



**Proceedings of  
International Conference on EcoHealth Nexus:  
Bridging Cascade Ecology & Human Well-Being  
ICEN 2023 - Anuradhapura, Sri Lanka**

**19<sup>th</sup>, 20<sup>th</sup>, & 21<sup>st</sup> of December 2023**





**Proceedings of**

**International Conference on EcoHealth Nexus:**  
**Bridging Cascade Ecology and Human Well-Being**

**ICEN 2023**

**19<sup>th</sup> - 21<sup>st</sup> December 2023**

**Rajarata University of Sri Lanka**  
**Mihintale, Sri Lanka**  
**2023**

**Proceedings of International Conference on EcoHealth Nexus:  
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**ICEN 2023**

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## Foreword



It is an honour to enclose this foreword as the Editors-in-Chief of the Proceedings of the International Conference on Eco-Health Nexus: Bridging Cascade Ecology and Human Well-Being - ICEN 2023, hosted in the Golden Mango Village, Anuradhapura, Sri Lanka, from December 19<sup>th</sup> to 21<sup>st</sup>, 2023.

This conference marks a historic occasion, being the first of its kind held in Sri Lanka following the global recognition of the Tank Cascade Systems of the country as one of the Globally Important Agricultural Heritage Systems by the Food and Agriculture Organization of the United Nations in 2017. The significance of this event lies in providing a platform for academia, practitioners, and policymakers to converge, share the latest knowledge, and disseminate findings in the unique discipline of tank cascade systems.

The traditional village tanks of ancient Sri Lanka have been evolved into the tank cascade systems showcasing their resilience against climate change adaptation and mitigation. The conference organizers assembled a diverse range of tracks covering multidisciplinary topics, including: biodiversity, conservation, and restoration ecology; climate change, disasters, and ecological resilience; watersheds and water quality management; socio-economic systems, governance, and sustainable development; health and healthy landscapes; food security and human nutrition; integrative approaches and emerging technologies. This colloquium is expected to generate a lively discussion to facilitate identifying future research needs, gaps in knowledge, future directions for policy formulations, and best practices for sustainable management of tank cascade systems.

We acknowledge the exceptional contribution from the authors of 106 abstracts to be presented in this conference, the panel of reviewers for the support for providing their expertise knowledge to review abstracts, and the editorial board who committed their time amid the busy work schedule at the university. We would like to thank the Vice Chancellor and Conference Chair for assigning us for this endeavour. Two excellent editorial assistants, Mrs. Kaushalya Dilanjani, and Mr. Lahiru Perera gave us splendid support to produce this proceeding.

**Prof. N.S. Abeysingha**  
**Dr. N. Geekiyanage**  
Editors-in-Chief  
Proceedings of ICEN 2023

# The ICEN 2023

## About the Event

The International Conference on Eco-Health Nexus (ICEN 2023) seeks to promote interdisciplinary dialogues and solutions surrounding cascade ecology and human well-being. Cascade ecology refers to the study of ecological interactions in connected networks of tanks, streams and wetlands that exchange water, nutrients, and organisms. This conference explores how protecting the tank cascade systems would improve eco-health and community resilience. With its theme "To Bridge Cascade Ecology and Human Well-Being for a Sustainable Future," the event brings together experts and practitioners across domains - from water management and climate science to agriculture, archaeology, governance and more. The conference envisioned to facilitate a collective synthesis of existing and new knowledge that integrates environmental and human health for future benefit.

Spanning three days, the conference program features several tracks on diverse topics, from biodiversity conservation and ecological interactions to indigenous wisdom and societal governance. Participants can explore water-centred solutions; innovations in monitoring, technology and management; and nexuses between factors like food, nutrition, disasters, development etc. Sessions also focus directly on Sri Lankan tank cascade systems and how applying such ancient knowledge can build future sustainability. By facilitating synergetic nexus between cascade ecology, sustainability and policy, the ICEN 2023 promises a vibrant exchange of ideas to chart an integrated path ahead - one where ecological and community wellness reinforce each other.

