THE OPEN UNIVERSITY OF SRI LANKA

PROCEEDINGS OF THE 1ST INTERNATIONAL CONFERENCE ON MANGROVES FOR ECOLOGICAL & ECONOMIC SUSTAINABILITY

ICMS

Centre for Environmental Studies & Sustainable Development

26 July, 2023

ICMS 2023

THE OPEN UNIVERSITY OF SRI LANKA

CENTRE FOR ENVIRONMENTAL STUDIES & SUSTAINABLE DEVELOPMENT

BIODIVERSITY SECRETARIAT MINISTRY OF ENVIRONMENT

International Conference on Mangroves for Ecological & Economic Sustainability

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ABSTRACTS

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Biodiversity Secretariat, Ministry of Environment

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Message of the Vice Chancellor

It is with my great pleasure I write this message as the Vice Chancellor of the Open University of Sri Lanka. Conducting research, share findings among relevant parties, and providing international platforms to present research findings are indeed paramount duties by the higher education institutions.

Understanding the role of higher education institution's, Centre for Environmental Studies and Sustainable Development (CESSD) of the Open University of Sri Lanka (OUSL) has organised the "International Conference on Mangroves under a timely important theme on "Mangroves for Ecological and Economic Sustainability" (ICMS). Mangrove is a vital ecosystem on Earth with distinguishing ecological features and critically important habitats for animals in the coastal areas. Mangroves provide significant ecological, social, and economical benefits for a country's development. Therefore, I recognise the importance of taking the leadership of having a research conference dedicated to mangroves on the 26th of July 2023, marking the World Mangrove Day.

I hope that the outcome of the research studies will be taken up by the interested parties including national decision-making authorities in making administrative, and necessary conservation and managerial decisions. Further, research findings will definitely be helpful in understanding challenges faced by the highly important mangrove ecosystem at large and it will support regional collective efforts in conservation and development of mangrove ecosystem.

Finally, I convey my gratitude to all the participants for keeping trust and choosing the "International Conference on mangroves: ICMS 2023, organised by the CESSD of the OUSL to publish their valuable research findings. I would like to convey my sincere thanks to distinguished keynote speakers, plenary speakers, reviewers, collaborators, sponsors and

participants. I also wish organizing committee of the conference and all staff members of the CESSD for organizing the first virtual conference on mangroves for ecological and economical sustainability. I wish you good luck to continue this event annually!

Professor P. M. C. Thilakerathne
Vice-Chancellor
The Open University of Sri Lanka
Sri Lanka

Message of the Secretary – Ministry of Environment

Mangrove forests are unique in their fauna and flora and provide significant environmental services which brings about socio-economic benefits to the country. The mangrove ecosystem plays a key role by acting as a filter between marine and terrestrial ecosystems. The main ecological services of mangroves are protecting the coast from "greenhouse" effects, cyclones, floods, sea level rise, wave action and coastal erosion. Mangroves contribute significantly to the global carbon cycle and produce large amounts of litter in the form of falling leaves, branches, and other debris. Besides, mangrove habitats contribute to complex food webs and energy transfers.

Sri Lanka has nearly 19,000 ha of mangroves with 21 true mangrove species which is almost one third of the global diversity of true mangroves and several mangrove associates. Despite all the above benefits delivered by mangroves, a considerable extent of mangroves in Sri Lanka is being destroyed and degraded due to various factors. Accordingly, the country has taken a number of significant measures to restore and conserve mangroves in order to safeguard biodiversity and to ensure the ecosystem services of mangroves as well as opportunities for livelihoods.

Ministry of Environment has taken many steps to restore mangrove ecosystems by establishing Expert Committee and a Task Force with relevant stakeholders, including universities and private sector. In 2018, then H.E. the President of Sri Lanka and the Minister of Environment officially announced the willingness of Sri Lanka to Champion the Commonwealth Blue Charter Action Group on Mangrove Restoration and livelihoods during the Commonwealth Heads of State Meeting held in London.

The “National Policy on Conservation and Sustainable Utilization of Mangrove Ecosystems in Sri Lanka” was approved by the Cabinet of Ministers in 2019.

Creating awareness among children and youth on restoration of mangrove ecosystems and getting them involved actively in management and sustainable utilization of resources is very important. In addition, at present research are being carried out to explore the potential of blue carbon economy.

I wish to congratulate the Open University of Sri Lanka for organizing the "First International Virtual Conference on Mangroves for Ecological and Economic Sustainability " to commemorate the “International Day for the Conservation of the Mangrove Ecosystem”2023, which will bring many professionals together to share, scientific information, experiences in mangrove conservation and sustainable utilization practices.

Dr. Anil Jasinghe
Secretary
Ministry of Environment
Sri Lanka

Message of the Director - Centre for Environmental Studies & Sustainable Development

On behalf of the organizing committee, it is my honour and privilege to welcome you all to the 1st International Virtual Conference on Mangroves for Ecological & Economic Sustainability. As the Chair of this conference, I extend my warmest greetings and heartfelt appreciation for your valuable presence in this momentous event.

Mangroves hold a vital position in the preservation of our planet's delicate ecosystems, and it is our collective responsibility to safeguard their existence. With the diverse range of themes encompassing this conference, we aim to explore the multidimensional significance of mangroves in promoting ecological balance, economic prosperity, and the sustenance of coastal environments and biodiversity.

The Centre for Environmental Studies & Sustainable Development at The Open University of Sri Lanka, located in the vibrant city of Colombo, is honoured to host this prestigious conference on 26th July 2023. We sincerely thank all the participants, keynote speakers, session chairs, and scientific committee members for their immense contributions in shaping this conference and making it a resounding success.

We eagerly anticipate fruitful discussions, insightful presentations, and the emergence of collaborative partnerships that will propel mangrove conservation and sustainable development to new heights. Together, let us champion the cause of mangroves and work towards a future where ecological and economic sustainability go hand in hand.

Prof. Bandunee C.L. Athapattu
Director - Centre for Environmental Studies & Sustainable Development
The Open University of Sri Lanka, Sri Lanka

Message of the Director – Research Unit

I am delighted to contribute this message to the First International Virtual Conference on Mangroves for Ecological & Economic Sustainability (ICMS 2023) organized by the Centre for Environmental Studies & Sustainable Development (CESSD), OUSL together with the Biodiversity Secretariat, Ministry of Environment, Sri Lanka.

The annual Open University Research Sessions (OURS) organized by the Research Unit of OUSL established itself as a high caliber research forum that attracts not only researchers from the OUSL community, but also from other state universities and higher education institutions, creating a forum for presenting and discussing valuable research findings leading to enriching experiences to the researchers. OURS significantly contributed to enhance the research culture among OUSL staff members in ODL and disciplinary-based research, which directly inspired our staff members to participate at other national and international conferences including the Asian Association of Open Universities (AAOU) conference by contributing quality research findings. The OUSL hosted the 34th Annual Conference of AAOU in 2021.

This year on 9th and 10th November, the Research Unit is planning to hold the Open University Research Sessions (OURS 2023) with the objective of bringing local and foreign researchers to one forum. In addition, the Faculty of Management Studies of OUSL hosted the International Conference on Management and Entrepreneurship (ICOME) in year 2022 and in May 2023.

As a further step towards enhancing the research culture in OUSL, CESSD together with the Biodiversity Secretariat, Ministry of Environment is hosting the 1st ICMS 2023 on 26th July 2023.

Mangroves provide an essential habitat for thousands of species and act as carbon sinks. Mangrove forests are biodiversity hotspots and stabilize shorelines, preventing erosion and protecting the land and the people who live there, from waves and storms.

A conference is not just an *avenue for a scientist/researcher to present their research to the wider community*, but it can be an important venue for brainstorming, networking, and making vital connections that can lead new initiatives and findings.

Therefore, ICMS 2023 will provide visions to explore the multi-layered significance of mangroves. The conference brings together an esteemed gathering of scholars, researchers, policymakers, conservationists, industry professionals, and enthusiasts from around the world.

While congratulating the presenters and thanking the Conference Committee, I wish the ICMS 2023 all success.

Professor Shyama R. Weerakoon
Director
Research Unit
The Open University of Sri Lanka
Sri Lanka

Message of the Director – Biodiversity Secretariat, Ministry of Environment

Mangrove ecosystems are unique in nature and are found in tropical and sub-tropical regions of the world. In late 1970, Sri Lanka had over 25,000 ha of mangroves which and are now under various land use categories. For restoration of these ecosystems the options are available at abandoned shrimp farms, abandoned salterns, small patches that are present in between developed lands that can be restored as isolated patches, mangroves that are degraded and present as remnant patches in some military occupied areas, private and state lands along river mouths until the limit of tidal influence (tidal back water areas), some abandoned paddy areas adjacent to mangroves in coast.

Therefore, including these areas realistically further 1000 ha can be restored as mangroves according to the information of Forest Department.

The Biodiversity Secretariat of the Ministry of Environment has recognized the importance of conservation and sustainable use of mangrove ecosystems and established the National Expert committee on Mangrove conservation and sustainable use in year 2015 and it comprises of the relevant government, private and non-government stakeholder agencies and experts from universities. The Committee coordinates and steer the activities related to conservation and sustainable use of mangrove ecosystems in Sri Lanka.

The National Policy on Conservation and Sustainable Utilization of Mangrove Ecosystems was developed and approved by the Cabinet of Ministers in 2020, In order to implement the Policy, the National Strategic Action Plan for Conservation and Sustainable Utilization of Mangroves in Sri Lanka (2022 -2026) was prepared and introduced to the relevant stakeholders and experts. This National Action Plan has been focused on

“Conservation, Research, Land Use Conversions and sustainable resource extraction and restoration parameters” as stated in the Policy

I wish to thank the Open University of Sri Lanka for organizing the "First International Virtual Conference on Mangroves for Ecological and Economic Sustainability " to commemorate the “International Day for the Conservation of the Mangrove Ecosystem”2023, which will be very much helpful in taking the message of mangrove conservation, restoration, and sustainable use across a wide range of participants to strengthen the national and international activities to restore this unique ecosystem.

Ms. Sujeewa Fernando
Director (Biodiversity)
Ministry of Environment
Sri Lanka

Message of the Chairman – Sri Lanka Turtle Conservation Project

Mangroves are unique ecosystems located in coastal areas and have many fascinating adaptations that enable them to survive in water with high salinity. The environmental, economic, and social benefits provided by the Mangroves are innumerable and the Mangroves help the sustainable fishery as well as biodiversity conservation. Mangrove acts as a first line defense in natural disasters like Tsunami and is a bio-fence that protects the humans as well as inland infrastructure. Unfortunately, this important ecosystem is currently being destroyed by the anthropogenic actions. Clearing of mangroves for aquaculture and shrimp farming projects, destruction of mangroves for agricultural purposes and acquiring mangrove lands for human settlements are the main reasons for destruction of important mangrove habitats.

The mangrove conservation has drawn the attention of the global community and 26th July is designated as the 'International Mangrove Day'. It is a great pleasure to provide financial assistance to the symposium "1st International Virtual Conference on Mangroves for Ecological and Economic Sustainability" organized by the Center for Environmental Studies and Sustainable Development of Open University of Sri Lanka to commemorate this special day. Considering the rapid destruction of mangrove ecosystems in Sr Lanka, this symposium is highly relevant and timely arranged. The experience of global community will assist the mangrove conservation efforts of Sri Lanka. Knowledge on different mangrove restoration methods, strategies that were successful or unsuccessful can be exchanged. This is a highly relevant in current context. Similar symposia will encourage university students to be involved in further scientific research and studies on mangroves. There is great potential to bring foreign revenue to Sri Lanka through Blue Carbon projects involving mangrove restoration projects. This can also be an

investment opportunity. Long-term research data is essential to the success of above projects and the initiative taken on this regard by professor Bandunee Athapaththu and professor Rangika Bandara and the panel of lecturers at Open University of sri Lanka is highly appreciated and commended.

