum pH for decolorization was 7. Methylene Blue of 10 ppm can be decolorized in 15 min using 1 gL⁻¹ of the MnO₂-rGO nanocomposite with a 98% decolorization efficiency. The rate of decolorization decreased (from 96.5% to 28.3%) with increasing MB dye concentration (10-50 ppm) when used with a nanocomposite dosage of 1 gL⁻¹. Further, with an increasing nanocomposite dosage (from 1-2 gL⁻¹), an increased decolorization was observed in 20 ppm MB solution. The reusability of the nanocomposite was investigated using a nanocomposite dosage of 1 gL⁻¹ with 10 ppm dye solution. After three successive cycles, decolorization rate dropped to 76%. The pseudo-second-order model appeared to be the appropriate model for the adsorption of MB (r²=0.9958). Results indicated that the MnO₂-rGO nanocomposite could successfully adsorb MB in aqueous solutions and demonstrated high decolorization and removal efficiency.

Keywords: methylene blue, nanocomposite, pollutants, reduced graphene oxide



Session H

Land Use planning and Environmental Monitoring

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H - 01

Beach Slope Responses during the Northeast Monsoon in the West Coast of Sri Lanka

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The western and southwestern coastal zone of Sri Lanka is an important geographical region in terms of socio-economic and environment contribution. However, coastal erosion has been a significant problem in this coastal zone for a long period of time due to both natural and man-made causes. As beaches become narrow or disappear, coastal communities become increasingly vulnerable to coastal hazards. Long-term beach topography monitoring is critical for forecasting coastal erosion and accretion, and consequently for proper coastal management. Furthermore, it is essential for modelling the morphodynamics of specific sedimentary environments. This study assessed the spatial pattern of beach slopes on the sandy beaches along the western coast, extending from *Maha Oya* to *Kalu Ganga*, during the Northeast monsoon (NEM). Beach survey measurements from various locations representing the entire study area were used to obtain accurate information about the beach profiles of the western coast. Thirteen beaches were selected from eight different locations, from the high water line (HWL) to the backshore (5 m from HWL) along a transect during the neap tide. These measurements were analyzed and interpreted using Microsoft Excel and AutoCAD applications. The slope pattern in the environment varied over space, from steep slope to gentle slope (14.2-3.2°). Dikkovita, Wellawatha, Mount Lavinia South, Panadura South and Kalu Ganga North and South beaches can be classified as steep slopes (14.2-9.3°) with narrow beach widths. Meanwhile, Panadura North and Galle-face beaches have gentle slopes (3.2° and 4.5°) with beach widths of 3.4 m and 5 m respectively. According to literature, in the western coast, the wave energy is comparatively low during the period of NEM. Therefore, onshore accretion is predominant in this coast. However, the availability of sediment and various human interferences in this region are attributed to such spatial patterns of the slope responses. As a result, the beaches of Dikkovita, Panadura South, Kalu Ganga North and Wellawatha with steeper beaches are more vulnerable to coastal erosion.

Keywords: Beach topography, calm weather, western coast, northeast monsoon.

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H – 02

Monitoring the Spatial and Temporal Changes of Land Area under Rubber Plantations: A Case Study in Millaniya Divisional Secretariat of Kaluthara District, Sri Lanka

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Rubber plantations are important for both industrial and non-industrial production processes, and play a crucial role in the global economy. Monitoring the distribution and changes in rubber plantations is important for sustainable land management. This study focused on the spatial and temporal changes of area under rubber plantations in Millaniya Divisional Secretariat, Kaluthara District, Sri Lanka. Using Google Earth images from 2000 to 2022, land use changes were detected, and root cause analysis were employed. Furthermore, semi-structured interviews and a systematic literature review were conducted to explore the factors influencing the temporal changes of rubber plantations. The results revealed that in 2000, the total area of rubber plantations was 34.5 km², but in 2016, it declined to 23.9 km². This was further reduced to 12.6 km² by 2022. Diversification of rubber lands to other alternative land uses, such as build up areas, establishment of new coconut plantations, bare lands and fallow forests is found to be the main reason for this decline. This study revealed that the conversion rubber plantations to home gardens is a prime underlying cause for the reduction of the area under rubber plantations. During the period from 2001 to 2016, 7.2 km² area of rubber plantations have been converted into home gardens, and from 2016 and 2022, further 4.6 km² area were converted into home gardens. These findings may contribute to make decisions in implementing sustainable rubber industry and sustainable development of the country.