## Parallel Events

### *Art Competition*

A fitting art competition was organized alongside the conference, inviting young artists to creatively interpret the forum's theme on the vital role of cascade tank systems. With the visionary title "Tank is our Life", this contest was open to three age categories - below 10 years, 10-15 years and 16-20 years. Participants were encouraged to employ any art medium to portray local village tanks as the lifeblood nurturing agriculture, community and culture. Emerging artists thus engaged their fresh perspective on the ancient but timeless tank wisdom that sustains human health and resilience alike. The incredible artwork submissions conveyed tanks as the very cradle of their livelihoods, security and heritage. A selection was exhibited at the conference venue to showcase such inspiring visions from younger generations about preserving Sri Lanka's unique water heritage as an interconnected "water-culture-community" ecosystem essential to national identity. The art competition aimed to parallel the conference's academic debates on cascade systems with creative impressions from children dependent on such tanks in their everyday lives.

## ***Photography Competition***

Aligned to the aims of ICEN 2023 on promoting water-cantered environmental concepts, this competition aimed to broaden public engagement through visual storytelling. The contest featured two categories, one for professional photographers using high-end cameras and another opened to mobile phone photographers. Participated artists across amateur and expert levels were allowed to submit photographs that showcased the interconnectedness of lakes, rivers, wetlands, forests and human communities sustained by such water networks. These images could reveal biodiversity, agriculture, culture or vulnerabilities of landscapes linked by cascade systems. The photographs were evaluated by a jury on technical aspects like framing, clarity and editing aptitude. However, the key focus lied in how imaginatively the images portrayed the relationships within cascade ecology, be it shifting seasonal flows or timeless human connections to such water-shaped terrains. Selected photographs were exhibited at the conference. By showcasing photographs that reflected the connections between nature's aquascape and human heritage, this photography contest hoped to highlight the integrated "systems-within-systems" crucial to community health and resilience at that time, much like Sri Lanka's ancient cascade tanks that nourished generations.

## ***Practitioners' Forum***

The International Conference on EcoHealth Nexus 2023 hosted a vibrant Practitioners' Forum focused on sharing insights from on-ground experiences working with cascade ecosystems. Titled "Sharing Ideas of People Working with Cascades," the open session created a collaborative platform for practitioners from diverse backgrounds to exchange knowledge on emerging ideas, innovations, and lessons learned. The vibrant exchange marked the convergence of theory and practice, research and action - setting the stage for knowledge co-production that accelerates sustainable cascade restoration and management. Participants emphasized the need for continued platforms that inform practitioner-led initiatives, collaborative field projects, and policy changes to improve cascade resilience and human well-being.

## ***Field Excursion***

A memorable field excursion was organized in parallel to the ICEN 2023 to showcase the village tank cascade systems *in-situ*. The agenda featured a journey to several locations that brought alive the interconnected landscapes presented at the forum. The tour began by visiting the historic Mihintale sacred site, which is believed to have strong connections with the origins of Sri Lanka's long-running cascades heritage. It then travelled to the model eco-village of Hiriwadunna for an insightful walking tour around their local tank networks that sustain agriculture and community needs. A traditional village lunch enabled first-hand experience of the culture nourished by such intricate water systems. The highlight was the visit to the ecologically restored Thumbikulama tank that conveyed the modern revival of ancient cascades wisdom. This field trip offered a unique opportunity to physically traverse the contours of cascade systems hailed at the conference as essential lifelines worldwide.

### ***Panel Discussion: Sharing ICEN 2023 Research Insights with Policy Makers***

The closing panel discussion of the ICEN 2023 brought together researchers and policymakers to facilitate meaningful dialogue on critical research insights and their integration into policy considerations. Titled "Sharing Research Insights with Policy Makers," the session created a vital platform for stakeholders across sectors to advance a collective understanding of the complex interlinkages between cascade ecology and human well-being. By facilitating open exchange between researchers and decision-makers, the panel marked a critical step in nurturing a knowledge-policy interface that enhanced responsiveness to emerging research insights. Participants reinforced collective commitment to science-backed decision-making that balances ecological integrity and human development needs, advancing the conference objectives of bridging cascade ecology and human well-being.