I am sure their efforts will greatly contribute to the upliftment of mangrove conservation in Sri Lanka. I, along with the staff of Sri Lanka Turtle Conservation Project wish all the success to this symposium.

Mr. Thushan Kapurusinghe
Chairman
Sri Lanka Turtle Conservation Project

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KEYNOTE ADDRESSES

Contribution of mangroves to ecological sustainability and human survival in a changing world

All forms of life, including humans need basic requirements, i.e. air, food, water, and habitats to sustain on Earth and they are produced by Nature through myriad interactions or ecological processes that take place between biotic and abiotic components of the planet. Nature's capacity to support life, therefore, depends on how well these processes would take place or in other words, the ecological sustainability of the Earth's ecosystems, on which survival of all life including our own, essentially depends on.

Mangroves form one among many ecosystems on planet Earth and they are unique as they occupy the land -sea ecotone, the inter-tidal zone. Harsh environmental conditions, i.e., unstable saline substrata, soil anoxia, lack of freshwater, exposure to sun in the tropics have favoured the evolution of adaptations to cope with these adverse conditions for millennia and thus present-day mangroves represent a group of plants with unusual abilities to thrive in the inter-tidal zones of tropics. They are halophytic and equipped with organs and mechanisms to overcome adverse effects of anoxia, salinity, physiological drought and unfavourable conditions for sexual reproduction. Mangroves have thus become superior primary producers and atmospheric decarbonizes through the processes of photosynthesis and sequestration of carbon in plant biomass and in soil. Mangrove soils sequester at least five times more organic carbon than in biomass, indicating the superior contribution of mangrove ecosystems to reduce greenhouse effect and climate change.

Mangrove ecosystems, therefore, contribute immensely to reduce climate change that we experience currently and its detrimental effects on life, such as sea level rice due to glacial melting, ocean acidification, habitat

degradation and loss of both aquatic and terrestrial organisms, affecting human livelihoods, mainly agriculture, fisheries, aquaculture, animal husbandry, nature-based (wildlife) tourism, that are dependent on biodiversity and abundance. Besides, increasing incidence of droughts, floods and storms directly impact the quality of habitats available for humans and all other forms of life on Earth.

Mangroves that can naturally grow 10 – 20 m in height may provide effective barriers against storms and high energy wave events such as tsunamis and the aerial roots check coastal soil erosion. Mangrove areas provide habitats for a wide spectrum of species, including those in coastal and marine waters as well as on land. The unique habitats that are available within mangrove areas are those that are formed by the aerial roots of mangroves. These are protective against predators, especially of the juveniles and provide safe substrata for larval attachment of most marine finfish and shellfish species. Dissolved and particulate mangrove organic matter provide them food. This nursery function of mangroves therefore is of paramount importance for the diversity and abundance of coastal and marine biodiversity on which the fisheries production is dependent.

Protecting the existing mangroves and rehabilitating degraded mangroves have gained attention as a need of the hour to abate the impacts of anthropogenic climate change and ensure perpetuation of human and other forms of life on Earth.

Prof. Mala Amarasinghe
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Carbon sequestration by mangroves based on salinity profile

The rising emission of Green House Gases (GHGs) and the associated adverse impacts on the ecosystem has led to increased interest in identifying mangrove floral species with high carbon storage capacity.

The mangrove forest ecosystems are known to store considerably higher quantities of carbon per unit area. Despite the importance of mangrove forest vegetations in storing carbon, the economic aspect of these services has not been considered in the management decisions. Various studies have now provided a monetary value for carbon stocks.

Floral communities of the planet Earth (which are popularly called producers of the ecosystem) absorb carbon dioxide from the ambient environment/atmosphere during the process of photosynthesis and store it as biomass. Carbon is stored in five pools, namely above-ground biomass (AGB), belowground biomass (BGB), leaf litter, dead wood, and soil carbon stock in forest ecosystems (Fig. 1). However, the magnitude of carbon pool in halophytes is regulated by the ambient aquatic salinity.

India has a total mangrove cover of 4627.63 sq. km, which is 0.15% of the country's land area, 3% of the global mangrove area, and 8% of Asia's mangroves. Recent assessment of mangrove area in India (1987– 2013) reveals that the mean annual change during the period is 24.25 ± 82.57 sq. km. Most of the states are experiencing an increase in area under mangroves, except Andhra Pradesh (–5.95 ± 15.70 sq. km) and Andaman and Nicobar Islands (–3.41 ± 52.32 sq. km). Mangroves in India are unique in terms of their extent, variability, and biodiversity. A total of 4011 species, including 920 plant (23%) and 3091 animal (77%) species have been recorded from Indian mangrove ecosystems, which is highest in the world.

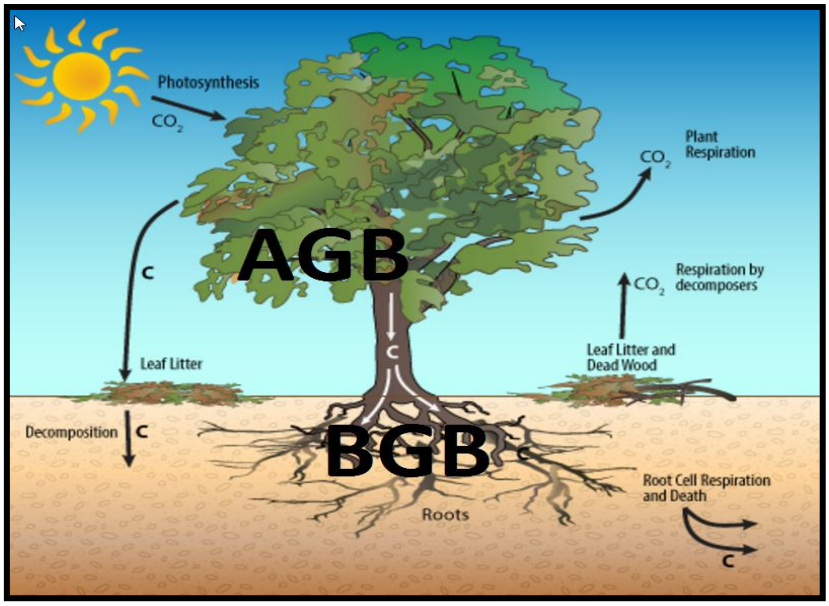

Fig. 1. Compartments serving as carbon pools

It is interesting to note that the oceans, seas, bays, and estuaries in and around the Indian Sub-continent has significant variations in terms of salinity. In Arabian sea and the Indian ocean, the salinity is considerably high, whereas in the Bay of Bengal off the east coast of India, salinity is relatively low owing to riverine discharge. Again, within the Indian Sundarbans mangrove ecosystem, there exists significant salinity variations.

The western and eastern Indian Sundarbans are hyposaline, whereas the central sector is hypersaline due to siltation in the upstream region since the 15th century. Because of this, the diversity, composition, biomass, and carbon storage potential of mangroves also differ greatly. It has been found that the carbon storage is 128.58 tha^{-1}, 67.44 tha^{-1} and 139.13 tha^{-1} in the western, central, and eastern Indian Sundarbans respectively. This proves that salinity, as the main driver of carbon sequestration in mangrove, needs to be regulated either through large scale expansion of rainwater harvesting pockets in the hypersaline central sector or through interlinking of the Hooghly (hyposaline estuary in the western Indian Sundarbans) and the Matla (hypersaline estuary in the central Indian Sundarbans) after

conducting EIA and EMP for the entire process as per the guidelines of the Government of India.

Prof. Abhijit Mitra
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THEMATIC SPEECHES

Impacts of climate change on mangrove ecosystems in Sri Lanka

Deep organic matter-rich soil and dense vegetation, qualify mangroves to be ranked among the most carbon-dense forests in the tropics. Combination of high primary productivity as well as the anaerobic conditions prevailing in the substratum favours accumulation of organic matter in mangrove soil.

Mangrove forests in Sri Lanka are scattered mainly along the northwestern, northeastern, and eastern coasts in a narrow strip along with intertidal areas of lagoons, estuaries, or associated islands and river mouths. They rarely extend beyond 1 km landwards from the mean low water tidal level. The key climate and ocean drivers of change that are expected to impact mangrove ecosystems as variations in air and ocean temperatures; ocean chemistry; rainfall; wind strength and direction; sea levels and wave climate (especially extremes such as hurricanes, drought and storm surges). Inter-tidal zones may shift landward with increasing sea level, and it could potentially affect the total extent of mangrove areas. Soil surface elevation, a phenomenon governed by surface and sub-surface processes, however, may influence the inundation patterns due to sea level rise (SLR). Carbon sink function of mangrove ecosystems therefore could potentially be affected with SLR as permanent inundation of mangrove roots for a long period of time could possibly deprive the roots of air (relevant adaptations may not be adequate to withstand such a situation) and cause death of the plant. Based on available evidence, relative SLR may be the greatest threat to mangroves. However, the increased surface temperature combined with atmospheric CO_2 is expected to affect mangroves not only by changing both species composition and the phenological patterns, but also the metabolic activities. Thus, it will threaten the resilience of mangrove ecosystems that typically occupy intertidal zones.

Impacts of SLR (based on the predictions of Intergovernmental Panel on Climate Change for years 2100 and 2150) on mangrove ecosystems of Chilaw Lagoon, Sri Lanka were studied in detail in 2022. Carbon storage, carbon accumulation, carbon emissions, net carbon sequestration, and valuation of net carbon sequestration were modelled considering four SLR scenarios. Total carbon sequestration (2021–2150), the monetary value of carbon sequestration in 2150, and carbon accumulation (2100–2150) were all predicted to decrease with rising sea levels. Emissions of carbon were found to increase with the increasing level of disturbance owing to SLR.

In addition to SLR, removal of mangroves has made the case severe in Sri Lanka. Land reclamation for agriculture, salterns and aquaculture activities, physical infrastructure developments and over-exploitation of the forest resources were some of the main causes for mangrove loss in the country.

Dr. D.D.G.L. Dahanayaka
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Mangroves of Indian Sundarbans: Pave the way towards alternative livelihood schemes

According to the World Resources Institute, about 39% of the World's population (which is around 7.9 billion in 2022), is approximately 3.0 billion people. This considerable chunk of the global population lives on or within 100 km (60 miles) of the seashore. Their lives and livelihoods are totally dependent on the resources available from the marine and estuarine ecosystems. It has been documented that poverty-stricken people (preferably the poor island dwellers) of Indian Sundarbans are more susceptible to adverse impact of climate change. They have no proper shelter, no fund for resettlement and no insurance against their lives, health and properties. Institutional help hardly reaches them. Hence, reduction of poverty through development of sustainable livelihoods is an important component in fighting against temperature rise, sea water intrusion, and disease outbreaks which are the clutches of climate change frequently scratch the economics of the region.

Mangroves constitute a small fragment of the total global forest cover, but still provide a wide range of livelihoods. The principal goods and services provided by mangroves are very wide in dimension, but we have considered here only few innovative mangrove floral based livelihoods, not addressed so far by any researchers in context to the framework of Indian Sundarbans. These include preparation of mangrove (*Sonneratia apetala*) fruit-based coconut ladoo (Narkel Naru) and *Sonneratia caseolaris* fruit-based jelly, which may sound 'odd man out', but has tremendous potential to develop eco-friendly sustainable mangrove based livelihood for the people of Sundarbans.