Keywords: change detection, Google Earth, replacements, rubber plantation, spatial changes

H – 03

Spatial Distribution Pattern of Beach Sand Properties on the Western Coast of Sri Lanka

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The beaches of Sri Lanka, which contain a variety of sediments with varying textural properties, are more attractive destinations for tourism. The destruction of beaches by coastal erosion has intensified in some areas as a result of both natural and man-made causes. In order to plan conservation measures, it is imperative to collect baseline data on textural characteristics of beach sediments. Further, textural characteristics provide useful information on the source of sediments and their transport pattern, morphology, and hydrodynamic characteristics in the corresponding sedimentary environment. This study investigates the spatial variation of textural foreshore properties of sediments on sandy beaches along the western coast extending from *Maha Oya* to *Kalu Ganga* during the Northeast monsoon. The study focuses on statistical parameters of texture such as mean, sorting, skewness, and kurtosis to describe the textural changes of grains in various locations that cover the entire study area. Thirteen sediment samples were collected from different beach cells along the foreshore during the neap tide subjected to dry sieving and then analyzed using GRADISTAT grain size software adopting the Folk and Ward method. Spatially, the beach sediments were characterized by coarse to fine, with a sorting variation from poorly sorted to well sorted. A non-uniform activity of skewness and kurtosis ranging from a higher proportion of platykurtic to leptokurtic nature was observed. Specifically, sediments deposited at *Maha Oya*, *Kelani* and *Kalu Ganga* river mouths were poorly or moderately sorted with a skewed and platykurtic or mesokurtic nature. Because, these river-based beaches and their characteristics were likely influenced by the respective river velocity and wave characteristics of the weather condition. Furthermore, the river outfall directions were southward. Therefore, it can be considered that the energy level of the transport medium, the source of sediment and the regional morphology might influence the sediment distribution in the study area.

Keywords: beach sediments, calm weather, grain size, influencing factors, western coast

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H – 04

Assessing PM10 Content under Different Lockdown Scenarios of the COVID-19 pandemic period: A Case Study in the Colombo Municipal Council Area

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Poor air quality has been identified as one of the leading environmental issues in Sri Lanka during the last few years. PM10 levels in Colombo Municipal Council Area are often higher than the permissible levels recommended by the World Health Organization and the Central Environmental Authority of Colombo. Many researchers worldwide observed the change in air quality during the lockdown period of COVID-19 pandemic. This study mainly focused to assess the spatiotemporal impacts of COVID-19 in the Colombo Municipal Council area. Landsat 8 (OLI) data from the United States Geological Survey and PM10 data from NBRO and the Sri Lanka Embassy in Sri Lanka were used to identify spatiotemporal variations. Spatiotemporal analysis and regression analysis were done by using ArcGIS 10.5 and SPSS software. PM10 data was obtained for three consecutive years from 2019, 2020, and 2021. The PM10 data for 2020 was divided into three main phases as before COVID-19 lockdown period, COVID-19 Lockdown Period, and travel restriction period. Similarly, the PM10 data for 2019 and 2021 were divided according to respective phases as in 2020. According to spatiotemporal distribution, the PM10 levels other than the 'travel restriction period' in 2019 reported high values of (36.94-185.42 $\mu\text{g}/\text{m}^3$), though it varied over space in the study area. Localities such as the port city, city center, main trade centers, and junctions (Borella, Maradana), industrial zones, and construction areas showed higher PM10 levels than 50 $\mu\text{g}/\text{m}^3$. The lowest PM10 value was reported during the 'lockdown period 2020', which fluctuated between 20.03-75.56 $\mu\text{g}/\text{m}^3$. In conclusion, the reduction of urban activities during the lockdown period could be the main reason for the decrease in atmospheric PM10 level in that period. High PM10 levels under normal conditions pose health risks and therefore necessary to take suitable remediation measures.

Keywords: Colombo, COVID-19, PM10, spatiotemporal

H – 05

Nexus of Climate Change and Maritime Security in Sri Lanka: Implications for Small Island Developing States