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## Message from the Chancellor



It gives me great pleasure to extend my humble greetings to all esteemed participants of the International Conference on Eco-Health Nexus 2023. The profound theme - "To Bridge Cascade Ecology and Human Well-Being for a Sustainable Future"- also deeply resonates on spiritual planes. Our nation's enduring tank cascade heritage stands testimony to the wisdom of our ancestors in sustainably harmonizing water-soil-flora-fauna-community in line with nature's rhythms – a philosophy most relevant to addressing modern sustainability challenges.

While rapid development brings conveniences, it also severs vital ecological and social connections essential for long-term prosperity. As scholars and practitioners across diverse domains, may the crucial dialogues and networks seeded at this conference inspire you to restore healthy nexuses between man and nature, between traditional knowledge and cutting-edge solutions.

I sincerely appreciate the joint organizers, Rajarata University of Sri Lanka and Healthy Landscape Project of the Ministry of Environment, all funding agencies, and those involved in spearheading this meaningful conference. May your individual and collective efforts towards cascade-centred sustainability bear rich fruits.

With *metta* and best wishes for a successful event.

**Ven. Ethalawatunawewe Gnanatilake Thero**  
Chancellor  
Rajarata University of Sri Lanka



## Message from the Vice Chancellor



It gives me great pleasure to extend a warm greeting to you for the International Conference on EcoHealth Nexus: Bridging Cascade Ecology and Human Well-Being, which is being co-organized by the Ministry of Environment's Healthy Landscapes Project and the Rajarata University of Sri Lanka. The conference's topic, "To Bridge Cascade Ecology and Human Well-Being for a Sustainable Future," succinctly conveys the significance and immediacy of this gathering.

Through the establishment of profound links between research, policy, and practice in several fields, ICEN 2023 aims to map out a future integrated route in which the goals of human and ecological health complement and enhance each other.

The ancient tank cascade systems in Sri Lanka are the perfect example of such nexus thinking in action. This tried-and-true water management approach has supported successful hydro-social complexes in the past, and its wisdom still provides important sustainable answers for the modern world. I commend the conference organizers for using our nation's cascades as the focal point of discussions despite using global perspectives to address more general challenges like food, water, climate change, disaster management, and more.

I would like to express my gratitude to the following people: funding agencies, event organizers, representatives from the Healthy Landscapes Project, Prof. M.H.J.P. Gunarathna, who chaired the conference, Mr. Ajith De Silva, and his team, and all those who helped make this event possible.

I also thank the editorial board members, reviewers, and authors who presented their research findings at ICEN 2023, Editors-in-Chief Prof. N.S. Abeysinghe and Dr. Nalaka Geekiyanage, and all those who contributed in any manner to the success of this proceeding.

I'm hoping that the lively intellectual conversation at ICEN 2023 will be quite beneficial to you. May the connections and knowledge you get from this experience inspire further interdisciplinary teamwork to pursue cascade-centred eco-health objectives in your respective fields of expertise. I hope your conference is really successful, fun, and unforgettable.

**Prof. (Mrs.) G.A.S. Ginigaddara**  
Vice Chancellor  
Rajarata University of Sri Lanka



## Message from the Conference Chair



With immense pleasure and gratitude, I warmly welcome all participants, collaborators, and invitees to the International Conference on EcoHealth Nexus: Bridging Cascade Ecology and Human Well-Being (ICEN 2023).

Our vision for ICEN 2023 is rooted in the commitment to "Bridge Cascade Ecology and Human Well-Being for a Sustainable Future." Pursuing this vision aligns with our overarching mission to promote the vital concepts of Cascade Ecology among national and international partners. Through collaborative efforts and shared insights, we aim to foster a holistic understanding of the intricate connection between ecological systems and human well-being.

ICEN 2023 goes beyond traditional conferences, offering engaging side events to enhance the overall experience. The art and photography competitions foster creativity and reflection on the conference themes. The practitioners forum provides a unique space for professionals to exchange practical insights, enriching the discourse on EcoHealth. A panel meeting with policymakers is crucial for translating research into actionable policies.

With immense pleasure and pride, I congratulate Emeritus Professor C.M. Madduma Bandara and Dr. M.U.A. Thennakoon, who received the well-deserved felicitation awards during ICEN 2023. Your exceptional contributions to the research and development of tank cascade systems and landscapes have distinguished you as scholars and have impacted the academic and professional communities.