Mangrove associate flora like saltmarsh grass and several other halophytes like *Suaeda* and *Salicornia* constitute an integral part of the mangrove ecosystem and render a wide array of ecosystem services like erosion control, protection against hyper salinity, wave attenuation, stability of intertidal mudflats, bioremediation, carbon sequestration etc. However,

these associate species can also generate a few innovative alternative livelihoods like prawn feed from *Salicornia brachiata*, mangrove associate floral based popular Indian street food items such as Golgappe/Phuchka etc., which are befitted to the region. However, a sound supply chain and a nursery backup are needed to make these innovations a success, which are still in pilot scale.

Dr. Sufia Zaman
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Mangrove restoration: for what?

As a national contribution to the UN Decade of Restoration as well as for other in-country, regional and international commitments, mangrove restoration is currently in the limelight. However, in Sri Lanka, attention to mangrove restorations spans beyond current renewed global interest. Since the last Tsunami in 2004, which highlighted the role played by mangroves in disaster mitigation in coastal areas, an attempt to expand mangrove cover is evident in many sectors. Expansion of marine protected area network in Sri Lanka and declaration of key areas that harbour mangroves as International Ramsar Wetland can be quoted as examples of protecting the existing. Restoration of mangroves adopting assisted natural regeneration as a scientific approach was proposed after published evidence indicated failures more than successes. Hence, the purpose of restoration needs to be clearly defined. Firstly, any nation including Sri Lanka, should act with the understanding that availability of areas for restoration is an indicator of lapses in efforts to conserve and sustainably develop in and around mangroves. Hence, conservation should be the first target. Restoration is also for scientifically evaluating what the areas that are actually degraded, what are available for restoration and the feasibility of projects. Restoration is neither for expanding mangroves to other ecosystems nor for destroying a well-established coastal vegetation type to bring back mangroves, as historical evidence suggests the presence of mangroves in the past. Restoration is also to ensure recovery of ecosystem processes and services butjust establishing plants. Hence restoration should focus on abiotic and biotic system re-activation. Ultimately, restoration should be for people and done with people without alienating the livelihood of daily mangrove dwellers.

Prof. Sevvandi Jayakody
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ABSTRACTS

Abstract No: 001 Mangroves and Ecotourism

Using mangroves to promote tourism - A case study of Madu River Safari

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Mangroves are among the most productive ecosystems on the planet, and they can also be found along Sri Lanka's coastline. Mangroves play an important role in ecotourism because they provide ecosystem services. One of Sri Lanka's most well-known river safaris is associated with the Madu River, which is in the Galle district. This minor watercourse in Sri Lanka begins near Uragasmanhandiya in the Galle District and flows into the Madu Ganga Lake at Balapitiya. Ecotourism practices can be identified associated with this river. The primary goal of this research is to identify the significance of mangroves in promoting tourism at Madu River. This research will aid in assessing the usage of Mangroves in the promotion and attraction of Madu River safaris. To collect qualitative data on mangrove ecosystem-related works, 46 safari service provider websites were chosen. Additionally, published research papers and tourist reviews on websites were used to determine tourists' perceptions of the Madu River safari. The content analysis method was used to analyse the collected data. According to the findings, 91% of Madu River safari service providers use the term "Mangroves" to promote their service. Among them, 62% use the term solely to mention it on their website, while 33% explain the mangrove ecosystem, different types of mangroves, and ecosystem services. Another 5% use the term very casually as "Boat ride through mangrove trees". When considering tour promotion, tourist attraction also should be considered. According to reviews and related research, tourist satisfaction was primarily found in the mangrove ecosystem. According to the findings, tourists are not that much satisfied with other factors such as safety, boat quality, and safari fees. Majority of Madu River safari service

providers use the term "Mangroves" to promote the trip, and tourists are pleased with their experiences with the mangrove ecosystem during their trip. Thus, mangroves play an important role in tourism promotion. Mangroves should be protected in order to boost ecotourism in Sri Lanka.

Keywords: *Mangrove, Ecosystem, Madu River, Safari*

Abstract No: 002 Mangroves for Economic Development

Review study: Pharmaceutical value of Sri Lankan mangroves

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Mangroves wield a crucial ecological function in Sri Lanka, shielding coastal communities and marine life from natural disasters. However, beyond their ecological significance, these mangroves house untapped medicinal properties. This review examines the potential pharmaceutical value of Sri Lankan mangroves, laying the groundwork for future investigations. With over 20 mangrove species constituting 10% of global mangrove biodiversity, Sri Lanka presents an opportunity for further exploration. Mangroves showcase abundant diversity when it comes to novel chemical compounds. Flourishing in harsh and challenging environments, they have devised adaptive strategies, resulting in the creation of unique chemical compounds. These compounds not only ensure their survival but also bear tremendous potential for pharmaceutical applications, serving as a valuable resource for scientific inquiry and exploration. Mangroves possess a wide array of bioactive compounds, including alkaloids, phenolics, saponins, flavonoids, steroids, and terpenoids, which shield them from various biotic and abiotic stresses like salinity variations, anoxic soil, water logging, direct exposure to sun and temperature variations. Considering stressful conditions, scientists are exploring to development pharmaceutical products. Sri Lankan coastal communities have tapped into the pharmaceutical potential of mangroves in treating diverse ailments. Traditional practices involve utilizing specific parts of different mangrove species to address specific health conditions. For instance, the bark of *Rhizophora mucronata* is

steeped in tea to alleviate fevers, while *Avicennia marina* leaves are boiled for treating diarrhea and dysentery. *Bruguiera gymnorrhiza* bark is employed in tea form to combat malaria, and crushed leaves of *Sonneratia alba* are topically applied for managing skin diseases. Although these traditional remedies lack scientific proof, they underscore the extensive knowledge and potential of mangroves in Sri Lankan traditional medicine. Scientific evidence substantiating the medicinal properties of mangroves remains limited not only in Sri Lanka but also in a global context. However, recent studies have successfully validated the effectiveness of mangrove extracts, Alkaloids like rhizophoramuconate from *Rhizophora mucronata* bark and bruguierin from *Bruguiera gymnorrhiza* bark exhibit anti-inflammatory, antioxidant, anti-diabetic, and anti-cancer effects. Phenols such as gallocatechin from *Avicennia marina* leaves possess anti-inflammatory and antioxidant properties. Triterpenes like ceriosin from *Ceriops tagal* bark demonstrate anti-inflammatory and antioxidant activities. Terpenoids like furanocoumarins from *Avicennia marina* leaves exhibit insecticidal properties. Additionally, Bruguierin, Gibberellins, Triterpenes from *Bruguiera gymnorrhiza* bark have demonstrated antiviral properties against HIV, hepatitis B, and the dengue virus. These extracted compounds highlight the immense potential of mangroves as a source of new medicines. In conclusion, the pharmaceutical potential of mangroves, particularly in Sri Lanka, is a promising field of study. These unique ecosystems not only wield a vital ecological role but also possess untapped medicinal properties. Traditional knowledge and scientific research confirm the presence of potent bioactive compounds within mangroves. However, further research is needed to fully comprehend and harness their therapeutic potential. Additionally, addressing gaps in mangrove microbiology, genetics, and physiology will enhance our understanding and utilization of these invaluable resources. Continued research efforts hold great promise for advancing pharmaceutical discoveries and improving human health and conservation endeavors.

Keywords: *Bio-active compounds, Medicinal properties, Pharmaceutical value, Sri Lankan mangrove, Traditional medicine*

Abstract No: 003 Mangroves for Economic Development

Mangrove restoration enhances economic development among beneficiaries

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Mangrove forests are among the world's most economically valuable ecosystems in terms of providing multiple ecosystem services, including biodiversity, carbon sequestration, anchoring coastal ecosystems, climate regulation etc. Mangroves are highly interconnected within the ecosystem itself, but they also make up a transitional zone between land and ocean, connecting and supporting both. Sri Lanka has an estimated 12,000-15,000 hectares of mangroves around the island. Large mangrove communities can be seen in Puttlam, Batticaloa and Trincomalee Districts. Due to many anthropogenic causes, mangrove habitats have been rapidly declining in Sri Lanka. Therefore, restoration efforts are needed to ensure the conservation and management of mangrove communities in the country. In 2021, the Turtle Conservation Project (TCP) has initiated a long-term mangrove restoration project in Sri Lanka in collaboration with the Ministry of Coast Conservation and Low-Lying Lands Development which includes restoration of 13.5 million mangrove plants covering 3,000 hectares. The project is being implemented in Puttlam, Jaffna, Kilinochchi, Mulathivu, Trincomalee, Batticaloa and Ampara districts. This project brings US $ 4.3 million to Sri Lanka during its initial stages of establishing the mangrove plants in lagoons. More economic benefits will be received as the project progresses. So far, community members are economically benefitted from this project by collecting and selling mangrove saplings, sorting of saplings, maintaining nurseries, transporting saplings and plants, planting saplings in lagoons, making fences, maintaining plants and fences etc. In addition, economic benefits

are received by boat owners, vehicle owners, hotel owners, food suppliers, shop owners who sell bags for nurseries and wires for fencing, soil for nurseries etc. Furthermore, this mangrove restoration project has a strong research component which recruits recognized researchers as research consultants and data collectors. GIS mapping team has been contracted to map all planting plots in the field. Officers were recruited to monitor the progress of the project activities. Another special team was assigned to estimate the survival rates of the established mangrove plots. A media unit was hired to produce a documentary film on this mangrove restoration project. This paper summarizes how different beneficiaries are economically benefitted from this on-going mangrove restoration project.

Key words: *Economic benefits, Mangrove restoration, Project beneficiaries*

Abstract No: 004

Mangroves to sustain Coastal Environment & Biodiversity

Mangrove-associated macrobenthic fauna diversity in Kadolkele Negombo, Sri Lanka

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The benthic fauna species are considered as an indicator of environmental changes in aquatic ecosystems' capacity to encourage the mineralization, mixing, and cycling of organic materials. There is a lack of information on the benthic macro invertebrate assemblage in Sri Lankan lagoons, especially in mangrove ecosystems. According to scientists, the main macrobenthic creatures of mangrove sediment are polychaetes, gastropods, and crustaceans. Further macrobenthosare the primary food supply for fish and other species. The present study was carried out to investigate the diversity of macrobenthic fauna in Kadolkele mangrove ecosystems in Negombo, Sri Lanka. Soil samples were collected in three sampling rounds during August to October 2022 from three selected mangrove zones, *Rhizophora*, *Avicennia*, and *Luminitzera*, using a 2m x 2m quadrate. Samples were collected once a month and 45 samples were taken per day, 15 samples each from one zone. A total of 135 soil samples were collected \and identifications were done in the laboratory. The soil salinity variation observed in the site ranged from 18 ppt to 23 ppt, and pH ranged between 7.1 to 8.0 in all three zones. As many as twelve species of benthic macrofauna was recorded in the study area.*Rhizophora* zone recorded 30% of *Sesarma smithii and Sesarma guttatum* and 15% *Scylla serrata. Avicennia* zone was highly recorded in 44% *S. guttatum* and 38% *S. smithii.* 48% *S. guttatum* and 30% *S. serrata* were recorded in the *Luminitzerea* zone. Crustaceans were found to be the dominant group

with seven species; Bivalve emerged as the next dominant group with two species and polychaetes and gastropods came next in the order with one species each. The most abundant Crustacean was *Oecophylla smaragdina*. Among all results, *S. guttatum* was recorded in the majority of the sampling sites. The maximum diversity was recorded in the *Luminitzera* zone and the minimum in the *Rhizophora* zone. Results revealed that the salinity and pH of soil varied between the mangrove zones and that can affect the distribution of benthic fauna following the mangrove zonation. In a previous study in 2014, the Kadolkele mangrove forest area was recorded as having a high diversity of macrobenthos, compared with the present study which showed less diversity of macrobenthos. As a large volume of plastic waste was reported at the sampling sites and in the vicinity of the lagoon, pollution can be the main reason for the lack of macrobenthos fauna reported in the present study. Moreover, plastic pellets, oil cans removed from boats, and oil patches were also found at the sampling sites.