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Small Island Developing States (SIDSs) face urgent challenges at the intersection of climate change and maritime security. Their limited land area, delicate ecosystems, and reliance on coastal resources make them highly vulnerable to the compounded effects of climate change, intensifying storms, rising sea levels, and ocean acidification. These factors exacerbate existing maritime security risks, such as illegal fishing, piracy, and territorial disputes. This research comprehensively assesses the vulnerability of SIDSs to climate change-induced maritime security risks, with a focus on Sri Lanka as a representative SIDS. The research objectives are to evaluate the specific impact of climate change on maritime security of SIDSs, encompassing socio-economic consequences, environmental degradation and potential conflicts, and to examine the adaptation strategies and policy responses implemented by these states to mitigate and respond to the identified risks. The research adopts a desk review with content analysis, through which contextual insights into the vulnerability of SIDSs were assessed examining policy documents, reports, and academic literature. The content analysis identifies key themes and patterns related to climate change impacts and maritime security challenges faced by the state, such as economic losses, resource scarcity, social unrest, and territorial disputes. The analysis of adaptation strategies and policy responses reveals successful approaches and areas needing improvement. The discussion emphasizes the need for robust adaptation measures and effective policy frameworks to safeguard the interests of SIDSs in the face of climate change and maritime security challenges. Further, international cooperation, knowledge sharing, and sustainable development are crucial aspects in mitigating the fragility faced by SIDSs. In conclusion, this literature review enhances understanding of the challenges encountered by SIDSs at the convergence of climate change and maritime security, and offer valuable insights for policymakers and stakeholders to develop informed strategies addressing vulnerabilities and enhancing the resilience of SIDS.

Keywords: Small Island Developing States, climate change, maritime security, Sri Lanka, adaptation strategies

H – 06

Challenges in Implementing Climate Change Adaptation Policy in Bhaktapur, Nepal: A Case Study on Reluctance to Adapt

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The impact of climate change produces disruptive effects that are unpredictable and context-dependent. The negative impact of climate change on the developing world is severe, and studies indicate that robust and sustainable approaches to resilience are vital for those countries. For example, Nepal, being a land-locked country in the Himalayan region, is often subjected to climate change. Strengthening the resilience and adaptive capacities of climate-vulnerable communities, such as land-locked areas, would bring about favourable opportunities globally. However, some communities in the developing world encounter difficulties in establishing appropriate adaptation policies. Thus, this study was conducted to understand why people in the most climate-vulnerable communities fail to actively incorporate themselves with such climate change adaptability policies. The case study design was employed, and data were collected through in-depth interviews (n=15, 10 women and 5 men mainly employed in agriculture) and two focus group discussions with individuals who had experienced the devastating impacts of climate change in Bhaktapur, a remote village in Nagarkot, Nepal. Data were analyzed thematically using MAXQDA. The analysis revealed five themes that describe why people in the said vulnerable community are not ready for climate change adaptation. Firstly, people are unaware of the impact of climate emergencies because information about climate change emergencies is not properly communicated to them, and they receive information only through informal sources. Secondly, as a result, particular focus is not given to communities facing such emergencies, in Bhaktapur. Thirdly, people are bound by certain cultural values and traditional normative structures that are not aligned with climate change adaptability programs, making them less likely to change. Fourthly, migration to a another location within Nepal is not considered as a viable solution, since many places in Nepal also experience the same climate change impacts. Finally, despite the strengthening of internal social networks among people (social capital), it is not effectively incorporated into implementing climate change adaptation policy due to inadequate connection with external policy organizations (disparaging linking social capital). Overall, the research found that implementing climate change adaptation policies in the most vulnerable communities can be jeopardized when people are not empowered before the adoption of policies.

Keywords: climate change adaptation, Nepal, resistance to change, social capital, vulnerable communities

H – 07

Identifying Critical Environmental Regions within the Colombo Metropolitan Area based on Urban Heat Island Effect using Remote Sensing and GIS

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Urban Heat Island (UHI) effect is a phenomenon where the surface and atmospheric temperatures of urban areas are higher than the rural areas that surround them. Colombo Metropolitan Area (CMA) has been experiencing rapid urbanization over the past few decades owing to rapid infrastructural development projects. The study aims to detect spatial and temporal changes in the CMA from 2018 to 2021 using Remote Sensing (RS) and Geographical Information Systems (GIS). Preprocessed data sets retrieved by the Landsat 8 satellite imagery were used to map Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Normalized Difference Built Up Index (NDBI) and Urban Thermal Field Variance Index (UTFVI) for 624 point locations using version 10.8 of ArcGIS. From year 2018 to 2021, the mean LST and NDVI of the CMA showed an overall increase of 0.26% and 1.73% respectively while the NDBI and UTFVI showed an overall decrease of 4.86% and 32.97% respectively. According to association analysis conducted using SPSS version 26, variations in LST in the years 2018, 2019, 2020 and 2021 have been explained by NDVI via 8%, 17.6%, 11.9% and 16.8% and by NDBI via 0.3%, 0.3%, 0.2% and 0.1% respectively. The correlation matrix revealed that relationship between NDVI and LST was relatively stronger than the relationship between NDBI and LST though both showed weak relationships ($\pm 0.3 < r < \pm 0.5$). Mapped UTFVI disclosed that the major Environmentally Critical regions lie primarily at Fort, Wickramasinghapura, Mattegoda, Rawathawatta East, Navinna, Lunupokuna, Mahawatta, Pamunuwa, Angulana South, Korlawella South, Makandana East, Moratumulla East, Pahala Biyanvila East, Balagala and Boralessgamuwa East regions (UTFVI > 0.010) indicating a strong UHI phenomenon and a worse ecological evaluation index. UTFVI provides valuable thermic insights of CMA, and it would be beneficial for the city planners and decision makers to utilize the Environmentally Critical Zones in a prudent manner.