As we gather for this transformative event, I would like to express our deep appreciation to Mr. Ajith De Silva, National Project Manager of the Healthy Landscapes Project (HLP) of the Ministry of Environment and his team for their unwavering support and commitment. Their dedication has been instrumental in shaping ICEN 2023 into a platform for meaningful dialogue and collaboration. I extend heartfelt thanks to all the funding and monitoring agencies of the HLP, including the South Asia Co-operative Environment Programme (SACEP), United Nations Environment Programme (UNEP), Global Environment Facility (GEF) and Alliance Bioversity International, whose support has been crucial in realizing our mission. The investment in ICEN 2023 signifies a shared commitment to advancing knowledge and practices for the betterment of our global community.

I extend my deepest gratitude and appreciation to Dr. Anil Jasinghe, Secretary of the Ministry of Environment, and the dedicated staff of the ministry for your invaluable contributions. They inspire us all to work towards a harmonious coexistence with nature.

I extend my sincere appreciation and gratitude to Prof. Katarzyna Glinska-Lewczuk, University of Warmia and Mazury in Olsztyn, Poland and Prof. D.K.N.G. Pushpakumara, University of Peradeniya, Sri Lanka, for your invaluable contributions as keynote speakers at the ICEN 2023. Your expertise, insights, and thought-provoking presentations have significantly enriched our conference, providing a deeper understanding of the interplay between cascade ecology and human well-being. Your participation undoubtedly enhances the success of ICEN 2023, and we are grateful for the time and effort you invested in sharing your knowledge with our diverse audience.

I would also like to thank Prof. (Mrs.) G.A.S. Ginigaddara, Vice Chancellor of the Rajarata University of Sri Lanka, for your unwavering support and leadership. Your commitment to academic excellence and the success of ICEN 2023 has been instrumental in making this conference a resounding success. Your encouragement and guidance have been pivotal in ensuring the seamless organization and execution of this event.

I would be grateful for the support of Prof. N.S. Abeysighe and Dr. Nalaka Geekiyanage, Editors-in-Chief and the editorial board members, whose expertise has shaped the quality and rigour of the conference proceedings. I want to express my deepest gratitude to each member of the organizing committee and all other supporters who have played a pivotal role in making this event memorable.

I am delighted to extend my heartfelt gratitude to all the authors who contributed to the success of the ICEN 2023 through their abstract submissions. We received an overwhelming response, receiving 215 abstracts, each representing diverse perspectives and groundbreaking research in the field. The high quality and relevance of the submissions made the selection process both challenging and inspiring. After a rigorous review, we are pleased to announce that 105 abstracts have been selected to present at the ICEN 2023. The selection was made possible by the diligent efforts of our esteemed reviewers, who dedicated their time and expertise to ensure the highest standards of academic excellence.

In conclusion, your participation is integral to the success of ICEN 2023. Together, let us embark on a knowledge exchange, collaboration, and innovation journey to create a sustainable and harmonious future. Thank you very much, and I look forward to the enriching discussions and collaborations that lie ahead.

**Prof. M.H.J.P. Gunarathna**

Chair

ICEN 2023

## Message from the National Project Manager, HLP



I am very pleased to issue this message on the occasion of International Conference on Cascade ecology 2023 (ICEN-2023) - "Eco-Health Nexus: Bridging Cascade Ecology and Human Well-being" organized by the Rajarata University of Sri Lanka in collaboration with the Healthy Landscapes Project.

I am highly impressed and glad to note that the participants, such as academia, researchers, practitioners and even school children and teachers, have been extremely motivated and involved in high-quality multidisciplinary research with the aim of achieving the national development goals of Sri Lanka. I hope that ICEN-2023 - "Eco-Health Nexus: Bridging Cascade Ecology and Human Well-being" will provide a platform for all the presenters and participants to present and be awarded the novel and latest developments in the field of Cascade Ecology. I am sure that they will be able to exchange of knowledge, share opinions from researchers, engineers, scientists, academia and industry and nurture international research collaborations.