Keywords: *Macro Benthic, Physicochemical Parameters, Soil, Zonation*

Abstract No: 005

Mangroves to sustain Coastal Environment & Biodiversity

A Review: Contribution of macrobenthos to the mangrove ecosystems

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Mangroves are salt-tolerant trees that can be discovered on tropical beaches all over the world. Humans depend on mangrove forests for a variety of purposes, such as fisheries, forestry, protection against coastline erosion, and other regional subsistence needs. Mangroves also provide habitats, sustenance, and breeding grounds for a number of aquatic and terrestrial creatures. The main goal of this study is to evaluate the significant contribution of macrobenthos to the improvement of mangrove ecosystems. For this review article, a comprehensive search of various academic databases was done using relevant keywords and a total of 25 research papers was carefully assessed focusing on mangrove ecosystems and their interactions with macrobenthos, specifically examining the services provided by macrobenthos to the ecosystem. Both local and foreign articles were included in the review to ensure a diverse range of perspectives and findings. Crustaceans, mollusks, polychaetes, and one another additional taxonomic division of macrobenthos that are not specifically mentioned or categorized into above three divisions are the four primary taxonomic divisions of macrobenthos. Benthic invertebrates have a substantial impact on the structure of the sediments and their metabolic processes by enhancing the porosity and water movement through the sediments. According to researchers, macrobenthos are particularly helpful organisms for monitoring marine

ecology since they react to environmental changes very quickly. When there are abrupt changes in the physical parameters, the abundance of benthic creatures may decline. The haphazard distribution of these species throughout space increases the complexity and unpredictability of the ecosystem. Investigating the diversity of gastropods within natural ecosystems is crucial as it provides a wealth of information about the constantly changing environment. Benthic organism populations that are exceptionally large or lacking in others can be used as markers of pollution in water bodies. Therefore, macrobenthic communities play a crucial role in the ecological function of mangroves while serving as a good functional indicator for assessing the effects of human disturbance on benthic populations, and thus, benthic macroinvertebrates are frequently used in benthic studies. According to earlier studies, macrobenthos in mangrove ecosystems was the main component of the food web and provided the main source of nutrition for fish and other higher organisms. Many shorebirds and fish depend heavily on benthic creatures for their diets, which have a considerable impact on the species mixing and abundance of these tertiary consumers. They also play a significant role in the ecosystem's upkeep, health, and dynamics. The presence of gastropods in the mangrove ecosystems also improves nutrient recycling. Some of gastropods are scavengers generally serve as bioindicators for monitoring sediment and water quality. Additionally, feeding on the surface of the silt and plant materials encourages the recycling of nutrients. Consequently, actions including bioturbation, organic matter digestion, and propagule predation have shown how the macrobenthos shapes the structure and functionality of mangrove forests. It is crucial to research on the diversity, distribution, and ecology of macrobenthos in mangrove forests in order to better understand and manage this ecosystem.

Keywords: *Benthic invertebrates, Bioindicators, Gastropods, Macrobenthos, Mangrove Ecosystems*

Abstract No: 006

Mangroves to sustain Coastal Environment & Biodiversity

Preliminary study of mangrove diseases in Kadolkele, Negombo, Sri Lanka

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Mangrove ecosystems are immensely destroyed and highly threatened due to numerous anthropogenic and natural factors, but they are less known for the diseases associated with mangroves due to pathogenicity, pest attacks, and various other reasons. This study aimed at identifying mangrove diseases in Kadollkele, Negombo, Sri Lanka. The present study was carried out in the Kadolkele mangrove forest, which is extended over a 14-hectare area (7°11′ 49.82″N, 79°50′ 32.29″E), the northern extremity of the Negombo estuary of Sri Lanka. The site receives an annual rainfall of 2400 mm and an annual temperature range of between 24°C and 30°C. The reserve contains 18 true mangrove species and 33 other mangrove associates, with the highest abundance accounting for *Rhizophoraceae, Avicenniaceae*, and *Combretaceae*. The estuary-land interface dominated by *Rhizophora* species is a narrow patch with approximately 3m in width, a 15m in width *Avicennia* species-dominated middle zone, and a deeper *Lumnitzera* species-dominated zone where the width ranges from 50m to 30m. During data collection, mangroves were visually examined for the presence of diseases using a random sampling technique, and only the true mangroves were selected for examination. The tree trunks, branches, leaves, roots, and propagules at the level of eyesight were meticulously examined. Specific distinguishing features of plants like characteristic patterns, markings, scars, color variations, and body shape were carefully

observed to differentiate species of query symptomatic plants by comparison using "Photo-Identification". Two pest diseases, leaf galls diseases and leaf miner diseases were common among the leaves of *A. marina*. Additionally, die-back disease and stem cankers were observed. Among *Rhizophora* species, fungal diseases like curly leaves, gummosis on stems and branches, and a pest species of *Phenacoccus* were observed on the prop roots. Leaf spot disease, which was prominently observed as a fungal disease, was recorded among several species, for example, pink spots in *Rhizophora sp.* and black spots in *Lumnitzera sp*. Galls in branches and stems were the most frequent disease found throughout the *L. racemosa* and *Excoecaria agallocha* trees in the *Lumnitzera* zone. *Ceriops tagal* exhibited the growth of dust-like sooty molds on leaf surfaces. *Bruguiera* species were evident mostly with pest attacks such as the white fly found on *B. sexangula* leaves, and the White wax scale on branches of *B. gymnorhiza*. Other than that, leaf yellowing disease was observed rarely. This study reveals the presence of mangrove diseases and pests in Kadolkele Mangrove Reserve and provides insight for further research to fill the gap of lack of data on mangrove diseases in Sri Lanka to mitigate threats and ensure the long-term survival of mangrove ecosystems.

Keywords: *Kadolkele, Mangrove Diseases, Pest Diseases, Photo Identification*

Abstract No: 007

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Diseases and pathogens associated with mangrove Ecosystems; A systematic review

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Mangrove ecosystem is most fragile and threatened ecosystem due to urbanization and abiotic stresses such as hurricanes, floods, salinity variations, droughts, etc. exposing mangroves to various opportunistic pests, pathogens, and infectious diseases, ultimately contributing to their population decline. This research intended to review diseases and pathogens associated with mangrove ecosystems. Majority of the bacterial species colonize in red mangrove species (*Rhizophora mangle*). Bacteria species have two interactions with mangroves: endophytic colonization without apparent damage and facultative parasitism, utilizing tissues altered by abiotic factors. Some anaerobic species can cause wet wood, acting as pioneer microorganisms causing fungal decay. *Xylella fastidiosa* is a primary pathogen which causes leaf scorch and dieback in some mangroves and their shoots. Researchers identified potential pathogens, such as *Corynebacterium*, *Bacillus*, and *Pseudomonas*, threatening red mangrove trees, requiring further research to confirm their pathogenicity. Samples of symptomatic plant materials including leaves, barks, seeds, branches, and stems showing various disease symptoms such as leaf spots including pink and black leaf spots, brown leaf spots (BRS), white leaf spots (WLS), bleedings, cankers, and insect activity were collected and

examined. The samples were treated to remove debris and sterilize the surface before microbiological analysis. The research was conducted using various laboratory techniques, including fungal isolation, DNA extraction, PCR amplification, and phylogenetic analyses, to identify and classify the fungal species. Some beetle species recorded which are associated with wood-boring and stem cankers that contribute to the spread of fungal pathogens were collected using aerial traps and direct sampling methods. The beetles were identified based on their characteristics. Nutrient agar was used for the cultivation and enumeration of bacteria, and fungi. *Corynebacterium, Pseudomonas*, and two *Streptomyces* species were identified, and they pose an eminent threat to red mangrove trees. Others were saprotrophs and have the potential to become pathogens under certain environmental conditions. *Eutypella sp.* (Diatrypaceae), *Lasiodiplodia sp*. (Botryosphaeriaceae), and *Cyphellophora sp.* (Cyphellophoraceae) are the main fungal groups identified abundantly on *Avicennia. marina Pseudocercospora mapelanensis*, as the causal agent of leaf and fruit disease on *Barringtonia racemose.* Mangroves is a critically important ecosystem, however,diseases, pathogens and pests can kill it. Currently little is known of diseases affecting mangroves in Sri Lanka. Future studies on mangrove diseases are essential to investigate mangrove diseases and take remedial measures for the better survival of mangroves.

Keywords: *Enumeration, Facultative Parasitism, Fungal Isolation, Opportunistic Pests, Pathogens*

Abstract No: 008

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Conceptual engineering solution for successful management and restoration of Mangrove Forests on the West Coast of Sri Lanka

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Sri Lanka, a picturesque tropical island blessed with abundant biodiversity and a favorable equatorial climate, possesses a stunning coastline that encompasses a highly delicate ecosystem of mangrove plants. Nestled along the western coast lies the Muthupantiya Lagoon, a unique blend of lagoonal and estuarine deposits. Within this ecosystem, the southern reaches of the lagoon are adorned with expansive mangrove patches, which have unfortunately suffered degradation due to extensive shrimp farming. Recognizing the pressing need for restoration of the vital mangrove ecosystem, efforts have been undertaken to initiate the rehabilitation process. Artificial canals constructed using a “fishbone” structure as a foundation serve as conduits, channeling water through the once-distressed areas, and creating an environment conducive to the growth and rejuvenation of mangrove saplings. It is regrettable to note that the growth of the planted saplings has been disappointingly minimal. This outcome highlights the presence of deficiencies and setbacks in the executed mangrove rehabilitation program. The low tidal amplitude presents a formidable challenge as it precipitates a reduction in salt marshes. The canal system suffers from an absence of water circulation.

Consequently, the stagnant water within the canals has led to an unsuitable salinity level for optimal mangrove growth. Addressing these obstacles and revitalizing the mangrove ecosystem demands comprehensive solutions that consider the intricate dynamics of the coastal environment. Implementing measures to enhance tidal circulation and meticulously managing salinity levels are crucial steps towards restoring degraded mangrove habitats. It was discovered through a level survey that the canals had been established with improper slopes, thereby hindering the expected circulation within the system. To rectify this issue, an engineering solution such as the construction of canals with appropriate slopes, accompanied by the incorporation of catch pits at their ends is proposed. These catch pits will serve as connection points for sub-canals, allowing for the effective recirculation of saltwater flow with the aid of pumps. This enhanced circulation will facilitate the dispersion of nutrients, sediments, and other essential elements required for the growth and sustenance of the mangrove ecosystem. These catch pits can serve as collection points for excess water during high tidal periods, preventing flooding and facilitating controlled drainage during low tide. Ensuring proper circulation, and optimizing salinity levels, the growth and rejuvenation of the mangroves can be achieved, ultimately restoring the delicate balance of the coastal mangrove ecosystem from the Anawilundawa Ramsar wetland to the Muthupanthiya coastal area of Sri Lanka.