Keywords: Colombo metropolitan area, land surface temperature, Normalized Difference Vegetation Index, Urban Thermal Field Variance Index

H – 08

Remote Sensing Analysis of Impacts of Agrochemical Ban on Paddy Farming in the Maha Seasons of 2020/21 and 2021/22: A Case Study of the Deduru Oya Basin

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The Sri Lankan government implemented an agrochemical ban in April 2021 to reduce the expenses related to foreign exchange and to reduce the health impact on chronic kidney disease, especially in the Dry zone. Despite the subsequent withdrawal of the ban, its impact on agricultural crops and yield has persisted. In the field of Remote Sensing (RS), Aboveground Biomass (AB) and Normalized Difference Vegetation Index (NDVI), are commonly used to analyze crop productivity and vegetation health. This study examined the productivity and health fluctuations of paddy in the Deduru oya basin before and after the implementation of the agrochemical ban using RS during the Maha seasons of 2020/21 and 2021/22. The Deduru oya covers an area of 2616 km² across three climatic zones, including about 315 km² of paddy land. The study used net primary production data, land use data, and Landsat 8 satellite imagery as secondary data, collected from Wapor Portal, ESA World Cover, and USGS Earth Explorer. Mapping analysis, descriptive statistical analysis, and correlation analysis were conducted and calculations were performed using Model Builder in ArcGIS by calculating aboveground biomass over total biomass ratio, light use efficiency, net primary production, and moisture content in fresh biomass of paddy. The study revealed that the seasonal biomass of paddy before and after the agrochemical ban was reduced by approximately 25%, while the seasonal average biomass across Divisional Secretariat Divisions experienced a decline of 10-20%. Furthermore, the NDVI of paddy showed a decline and the correlation analysis indicated lower values for the biomass versus NDVI after the ban. Therefore, the agrochemical ban has resulted in a detrimental impact on paddy cultivation in the study area, but further research is necessary for a comprehensive understanding of the long-term effects of the ban on paddy productivity and health.

Keywords: agrochemical ban, remote sensing, aboveground biomass, Normalized Difference Vegetation Index, paddy cultivation

H – 09

Community Perception on Irrigation Rehabilitation Activities of the Yan Oya River Basin

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Ancient village tank systems in North Central Sri Lanka are a unique heritage of the country. These tanks in cascade systems are connected through canals. However, most of these tanks and canals have suffered degradation over time. Periodically, these tanks have been rehabilitated but the outcome of these rehabilitation activities have not often been socially accepted. The present study focused on the perceptions of the local community regarding rehabilitation work carried out at *Ilukwewa*, *Komarikawala* and *Hettuwewa* cascade systems of the Yan Oya River basin in the eastern part of the Anuradhapura District. These cascade systems have been rehabilitated in the 1980s. It is imperative to understand the connectivity and the flow of water when describing ancient cascade systems. Therefore, data were collected by interviewing key informants (one knowledgeable person like *Wel-Vidane* per village) and by a questionnaire administered to two officers from farmer organizations in each village. Thus, altogether, 58 persons from 29 villages were included in the study. Area of tank and the elevation above mean sea level were obtained from Google Earth Map and the Google Map facility, and Google's Street View facility. These cascade systems receive water from Hurulu wewa along the Yan Oya, by a canal constructed in the 1980s, which provides water to many of the tanks in the cascade systems. Thus, water coming from Huruluwewa reaches the new anicut at *Ilukwewa*. However, it bypasses the *Ilukwewa* tank. Further, in the *Komarikawala* cascade system, water that reaches some tanks is drained back to the canal rather than passing from one tank to the other, like in ancient cascade systems. In contrast, the *Hettuwewa* received more water from *Ilukwewa* anicut and to retain the water, some constructions have been conducted. This, however, resulted in the flooding of adjacent paddy fields and burial land. Many respondents felt that the rights of all the paddy farmers have not been adequately considered when making decisions during irrigation rehabilitation activities. Political pressure and a disregard for social needs were cited as the main underlying causes for this situation. This study highlights the importance of avoiding political agendas and involving the community in decision making for maintaining ancient cascade systems for the sustainable development of the country.

Keywords: Anuradhapura, cascade systems, irrigation rehabilitation, social

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