According to WHO and CBD, agriculture and sustainable land management depend heavily on healthy ecosystems and intact biodiversity, and the outcome of many of these ecosystem and biodiversity interactions will have significant positive and negative repercussions for human health. Increasingly alarming signals indicate that poor agricultural and unsustainable land management practices in Sri Lanka negatively impact important global biodiversity and contribute to ecosystem degradation and the essential services they provide. Hence, this, in turn, is translated into serious downstream impacts on the health of significant portions of Sri Lanka's population.

Deterioration and degradation of cascade wetland landscapes and the decline in the globally important biodiversity and multiple ecosystem services and co-benefits are becoming the most critical among the many ecological and environmental challenges facing Sri Lanka today causing a decline in the globally important biodiversity and multiple ecosystem services and co-benefits these landscapes provide. The Sri Lankan cascade landscape consists of Village Tank Cascade Systems (VTCSs), which is the focus target landscape of the Healthy Landscapes Project. It harbours many economically and ecologically high-value species and habitats. The local community depends on these resources for their tangible and intangible daily needs.

However, continual overexploitation of cascade ecosystem components has resulted in the accelerated decline in the abundance of a wide range of species and habitats. Poor understanding of the function of this complex landscape has led to ignorance and inadvertent destruction of the ancient VTCS. To date, there has been inadequate effort to study and disseminate knowledge of the best practices and the concept of

cascade ecology on which the sustainability of the landscape depends. I am sure that the 1st International Conference on Cascade Ecology 2023 (ICEN-2023) - "Eco-Health Nexus: Bridging Cascade Ecology and Human Well-being" would be one of the a that can pave the way to close the above gap and work towards a better and sustainable VTCSs.

Therefore, I wish to congratulate the Vice Chancellor, all staff and the organizing committee of the Rajarata University of Sri Lanka for organizing this international conference with the aim of improving cascade ecology research and knowledge management culture in the country to develop and expand each research to achieve the highest possible outcomes and wish ICEN-2023 every success.

**Mr. Ajith De Silva**

National Project Manager

Healthy Landscapes Project (HLP)

## Message from Director General of SACEP



As a Director General of South Asia Co-operative Environment Programme (SACEP), it is my great honour to welcome you and wish you professional success at the International Symposium on "Eco-Health Nexus: Bridging Cascade Ecology and Human Well-Being". SACEP, being the Implementing Partner of the Healthy Landscapes Project, is pretty much happy to be a partner of this international symposium, which brought together many eminent intellectuals on the subject.

I heard that Sri Lanka has a great and long history of water management especially through the construction of tank systems in the dry zone to provide water during droughts, conserve the forest, keep the wild animals away from villages and improve the livelihood of villagers. This is more relevant to the present climate change scenario as it can be considered to a greater extent as an adaptative measure for climate change.

The Healthy Landscapes project will strengthen the renovation and sustainable management of village tank cascade landscapes for the provision of ecosystem services for human health and wellbeing and safeguarding of agrobiodiversity in the dry zone region of Sri Lanka and provide a cascade landscape management model to catalyze scaling up to other cascade landscapes in the country. The project identified that it is equally important to establish knowledge management and partnership to promote greater awareness and understanding of cascade landscape ecology and management concepts, a much-improved enabling environment for improved cascade landscape management, and implementation of more sustainable practices in cascade landscapes.

This Conference provides a forum for scholarly discussion on the cascade system, its functionality, ecosystem services it provides and the benefit to the local communities and to the environment. The response of contributors and likeminded educational fraternity showing their keen interest in this conference is highly motivating. The presentation of such research papers is extremely beneficial for research scholars. I sincerely offer my earnest gratitude to those who have contributed through their research papers at the conference. I am sure that the conference would achieve its objective by providing a suitable platform for learning and experiencing the science behind the Sri Lanka's Village Tank Cascade System. I wish for the grand success of the conference.