Keywords: *Canal, Fish Bone, Mangrove, Restoration, Salinity*

Abstract No: 009

Mangroves to sustain Coastal Environment & Biodiversity

The success of *Rhizophora mucronata* in restoring native mangrove diversity

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In restoration of mangrove plantation, a key mangrove plant has to be chosen to restore ecosystems functions and obtain the endpoint community. This study aims to show the success of *Rhizophora mucronata* in restoring the mangrove ecosystem. Use of *R. mucronata* enhances flora species diversity. The plantation in which this study was conducted was initiated in 2005 at the Palakudawa in Puttalam lagoon in Puttlam District. The mangrove restoration site was periodically surveyed for the presences of other mangrove species. During the survey, the mangrove species *Lumnitzera racemosa*, *Bruguiera cylindrica*, *Xylocarpus granatum*, *Avecennia marina*, and *Sonneratia alba* were recorded. *R. mucronata* has high species abundance in the surrounding mangrove forests. These species demonstrate convergent evolution; many of these species are found in similar conditions to the tropical conditions of variable salinity, tidal range, anaerobic soils, and intense sunlight. It was chosen for the study because the desired endpoint community mimicked that of the surrounding mangrove forests. Establishment of new mangrove species on the site depends on the dispersal of new propagules to the restoration site. Establishment of a new plant can be shown in four stages as dispersal, germination, survival and adulthood. The presence of *R. mucronata* aided in the survival of these wildlings till they reach adulthood. This *R. mucronata* retains the propagules in their roots shows a nursing effect on the wildlings. *R. mucronata* also changes the soil micro-climate so that the more sensitive species can survive in it. The soil microclimate plays a critical role in the diversity of species and their growth. This study shows

that *Rhizophora mucronata* is a suitable species to use in mangrove plantations to restore native mangrove diversity.

Keywords: *Establishment, Mangrove restoration, Nursing plants, Plantation, Species richness, Survival*

Abstract No: 010

Mangroves to sustain Coastal Environment & Biodiversity

Enhancing mangrove conservation in Sri Lanka: A legal framework evaluation

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This paper examines the legal perspectives and approaches to mangrove protection in Sri Lanka. Mangroves play a crucial role in coastal ecosystems, providing numerous environmental and socioeconomic benefits. However, Sri Lanka face significant challenges in preserving these vital ecosystems due to various anthropogenic activities and inadequate legal frameworks. This study examines the existing legal provisions and policies in Sri Lanka and analyzes their effectiveness in conservation mangroves. The research employs qualitative research methods, utilizing primary data such as legislative enactments, conventions, and case laws, as well as secondary sources including journal articles and textbooks. In Sri Lanka, several legislative measures have been implemented to safeguard the country's mangroves and various Acts and Ordinances have been enacted, demonstrating the commitment to mangrove conservation. In addition, Sri Lanka has a number of policies, plans, and strategies that relate to the conservation and restoration of mangroves. These laws offer certain protections but lack comprehensive provisions specifically targeting mangrove conservation. Additionally, enforcement and monitoring mechanisms remain weak, leading to continued degradation and destruction of mangrove ecosystems. To enhance mangrove protection, it is crucial for Sri Lanka to strengthen their legal frameworks, improve enforcement mechanisms, and promote sustainable land-use practices. Collaborative efforts between government agencies, local communities, and NGOs can facilitate knowledge sharing and the development of innovative conservation strategies. Based on the evaluation, the study may provide policy recommendations to improve the effectiveness of conservation efforts in Sri Lanka's mangrove ecosystems.

These recommendations could include amendments to existing laws, the creation of new regulations, or the establishment of protected areas. This paper concludes by emphasizing the need for a holistic and integrated approach to mangrove conservation, encompassing legal reforms, public awareness campaigns, and capacity-building initiatives. By exploring innovative solutions, Sri Lanka can pave the way forward for effective mangrove protection, ensuring the preservation of these invaluable ecosystems for future generations.

Keywords: *Eco-systems, Evaluate, Existing Laws, Mangroves, Safeguard, Sri Lanka*

Abstract No: 011

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Potential usage of selected biostimulants for air-layering on endangered mangrove *Scyphiphora hydrophyllacea* in Kadolkele - Sri Lanka: Towards species conservation

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Evergreen true mangrove; *Scyphiphora hydrophyllacea* is considered as non-viviparous shrub belonging to genus Scyphiphora (family: Rubiaceae). Though it produces massive number of seeds after pollination, incapability of producing normal seedlings under natural environment explains the reason for limiting the population over the globe. Hence air-layering plant propagation technique with synthetic growth regulators recorded promising results, an effort was done to assess the potential of using biostimulants for air-layering at Kadolkele- NARA Regional Research Center. Cinnamon powder and bee honey were selected as bio stimulants for the study. The investigation was conducted with six replicates and two culture media. Healthy branches of *S. hydrophyllacea* were selected and a ring bark of about 2.5 cm width was removed. Under hormone treatment, commercial rooting hormone powder (0.3% Indole 3 butyric acid; IBA) was applied before wrapping along the wounded portion. Selected culture media; mangrove soil, mangrove soil with coconut coir (2:1 ratio) were moistened with brackish water and strapped with polythene sheet separately. Instead of IBA, same method was conducted by applying each selected biostimulant on the wounded portion of selected branch separately and the rooting response including root initiation and elongation (root length) was monitored weekly. Root initiation was first observed after 6-7 weeks. Approximately 50% of air-layered branches produced roots or root initials within 6-13 weeks.

Compared to branches air-layered with IBA, biostimulants layered branches showed more or equal capability of producing roots or root initials. The height root initials producing ability showed by the branches airlayered with cinnamon powder as it recorded 66.6% in mangrove soil+ coconut coir (2:1 ratio) medium. Root initial producing capacity of bee honey was similar to the branches air layered with IBA; 33.3% resulted with mangrove soil and 50% resulted in mangrove soil+ coconut coir (2:1 ratio) medium. Root initials produces in all hormone treated air-layered branches and branches air layered with selected biostimulants showed continuous development up to roots. The capability of cinnamon powder for acting as an organic control-agent and a rooting agent might have lead towards better root establishment. Compared to mangrove soil medium, higher fiber content for better aeration with lesser water holding capacity might lead to better root establishment in mangrove soil+ coconut coir (2:1 ratio) medium. Under experimental level, potential of air-layering using selected biostimulants are promising as successful propagation substances. Among selected media, mangrove soil+ coconut coir (2:1 ratio) medium can be recommended for successful air-layering. Further studies can be extended to evaluate the adaptability of air-layered plant materials with bio stimulants up to an independent mature shrub under natural environment towards its successful conservation.

Keywords: *Air-layering, Bio stimulants, IBA treatment, Scyphiphora hydrophyllacea*

Abstract No: 012 Mangroves for Climate Change mitigation

Development of an allometric equation to predict the stem carbon content of *Avicennia marina* in the Jaffna Lagoon Sri Lanka

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The carbon sequestration of the mangrove ecosystems is playing an important role in the context of managing the effects of global climate change. Assessment of the carbon sequestration capacity of mangrove plants can be done via both destructive and non-destructive methods. The destructive methods require the uprooting of the tree to assess the carbon content in the plant parts and therefore, this approach is not sustainable. The present study was focused on constructing an allometric equation to estimate the stem carbon content of *Avicennia marina* in the Jaffna Lagoon, Sri Lanka, using a non-destructive approach. The measurable tree parameters: Diameter at Breast height (DBH), merchantable stem height (MSH), crown height (CH), leaf area, total tree height of 75 trees from five sites (Ariyalai East (9°37'07.9"N, 80°05'55.3"E), Thanankilappu (9°37'56.2"N 80°08'53.7" E), Navali South (9°41'38.4"N 79°58'22.6" E), Mandaitivu Islands (9°37'15.8"N 80°00'10.0" E), and Allaipiddy (9º61′47.41N, 79º96′32.27E)) were recorded (15 trees from each site). The actual organic carbon content of stem core samples was determined using the loss on ignition method. The stepwise regression with backward elimination was followed to develop the stem carbon prediction model using measurable tree parameters. The model was constructed using 75% of the data and 25% of the data was used for model validation. MINITAB 17 statistical software was used for statistical analysis. The best-fit model derived for the stem carbon content of A. marina in Jaffna Lagoon was Ln C = - 0.2713 + 0.878 ln DBH + 0.2150 ln MSH with an R2 of 63.1%. The model bias value and the model efficiency value for the best-fit model were 0.039985 and 0.0644284 respectively. Furthermore, there was no

significant difference between the actual mean stem carbon content (1.78 ± 0.13 Kg) and the predicted mean stem carbon content (1.75 ± 0.17 Kg) of *A. marina* in the Jaffna lagoon at a 95 % level of significance ($p>0.05$). The present study indicates that the use of allometric equation-based models to predict the stem carbon content can provide sustainable insight to predict the stem carbon content of *A. marina* using a non-destructive approach.

Keywords: *Allometric equation, Avicennia marina, Jaffna lagoon, Stem carbon*

Abstract No: 013

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Improving the success rate of mangrove plantations in Mannar

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Mangrove plantations on the coast of Mannar, Sri Lanka, have faced notable difficulties, despite the significant benefits these ecosystems provide. This study investigates the causes of mangrove plantation failures in Mannar, identifies recommendations for improvement, and proposes sustainable solutions for long-term success. The study aims to analyze the causes of mangrove plantation failures in Mannar, provide recommendations to enhance success rates, and propose sustainable solutions for the long-term conservation and management of mangroves. The study involved analyzing location selection, soil suitability, species selection, the timing of planting, and the level of knowledge and commitment among individuals in the plantation process. The study identified several causes of mangrove plantation failures in Mannar. Inappropriate location selection was a major factor, with many plantations established in areas unsuitable for specific mangrove species growth. Soil conditions, including inadequate drainage and low organic matter content, further contributed to failures. Additionally, the selection of mangrove species ill-suited to the local environment hindered successful establishment. Plantation at the end of the rainy season exposed the mangroves to drier conditions. Furthermore, the lack of knowledge and commitment among individuals involved in the plantation process was evident, with negligent plastic waste disposal and a general absence of passion for mangrove conservation. The lack of passion has resulted in a more mechanical plantation than a long-term commitment. Organizing live visits to mangroves enables individuals involved in plantations to

observe the ecosystem's functioning and appreciate the benefits they provide. Demonstrations showcasing mangrove ecosystem services, such as coastal protection and support for marine life, further enhance understanding and encourage conservation efforts. Furthermore, incentives for sustainable mangrove management, including financial rewards and non-financial recognition, can motivate individuals to adopt responsible practices. To improve the success of mangrove plantations in Mannar and ensure the long-term conservation of these important ecosystems, it is essential to address the causes of failures through proper planning, suitable site selection, appropriate species choice, and planting during the optimal season. Training and awareness programs are crucial in enhancing knowledge and fostering a sense of responsibility among individuals involved. Additionally, live visits, demonstrations of ecosystem services, and incentives for sustainable management contribute to long-term success. Implementing these recommendations and measures will support the conservation and sustainable utilization of mangroves in Mannar and serve as a model for other coastal regions facing similar challenges.

Keywords: *mangrove, plantation,Mannar, species selection, sustainable solutions*

Abstract No: 014 Mangroves for Economic Development

Mangroves in Vidattaltivu nature reserve: a balancing act between conservation and sustainable livelihoods

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Mangroves in Sri Lanka play a vital role in the country's coastal ecosystem. These unique forests are found along the island's extensive coastline and estuaries. Sri Lanka is home to several species of mangroves, which provide a habitat for diverse marine and avian species. These mangrove ecosystems also offer protection against erosion, storm surges, and support local communities through fisheries and tourism. Efforts are being made to conserve and restore these precious mangrove forests in Sri Lanka to ensure their long-term sustainability. The present study investigates the level of awareness, challenges, and suggestions of residents in the Vidattaltivu Nature Reserve area in Sri Lanka regarding mangrove conservation and sustainable utilization. Further, it was aimed to assess the respondents' understanding of the significance of mangroves and their perceptions of the need for conservation efforts. Additionally, the study sought to identify the obstacles to residents in utilizing mangrove resources and deriving benefits from them. Lastly, the study aimed to gather suggestions from the respondents on measures that could ensure the sustainable management and conservation of mangroves while supporting local livelihoods. The findings revealed that the respondents displayed a notable level of awareness regarding the importance of mangroves and the necessity of conservation efforts. However, they also faced various challenges in effectively utilizing the resources and reaping benefits from mangroves. Their suggestions included increasing awareness through community programs, school education, and social media campaigns. The development of sustainable resource management practices was also emphasized by the respondents. The enforcement of

regulations to combat deforestation, overfishing, and pollution was crucial. Additionally, the respondents highlighted the significance of training and support for alternative livelihoods. The findings emphasize the importance of adopting a comprehensive approach to mangrove conservation, integrating both environmental and social components. Increasing awareness emerged as the key strategy, with recommendations for community-based programs and educational initiatives targeting schools and utilizing social media platforms. The establishment of mangrove nurseries and the promotion of alternative livelihoods to ensure sustainable resource management are vital. Enforcing regulations to address threats such as deforestation, overfishing, and pollution was deemed critical for effective mangrove conservation. Investing in research and development was identified as essential for enhancing the understanding of mangrove ecosystems and implementing effective management practices. The involvement of local communities in decision-making processes was seen as vital to align conservation strategies with their needs and priorities. The findings inform policymakers, conservation practitioners, and local communities engaged in the responsible protection and utilization of mangroves. By implementing the suggested measures and considering additional factors, it is possible to achieve the sustainable management and conservation of mangroves, benefiting the communities and the environment.

Keywords: *Mangrove conservation,* Vidattaltivu *Nature Reserve, Sustainable utilization, Challenges, Local livelihoods*

Abstract No: 015

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Evaluation of the heavy metal contamination status and some selected water quality parameters in the Anawilundawa mangrove restoration site

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The Anawilundawa Mangrove Restoration (AMR) site, situated in an environment both directly and indirectly exposed to various anthropogenic pressures such as, fisheries, agricultural, domestic, and industrial sectors, poses a potential risk of contamination by heavy metals. Recognizing this concern, the present study assesses the physico-chemical parameters and the contamination status of heavy metals in water and sediment of the AMR site and its periphery. Water and sediment samples were collected from four different locations; the paddy field outlet, shrimp farm outlet, Dutch canal outlet, and restoration site inlet, once in two weeks during October to November 2022. Basic physico-chemical water quality parameters, including temperature, salinity, and pH, were measured at the site and the nitrate and phosphate levels were analyzed following the standard spectrophotometric methods. The samples were digested and subjected to Atomic Absorption Spectrophotometry (AAS) for the presence of selected heavy metals: copper (Cu), chromium (Cr), cadmium (Cd), and nickel (Ni). Results were analyzed using one-way ANOVA. The study revealed that the water in shrimp outlet had the

highest average concentration of total nitrate, with a value of 0.13 ± 0.02 $mgdm^{-3}$, while the restoration site had the highest average phosphate concentration (26.96± 1.34 $mgdm^{-3}$). When considering the presence of selected heavy metals, the sediment samples indicated higher levels compared to the water samples. Notably, the sediment of the paddy field demonstrated the highest concentrations of Cr (0.46 ± 0.01 $mgkg^{-1}$) and Ni (0.54 ± 0.01 $mgkg^{-1}$), implying potential contamination sources from agricultural practices. The sediment of the Dutch canal recorded the highest concentration of Cu (0.90 ± 0.04 $mgkg^{-1}$). The highest Cd concentration was observed in the sediment of the paddy field (0.36 ± 0.02 $mgkg^{-1}$). Interestingly, no traces of cadmium were found in the water samples during the study period, whereas detectable levels of chromium were recorded identified in water across all four locations. Regular monitoring becomes imperative to prevent potential environmental issues associated with heavy metal contamination in the AMR site and its peripheral regions. By implementing robust monitoring strategies, future environmental risks and concerns related to heavy metal contamination can be effectively mitigated and addressed.

Keywords: *Anawilundawa Mangrove Restoration (AMR) site, Environmental monitoring, Heavy metal, Water quality*

Abstract No: 016

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Effect of water quality on mangrove system in Negombo Lagoon. Sri Lanka

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The mangrove ecosystem in Sri Lanka is a treasure trove of biodiversity, teeming with a rich array of plant and animal species uniquely adapted to thrive in its brackish waters. These dense coastal forests serve as vital nurseries for fish, crustaceans, and other marine life, providing them with shelter and food. Additionally, mangroves act as a natural buffer, protecting inland areas from the devastating impacts of tsunamis and storms, making them an invaluable defense against coastal erosion. The intricate network of mangrove roots also helps filter and purify the surrounding water, improving its quality and contributing to the overall health of the ecosystem. Therefore, present study was focused on the physico-chemical characteristics of the Negombo Lagoon, which is bordered by a rich mangrove ecosystem. The mangrove ecosystem provides a rich nursery and feeding ground for a variety of marine organisms. However, the water quality factors of the specific habitat are a major determinant of mangrove development as well as the frequency of various marine shell and finfish spawning. *Aegiceras corniculatum*, *Avicennia officinalis*, *Bruguiera cylindrica*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Rhizophora mucronata* are the common recorded mangrove types

in the Negombo Lagoon. The water quality parameters of Temperature, pH, salinity, dissolved oxygen, biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD), nitrite, nitrate, phosphate, and ammonia were evaluated using standards APHA methods for the samples taken from 10 different locations of the lagoon between January 2022 and February 2023 as part of this investigation. According to the results, the mean N-NO_3-, N- NO_2-and N-NH_4+, Total Phosphate, and Chemical Oxygen Demand (COD) concentrations were 0.030 ± 0.004 mg/L, 0.035 ± 0.002 mg/L, 0.030 ± 0.002mg/L, 0.050 ± 0.005 mg/L and 770.5 ± 20.4 mg/L, respectively. Importantly, the recorded COD level was greater than the maximum permissible national environmental ambient water quality standards levels (15 mg/L) (Category c). This indicates a considerable contamination level of lagoon water with different organic and inorganic oxidizable chemicals resulting a critical threat on mangrove eco system.

Keywords: Negombo lagoon, mangrove, water quality

Abstract No: 017

Mangroves to sustain Coastal Environment & Biodiversity

Spatial variation of Soil Organic Carbon (SOC) in the mangrove ecosystem of Indian Sundarbans

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Soil Organic Carbon (SOC) levels were monitored in the three sectors of Indian Sundarbans: Western, Central, and Eastern during June 2022. The three sectors are significantly different from each other with respect to salinity and anthropogenic activities. The level of SOC differs significantly between sectors ($p < 0.01$). The order of SOC level is as western sector > eastern sector > central sector. This variation may be attributed to a large extent by mangrove biomass and diversity, forest age, the degree of tidal exchange, erosion, and sedimentation of suspended matter. Also, anthropogenic activities like fish landing, tourism and shrimp farms contribute appreciable amount of organic load in the western sector of Indian Sundarbans. The central Indian Sundarban is an erosion prone zone, and the eastern sector is under the protected area of Reserve Forest (RF) with no anthropogenic activities. The present study is very important from the perspective of climate change as the saline soil of Indian Sundarban serves as the potential sink of carbon.

Keywords: *Anthropogenic activities, Indian Sundarban, Mangrove, Soil organic carbon*

Abstract No: 018 Mangroves for Climate Change mitigation

Mangrove cover in West Bengal: its role and community resilience measures in Sundarbans

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The objective of the present study is an assessment of mangrove area in West Bengal and proposal of Community resilience methods for restoration of mangroves. Sundarban mangroves in India have been constantly protecting the megacity of Kolkata and surroundings from vagaries of Cyclone and related damage. The delta of Mangrove on the Indian part consists of 102 islands out of which 54 are inhabited by people and the balance are forested. The area is impacted by tides twice a day. During high tide the water rises from six feet to ten feet high while during low tide, the mudflats become visible. Thus, to protect the islands having human habitation, embankment is built all around. Embankment to the tune of about 3122 km length is the only protection for Sundarban inhabitants against seawater. Embankments protect the islands from tidal water, act as roads and at the point where embarking or disembarking from water-vessels launches, other means of transportation take place. The data regarding mangrove cover from 1987 to 2021 in West Bengal were analyzed and annual change values were calculated, which varied from -29.0 km2 in 2013 to +19.5 km2 in 2003. Human population in Sundarban got increased 354% in last 50 years. Cyclone Sidr in 2007, Aila in 2009, Phailin in 2013, Hudhud in 2014, Komen in 2015, Mora in 2017, Titli in 2018, Fani in April 2019, Bulbul in November 2019, Amphan in May 2020 , Yaas in May 2021, Jawad in December 2021 impacted Indian Sundarbans . Salinity levels were analyzed through one-way ANOVA showing variation from 2017 onwards till 2021. Salinity changes in surface water (21.2 ppt in 2017 to 32.6 ppt in 2021) resulted in change in mangrove diversity and

ecological functions. *Avicennia marina* (12.20 in 2017 and 31.70 in 2021) , *Aegiceras corniculatum*(5.25 in 2017 and 8.17 in 2021) and *Proteresia corcata* (12.57 in 2017 and 16.01 in 2021) increase in number with increasing salinity while *Ceriops decandra* (4.69 in 2017 and 1.96 in 2021)show decrease as per Relative Density method. Results revealed that, with the increase in forest fringe population and lack of employment opportunities coupled with frequent cyclones is proving to be detrimental to local people as well as mangroves. In present context, Community Resilience measures like Permeable Dam, Thorn like structure from Bamboo and Mangrove dibbling in the areas in a phased manner near the embankment, appears to be viable alternative for tackling the problem. Moreover, afforestation with mangroves will decrease Carbon dioxide level in air. This would help in conservation of biodiversity including tiger at the top of trophic pyramid, whose number has enhanced from 87 in 2016, to 100 at Sundarbans in 2021, as per Tiger estimation. Furthermore, mangrove plantation would help the forest fringe population economically in earning credit for carbon in near future, with positive interventions from convergence of activities of Government line departments, among themselves on one hand and Non –Government Organizations on the other.

Keywords: *Community, Cyclone, Embankment, Mangrove, Resilience*

Abstract No: 019

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Impacts of nutrients in shrimp farms on the mangroves at Indian Sundarbans

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Indian Sundarbans noted for rich mangrove biodiversity is in the downstream of the river Ganges. Shrimp farming is one of the major livelihoods for the inhabitants dwelling in this region. However, most of the shrimp farms in Indian Sundarbans have been developed at the cost of mangrove forest, which is the primary cause of mangrove loss in deltaic Sundarbans. Data were collected from two shrimp ponds located at Chemaguri (88° 08/ 49.01// E and 21° 39 / 42.88 // N) in the Western part of Indian Sundarbans on major nutrients like nitrate, phosphate, and silicate from 2010 to 2019. Significant variations were observed between the two ponds with variable stocking density in terms of nutrient level as revealed through ANOVA ($p < 0.01$). The pond with high nutrient level exhibited significantly low dissolved oxygen (DO) due to which the survival rate of *Penaeus monodon* (tiger shrimp) exhibited low values. Mortality of shrimp is a major threat to the livelihood of the local inhabitants hence bio-treatment ponds need to be implemented using seaweeds and mangrove associate species such as *Porteresia coarctata* as agents of phytoremediation. Implementation of such technology will not only restore the environment of the shrimp ponds, but at the same time improve the livelihood of the island dwellers in Indian Sundarbans.