**Ms. Rokeya Khaton**  
Director General  
SACEP



## **Message from the Principal Scientist The Alliance of Bioversity International and CIAT**



Sri Lanka's Village Tank Cascade System is a unique and ancient hydraulic and ecological system that provides many ecosystem services for agricultural production, food security and nutrition, livelihoods and human health and wellbeing. It is supported by a unique cascade ecology rich in multiple ecological interactions. It is also a hotspot and home for unique biodiversity including the genetic diversity of wild, cultivated and domesticated species. Maintaining this socio-ecological landscape, rich in indigenous knowledge, is critical for Sri Lanka and the communities who reside there not only for the multiple benefits it provides but also as the severe impacts of climate change become increasingly apparent. However, it is not only changing climate that is impacting these tank landscapes. They also face other threats and challenges of a socioeconomic and socio-political nature. For the sake of current and future generations it is imperative that we urgently take the necessary steps to restore, maintain and enhance this unique socio-ecological landscape especially through mainstreaming biodiversity and safeguarding associated ecosystem services. This is not only a key strategy for adaptation to changing climate but is central to safeguarding a globally important cultural landscape for planetary and human health. This has always been the goal and aspiration of the GEF supported Healthy Landscapes Project in Sri Lanka which has been effectively and efficiently championed and led by the Ministry of Environment with execution and coordination from the Alliance of Bioversity International and CIAT and implementation support by the UN Environment Program and SACEP. The manifold elements of the unique Village Tank Cascade System and the multiple benefits it delivers, as well as the many challenges and threats it faces, will be focus of the ICEN 2023 – International Conference on Ecohealth Nexus: Bridging Cascade Ecology and Human Well-being which has been expertly planned and convened by Rajarata University. Through this symposium all partners will be able to intensify their future efforts to secure and sustain this globally important landscape.

**Dr. Danny Hunter**

Principal Scientist

The Alliance of Bioversity International and CIAT



## **Message from the Task Manager (Asia)**

### **GEF Biodiversity and Land Degradation Unit**



We are pleased to support this symposium, a unique platform that brings together researchers and practitioners of cascade water-tank systems. Cascade water tank systems are different things to different people: for environmental researchers, they provide an excellent case study of ecological functionality and services; for farmers, they provide critical water supply and storage during dry seasons; for birdwatchers, these are excellent recreation sites; for flower pickers, they are a means to their livelihoods; and for ethnographers, these are cultural landscapes. These living landscapes are an important part of Sri Lanka's rich cultural heritage and have reflected the traditional knowledge and intergenerational efforts of communities to build, maintain, and restore natural infrastructure over centuries. The Sri Lankan government has demonstrated its commitment to restoring these systems, and the results are visible and tangible.

However, while there has been tremendous work done under several undertakings of the government and donors, including the GEF Healthy Landscapes project, much remains to be done. Water tank cascades are entire ecosystems and restoring them means that we need to work cross-sectorally and over the long term. Through the valuable research that is being conducted by scholars from all over the globe, we are continuously learning more about the complexities of these systems. Furthermore, these unique and resilient systems have been brought into sharp focus in the context of climate and biodiversity crises, and efforts to restore them need to take a landscape-level approach, yielding multiple benefits for those living in these landscapes and contributing to Sri Lanka's SDGs.

I am delighted to see this symposium being held in Anuradhapura, a place of historical significance dotted with cascade water-tank systems, where history, culture, and nature are intimately linked.

**Ms. Kavita Sharma**  
Task Manager (Asia)  
GEF Biodiversity and Land Degradation Unit



## Message of the Secretary to the Ministry of Environment, Sri Lanka



The Ministry of Environment of Sri Lanka remains committed for the management of the environment and natural resources of the country, maintaining the equilibrium between the trends. Our vision is "A Sustainably Developed Sri Lanka". As a national focal point to the three Rio Conventions, Ministry of Environment implement numerous projects and programmes on Biodiversity Conservation, Sustainable Land Management and Climate change.

GEF Project on Healthy Landscapes: Managing agricultural landscapes in socio-ecologically sensitive areas to promote food security, well-being and ecosystem health in Sri Lanka, is a grant project implemented by South Asia Cooperative Environment Programme (SACEP) under the leadership of Ministry of Environment. The project aims to better manage agricultural land uses in the cascade landscape, promoting food security, wellbeing, and ecosystem health and mainstreaming biodiversity into integrated landscape management to realize health and environmental co-benefits of the village tank cascade systems. The third component of this project is dedicated to Knowledge management, partnerships and capacity building for better sustainable integrated landscape management in support of improved ecosystem services and eco-health outcomes.