Keywords: *Dissolved Oxygen, Indian Sundarbans, Nutrients, Shrimp farms*

Abstract No: 020 Mangroves for Economic Development

Standardization of combined minerals towards cost reduction in *Penaeus vannamei* farming in mangrove environment of Indian Sundarbans

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Production cost increase in *Penaeus vannamei* farming owing to drastic increase in input cost is a major bottleneck now a days. In this study, different combinations of commercially available salts of major minerals were tested towards cost reduction in minerals application being a major cost after feed and fuel in vannamei farming. The study was conducted in a shrimp farm at Ramkrishna Chawk, Kakdwip, South 24 Parganas. Three different combinations were tested in triplicate ponds. Among tested combinations, ratio of major minerals like Calcium, Magnesium and Potassium of 1:8:2 was found to be most effective in Indian Sundarbans. At that ratio of major minerals, shrimps attained 20 g size in 80 days at stocking density of 60 numbers/ m^2 with FCR of 1.25 and survival of 81%. This resulted mineral application cost of Rs. 11/ kg of shrimp biomass production which were significantly ($p<0.05$) lower than other two generally practiced tested combinations.

Keywords: Minerals, *Penaeus vannamei*, Production cost, Sundarbans

Abstract No: 021 Mangroves for Economic Development

Standardization of male tilapia farming at different salinities in pond and in freshwater biofloc system as an alternative livelihood in mangrove environment of Indian Sundarbans

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Shrimp farming in the mangrove environment of Indian Sundarbans is impacted by various issues like diseases, low sale price, slow growth, and high cost of production etc. Alternatives to shrimp farming have been required as per the farmer folks of the region. As freshwater fishes cannot be reared in those saline ponds, salinity tolerant species like tilapia could be a viable alternative. Growth and production parameters of male tilapia at stocking density of 8/ m2 were tested at 5, 15 and 25 ppt. Simultaneously, growth and production parameters of male tilapia at stocking density of 40/ m^2 were tested in biofloc system. Better growth and production of male tilapia were obtained at 5 ppt salinity in pond culture followed by at 15 ppt salinity. The results in 25 ppt salinity level were poor and found to be not viable economically. Results obtained from biofloc system was found to be most profitable but investment, availability of facilities like electricity and proper understanding of the system are the most important bottlenecks.

Keywords: *Alternative livelihood, Biofloc system, Male tilapia, Salinity*

Abstract No: 022

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Compartmentation of heavy metals in the mangrove ecosystem of Indian Sundarbans

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Indian Sundarban Biosphere Reserve with an area of 9630 sq. km has been designated as a World Heritage Site. Based on salinity, the entire region can be divided into western, central, and eastern sectors. In this study, three major heavy metals present in the sediments of the study site were determined. These sectors are exposed to different anthropogenic activities due to which the levels of heavy metals show considerable spatial variations ($p<0.01$). The order of dissolved heavy metals during our study period (2010-2019) is Zn>Cu>Pb. The western sector exhibits the highest dissolved metals compared to the other two sectors. The biologically available heavy metals in the sediments exhibit a completely opposite picture with the highest value in the eastern sector followed by the central and the western sector. All the heavy metals were analyzed by Atomic Absorption Spectrophotometric method. The aquatic pH seems to be the major factor in the compartmentation of heavy metals. Our view is confirmed through the direct positive correlation between aquatic pH and sediment metal ($p<0.01$) and a significant inverse correlation between aquatic pH and dissolved heavy metals ($p<0.01$). The correlation was carried out by the SYSTAT package. The variation of aquatic pH can be regulated through mass-scale mangrove plantation as this unique vegetation absorbs carbon dioxide and provides a buffering action.

Keywords: *Compartmentation, Heavy metals, Indian Sundarbans, pH*

Abstract No: 023

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Conservation and management of mangrove eco-system: way forward

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Mangroves are spread over the 123 countries with the total of 80 species of mangroves. These ecosystems are located in tropical and subtropical regions and are acting as hotspot for productivity and biodiversity. It yields valuable ecosystem services such as habitat for fisheries, cultural and religious value, ecotourism, filtration and terrestrial runoff, coastline stabilization against storms, carbon sink and mitigate climate change. Though there were economical and educational values are identified, research areas should be developed for proper management. Most of the services are supported by microorganisms that associate with mangroves. However, very few research have been conducted on mangrove microbiology, genetics and physiology. Lack of data regarding present mangrove cover and status of the restoration program, continuation of the restoration program is one of the major problems associated with management of mangroves in Sri Lanka. Research should be initiated to develop value added products, medicines, and other products from mangroves for sustainable utilization of mangroves. Incorporating the values of the services that ecosystems provide into decision making is becoming increasingly common in nature conservation and resource management policies, both locally and globally. Hence valuation of mangrove ecosystem is needed for future management. Lacking recent studies based on valuation of each mangrove species is a challenge. Knowledge of thresholds, spatio-temporal scalling and variability due to geographic, biogeographic and socio-economic settings will improve the management of mangrove ecosystem services. Gaps in mangrove science may stimulate further research. Even core issues, such as salinity

tolerance, soil redox conditions, temperature limitations, propagule dispersal, mineral cycling, carbon sequestration and land building, what constitutes a 'true' vs. 'associate, concept are still questionable. Finally, contentious issues such as using mangroves as sinks for industrial waste, micro-plastic and how much biodiversity is needed to maintain functionality in mangrove eco-restoration should be examined.

Keywords: *Conservation, Management, Research needs*

Abstract No: 024 Mangroves for Climate Change mitigation

Carbon sequestration capacity of Sri Lankan mangroves

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Mangroves are true ecotones, having components of both marine and terrestrial biomes, and developed a number of unique structural and functional adaptations to tolerate salt anoxic, and waterlogged substrates. Architecturally mangroves are simple compared with terrestrial forests, usually harboring few tree species and lacking an understory of ferns and scrubs. However, the standing biomass of some mangrove forests in equatorial regions can be immense, rivaling the height and weight of many tropical rainforests. Mangroves play an important role in carbon sequestration in intertidal environment due to their high net primary productivity represented by biomass and litter fall compared to other tropical ecosystems. As nearly half the biomass in trees contains carbon, large amounts of carbon are potentially stored in mangrove forests, and they may be the largest stores of carbon in coastal zones. It is estimated that by and large global mangroves sequester large amounts of carbon, approximately 25.5 million tons of carbon every year. The coastline of Sri Lanka is approximately 1600 km long and a narrow intertidal belt created by micro tidal conditions (tidal amplitude less than 1 m) occur in the coast. Total brackish-water areas around the island host a number of interrelated ecosystems. Recent estimates on extend Sri Lankan mangroves over an area of 19,758 ha, interspersed along the coastline. Study was based on the secondary data and total biomass (above ground and below ground) in Sri Lankan mangrove. According to previous studies the biomass ranges between 160 – 164 mg ha^{-1} with an average of 162 mg ha^{-1}. Distribution of mangrove biomass throughout the tropics indicates that higher values occur at lower latitudes. Total Organic Carbon (TOC) in mangrove soils was reported to a depth of 50 cm, and values ranged from 361 to 418 mg

ha-1 with an average of 390 mg ha^{-1}. Total amount of TOC (mangrove plants and soils together) in mangrove ecosystems ranged between 494 mg ha-1 to 526 mg $ha^{-1}$with an average of 510 mg ha^{-1}). TOC content in Sri Lankan mangroves is higher than that was recorded in Southeast Asian upland forests (250 to 400 mg ha^{-1}) and savannas (156 to 203 mg ha^{-1}) and few of upland forests (375 – 437 mg ha^{-1}). Based on the present extent of mangroves in Sri Lanka, total carbon sequestration capacity was calculated, 10,076.58x10^3 mg. Sri Lankan mangrove ecosystems therefore are evidently superior in performing the carbon sequestration function.

Keywords: *Carbon sequestration, mangroves, Sri Lanka*

Abstract No: 025 Mangroves for Climate Change mitigation

Potential role of carbon capture by seaweeds in mangrove ecosystem

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Seaweeds are macroalgae that are found in the estuaries of the mangrove dominated deltaic complex in the tropics. This species absorbs carbon dioxide from the ambient water and converts it into organic carbon by photosynthesis and stores it as biomass in their thallus body. Thus, it can act as the potential agent to reduce carbon dioxide. In the present study, three dominant seaweed species was collected viz., *Enteromorpha compressa, Enteromorpha intestinalis* and *Ulva lactuca* from Sagar South (21°39'04.68"N; 88°01'47.28"E) and Jharkhali (22°05'52.82"N; 88°41'47.25"E) located in the western and central sectors of mangrove dominated Indian Sundarbans respectively during premonsoon in 2023. The stored carbon was analysed by CHN analyser in each of the collected samples separately. It was observed that *E. compressa* is more efficient in carbon capture compared to the other two species. Thus, the culture of seaweed preferably *E. compressa* is suggested to combat carbon dioxide rise in the near surface atmosphere of Sundarban mangrove.

Keywords: *Enteromorpha compressa, Enteromorpha intestinalis, Ulva lactuca, Seaweeds, Stored carbon*

Abstract No: 026 Mangroves for Climate Change mitigation

Impact of climate change induced high salinity on mangroves seedlings

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Climate change has become a talk of the century due to which sea level rise is occurring in different corners of the world. Mangrove ecosystem of Indian Sundarbans is no exception to this rule and the sea level rise in this region is ~ 3.25 mm per year, due to which salinity intrusion is taking place. *Heritiera fomes* (Sundari) is getting extinct from the high saline pockets of Indian Sundarbans. This study attempted to mimic the situation in the *in-situ* condition by growing seedlings of *H. fomes* at different salinity levels. It was monitored Chl *a*, Chl *b* and carotenoid as indicators of salinity alteration at 2, 5, 10, 15 and 20 psu salinity levels. The concentrations of chlorophyll and carotenoid pigments exhibited significant negative correlations with salinity ($p < 0.01$). The total chlorophyll expressed, on unit fresh wt. basis decreased by 63.39% to 73.33%, and in case of carotenoid the decrease was from 27.78% to 36.84% with the increase of salinity from 2 to 20 psu. The Chl *a:b* ratio in the plant remained almost constant throughout the period of investigation. The results show that *H. fomes* of Indian Sundarbans region can be sustained and propagated under low saline environment. At 15 psu, the plants become acclimated in one to two weeks, however, at 20 psu the seedlings could not survive. The study is important as rising salinity is experienced in central Indian Sundarbans of lower Gangetic plain due to sea level rise and obstruction of freshwater flow from Ganga-Bhagirathi-Hooghly channel as a result of heavy siltation.

Keywords: *Chl a, Chl b, Carotenoid, Heritiera fomes, Salinity Level*

Abstract No: 027

Mangroves to sustain Coastal environment & Biodiversity

Satellite based analysis of spatial distribution and dynamics of mangrove ecosystems and other land uses in Rekawa, Lagoon, Sri Lanka

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The Rekawa Lagoon and its surrounding mangrove area are ecologically important ecosystems/habitats that support a diverse range of species. Twelve mangrove species can be found from the area with high abundance of *Bruguiera gymnorrhiza*, *Bruguiera sexangula*, *Ceriops tagal* and *Rhizophora mucronata*. Landsat satellite data were downloaded from the United States Geological Survey (USGS) website in Universal Transverse Mercator (UTM) projection with the WGS84 datum. The images from Landsat 7 ETM+ (2001 and 2007) and Landsat 8 OLI/TIRS (2014, 2021, and 2022) were used for image analysis. In order to develop an efficient method for mapping mangroves, the spatial distribution of mangrove forests and their spectral characteristics were concerned. Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) were applied and supervised classification techniques were used to differentiate the land use classes (NDVI values located between 0.7 and 0.8 considered as mangroves). To validate the results, ground truth data (monthly salinity data) were used. To analyze the health of the current mangrove area, Vegetation Condition Index (VCI) was calculated for year 2022. The NDVI results showed a slight variation in mangrove area over these years with percentages of 18.48% in 2001, 12.97% in 2007, 14.54% in 2014, 14.22% in 2021, and 17.24% in 2022. For the year 2022, VCI indicated

a healthy vegetation area at 69.24% surrounding buffer zone of Rekawa Lagoon. Healthy vegetation showed VCI values between 50 and 100, indicating favorable conditions for vegetation growth. No significant correlation was found between the salinity of the Rekawa Lagoon and the mangrove area (Pearson correlation= -0.187, P= 0.562) from 2021 to 2022. The research revealed that mangroves in the study area could be accurately mapped from integration of spectral data derived from Landsat. Furthermore, satellite remote sensing can play a useful role in determining the changes in land area and mangrove cover in Rekawa Lagoon. Such information is important for the future predictions, development, and management of this area as well as in the conservation of mangroves, considering the importance of these ecosystems/habitats for economic activities such as fisheries and recreation.

Keywords: *Mangrove , NDVI, Rekawa Lagoon*

Abstract No: 028

Mangroves to sustain Coastal environment & Biodiversity

Mapping and monitoring of mangrove ecosystems using Satellite Remote Sensing: Case study in Muthurajawela wetland, Sri Lanka

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Mangroves serve as highly productive ecosystems which provide numerous essential Ecosystem Services. Sri Lanka is home to a high number of mangrove tree species and these forests provide habitats for a variety of animals too. Yet, due to population increase and developmental pressure, mangroves, especially those in urban areas, are facing immense threats. Against this backdrop, the present study investigates the spatiotemporal changes in mangrove habitats within the Muthurajawela wetland from 2010 to 2021. Further, the intensity analysis method was employed to identify the Intensity changes of the LULC in the area. Finally, this investigation included a component of community perception of mangrove habitats. The remote sensing images from Landsat 5 TM and Landsat 8 OLI for the time points of years 2010 and 2021 were used for this study, median images were calculated with the Google Earth Engine and 30m resolution images were downloaded. The Iso Cluster Supervised Classification technique was employed to identify Land Use Land Cover (LULC) dynamics of waterbody, mangrove vegetation, other vegetation, settlement and open area, and LULC changes in the wetland area were computed using ArcMap 10.8. The Normalized Difference Vegetation Index (NDVI) value > 0.7 was selected to estimate the true mangrove and mangrove associates in the wetland area. The study reveals that the extent

of the true mangrove and mangrove associates was 41.3%, and 40.8% in the year 2010 and 2021 respectively. Transformation of areas of other vegetation into mangrove areas was prominent for the study period and transition intensity was recorded at 1.22%. Around 1.62 % of true mangrove and mangrove associates have been transformed to other vegetation. The overall accuracy of the classification was 84% and 84%, and the kappa coefficient was 80.0 and 80.0 for year 2010 and 2021 respectively. The community opinions indicated occurrences of forest fires in the mangrove forest areas due to anthropogenic activities and some local communities use mangroves as firewood. According to the results, the true mangrove and mangrove associates in the study area have undergone a slight increase in the extent. The findings indicate that the mangrove patches in the northern part of the lagoon which comes under a sanctuary were intact. However, strong management actions are needed to the sustainability of mangroves in Muthurajawela.

Keywords: *Intensity analysis, Mangrove , Muthurajawela wetland*

Abstract No: 029

Mangroves to sustain Coastal environment & Biodiversity

Can mangrove bivalve, *Geloina coaxan* be considered a sentinel for microplastic pollution in water? : A case study from Negombo Lagoon, Sri Lanka

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Bivalves as sessile organisms are considered sentinels or early warning systems to indicate local environmental changes, including water pollution, due to their higher water filtration capacity, sensitivity to pollutants, high availability, and comparatively higher longevity. *Geloina coaxan,* a mangrove-associated bivalve commonly found in Negombo Lagoon (NL) is an ideal candidate for this task. Being the largest estuarine lagoon near Colombo, Southwest coast of Sri Lanka (7 ° 091′ N 79 ° 51′ E) with inflows from Ja-Ela, Attanagalu oya, Dandugam oya and Old Dutch canal, NL is subjected to a primary influx of terrestrial floating effluents such as macro plastics and microplastics (MPs) of both fresh and seawater origin. The present study evaluates the applicability of *G. coaxan* as a sentinel to forecast MP pollution in water. Since MP will contribute to the alterations in the ecological parameters, including *in-situ* (surface water temperature, water pH and water conductivity) and *ex-situ* (Dissolved Oxygen content (DO), water quality (WQ) parameters were also measured over the monsoons. Sampling was conducted in five distinct locations around the NL. Bulk samples of water were filtered (~ 50 L, n=3/site/ visit) and the benthic bivalves were sampled (n=6/site/visit) during two inter-monsoon seasons (November 2022 and March 2023). The digested tissue samples of *G. coaxans* (cohort mean mass = 0.986 g) were free from MPs; however, water samples were positive for both MPs; threads, and beads. There was no significant seasonal difference in the concentrations of MPs (3200±1306items/m^3, $p>0.05$) in water. . There was a significant seasonal difference in the mean water pH (7.4±0.1, 7.7±0.1, $p<0.05$) and mean

surface water temperature (29.2±0.2 ˚C, 30.2±0.2 ˚C, $p<0.05$) but no difference in the water conductivity during the inter-monsoons (30.34±1.69 µS, 33.34±0.60 µS, $p>0.05$). Further, no significant difference was observed for DO but a low oxygen concentration was observed during the second inter-monsoon (6.29±0.39 mg/L, 4.87±2.46 mg/L, $p>0.05$). The results challenge the use of *G. coaxan* as a sentinel for MP pollution, suggesting more extensive study evaluating physiological indicators of *G. coaxans* that can be used as potential biomarkers of MP pollution in the NL.

Keywords: *Bivalves, Mangrove , Microplastics, Negombo lagoon, Sentinel*

Abstract No: 030

Mangroves to sustain Coastal environment & Biodiversity

Spatial and vertical distribution of organic matter in mangrove soils in Kadolkele, Negombo estuary, Sri Lanka

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Mangrove ecosystems are highly productive and provide critical habitats for numerous species. Organic matter content of mangrove soils is a key factor in shaping above-ground and below-ground species composition. The current study was initiated to determine the spatial and vertical distribution of the total organic matter content in soils of the mangrove ecosystem in the Negombo estuary. Ten-meter-wide belt transects were laid perpendicular to the shoreline across the water-land environmental gradient in the study area. Each transect was divided into 10m x 10m subplots. Soil samples were collected with a split core sampler from 10m distance along the transects. Samples of mangrove soils were taken from three depths, i.e., 0–10cm, 10–20cm and 20–30cm. The total organic matter content in soil was determined with the loss on ignition method. Moreover, species density was estimated by counting individual plants encountered in all plots. Our result indicated that surface soils (0–10 cm depth) contained significantly high amounts of organic matter, and total organic matter content gradually decreased with increasing depth. Furthermore, a statistically significant ($p < 0.001$) relationship was observed between organic matter content of surface soils and the other two depths of mangrove soils. However, there is no significant difference ($p < 0.05$) between organic matter content of intermediate and deeper soils (10–20cm and 20–30cm). The highest organic matter content was found from the surface soils on the landward zone of the vegetation, i.e., 30.20 ± 2.12%. Furthermore, results revealed that the tree density of the zone close

to land was higher and was statistically significant with the other vegetation zones ($p < 0.01$). Moreover, mangrove species *Avicenna marina* (733 no. of individuals/ha) and *Lumnitzera racemosa* (100 no. of individuals/ha) are significantly larger in the landward zone in the vegetation than those in the other zones. As such, the results of the current study highlight that vegetation density influences soil surface organic matter accumulation in mangrove ecosystems.

Keywords: *Density, Kadolkele, Mangrove soils, Organic matter, Spatial and vertical distribution*

Abstract No: 031

Mangrove Conservation, Restoration, Rehabilitation, and Enrichment

Plant Community Assemblages in Five Mangrove Sites on the South-Eastern Coast of Sri Lanka

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Mangroves are important ecosystems providing many services to the world. Despite these services, mangroves in Sri Lanka similar to many other countries are threatened due to various natural causes and anthropogenic activities. Therefore, immediate measures should be taken to conserve these valuable ecosystems. Identifying the diversity of mangrove ecosystems is significant in conserving them. Thus, under-explored mangrove ecosystems on the east coast of Sri Lanka were studied and their plant community assemblages were determined. The study was conducted in five important mangrove sites; Pottuvil lagoon, Panama lagoon, Okanda creek, Hada Oya estuary and Ragamwela creek located on the east coast of Sri Lanka. Eighty-six 10 m × 10 m quadrates were randomly placed in the above-mentioned mangrove sites. Individuals with > 10 cm diameter at breast height (GBH) were identified to species level using a field guide. The relative density of each species in each plot was calculated. Soil samples were taken from four randomly selected locations from each quadrate using a soil core from the top 0.45 m. Soil samples were air dried and pooled samples were prepared for each quadrate. Soil bulk density, pH and salinity were determined using standard methods. Cluster analysis and principal components analysis (PCA) were conducted to identify the plant community assemblages. Canonical correspondence analysis (CCA) was performed to identify the soil edaphic factors shaping the plant communities. Analysis of variance (ANOVA) was used to determine significant differences among soil edaphic factors in different plant

communities. Data analysis was conducted using PAST statistical software. Eight true mangrove species were identified from the five studied mangrove sites. Cluster analysis revealed nine different plant communities: *Excoecaria*, *Rhizophora, Lumnitzera*, *Avicinnia, Bruguiera* and *Excoecaria*, *Heritiera*, *Rhizophora* and *Excoecaria* and mixed communities. The same nine communities were revealed from the PCA analysis. *Excoecaria agalocha*, *Rhizophora mucronata*, *Avicinnia marina*, *Bruguiera gymnorhiza*, *Heritiera littiralis* were identified in the PCA as the species significantly contributing to demarcate plant communities in the studied mangrove sites. According to the results of CCA, soil salinity is the only edaphic factor significantly affecting the formation of the above plant communities. ANOVA also reveals the same. There were no significant differences in soil bulk density or soil pH between identified plant communities. The soil salinity of the mixed mangrove community was significantly higher than rest of the plant communities. According to the results, it can be concluded that the studied mangrove sites are rich in species diversity, especially in the diversity of plant communities. As salinity determines the plant community structure, to conserve the diversity of plant communities in these mangrove sites, it is important to maintain the current hydrodynamic pattern in the area. Otherwise, changing hydrodynamics could cause changes in salinity and thus change the plant community assemblages which could reduce the current diversity among plant communities in the study area.

Keywords: *Canonical correspondence analysis, Edaphic factors Mangrove communities, Soil salinity*

1ST ICMS

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