In terms of implementation of one of the main activities identified in the third component of the project, this symposium on "**Eco Health Nexus: Bridging Cascade Ecology and Human Well-Being**" has been organized by the Healthy Landscape project with the collaboration of Rajarata University of Sri Lanka. I hope this symposium is a unique opportunity for researcher's to share academic research and evidence generated at the field level on a common platform. Research work of our universities has and continue to contribute to policymaking, managerial decision making, as well as towards maintaining social justice and well-being. As a ministry responsible for the environment, we truly respect research findings and make use of them while we make decisions related to the environment.

Finally, I would like to thank the Chairperson of the research symposium, all sub-committee chairs, sub-committee members from all faculties and institutes, the National Project Manager and the team from the Healthy landscape project, , Director (Natural Resource Management) , Director General SACEP and all academic, administration and supportive staff who worked tirelessly to make this event successful. I wish for a successful symposium.

**Dr. Anil Jasinghe**

Secretary

Ministry of Environment

## Keynote Speaker



**Katarzyna Glinska-Lewczuk**, Prof. Dr Hab., is Head of the Department of Water Management and Climatology, Faculty of Agriculture and Forestry at the University of Warmia and Mazury in Olsztyn (UWM), Poland. Geographer (University of Gdańsk, 1993), specialized in water management (Wageningen University, Netherlands 1997-1998), PhD in Environmental Protection and Management (2001), Professor of Agricultural Sciences (2018). She specializes in hydrology, hydrochemistry and ecohydrology of freshwater ecosystems in lowland regions. Her scientific achievements focus on the

hydrological drivers of biogeochemical processes in river-lake systems under climate change. Involved in wetland restoration. Developed practical guidelines for aquatic ecosystems by establishing rules for ecohydrological monitoring and integrated water management.

Author and co-author of >300 publications; 4 patents; H-index (WoS) = 20;  $\Sigma$  IF > 220. Experienced academic teacher and PhD supervisor. Granted for studies on the hydrology of wetland ecosystems in agricultural landscapes in Central Europe. International cooperation in EU-funded consortia (e.g. CCWater, Water Harmony, OPTIFERT, BIOPROS). Member of, among others, the Polish Agricultural Committee, the Water Management Council of the Polish Academy of Sciences, the Water Management Council. Vice-Chairman of the Regional Council for Nature Protection at the Regional Directorate for Environmental Protection in Olsztyn. Member of, among others, the International Association of Hydrological Sciences, the Society of Ecological Restoration, the Polish Magnesium Society and the Polish Society of Ecological Engineering. Expert on EU funding. She is a wilderness traveler and nature photographer.

## Keynote

### **Nature-based Solutions for sustainable agricultural water management: from safe environment to healthy food and well-being**

By

Prof. Katarzyna Glinska-Lewczuk

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In recent years, increasing agricultural productivity has drastically reduced the number of people worldwide who cannot feed themselves adequately, but with high cost to nature. At the same time, agricultural production in regions with food insecurity, particularly in Asian countries, is threatened by climate change. The intensification and expansion of agriculture, which has been accompanied by high-yielding varieties, irrigation and a high levels of chemical doses, has led to the degradation of aquatic ecosystems and soils, the depletion of water sources and the reduction of biodiversity. Although agricultural irrigation causes the majority of water scarcity problems in high-risk areas and threatens food systems, community water supplies and ecosystem health, it is a key element of effective agriculture.

Today, modern pressurized systems (e.g. drip and sprinkler irrigation) dominate in agricultural landscapes. Large area sprinklers, ramp sprinklers, pivots and line systems show high irrigation efficiency, low electricity and water consumption and minimal work effort. Besides, micro-irrigation (drip irrigation) technology saves water and energy by reducing crop transpiration, evaporation and surface runoff. Each of these techniques has a number of advantages and disadvantages. However, none of them are based on nature or have a social benefit that can be scientifically proven.

In many parts of the world, particularly in Asia and Africa, traditional gravity-fed irrigation techniques, dating back as far as 6000 BC, still function. This type of system is often used in arid climates where every drop of water counts. In addition to the animal-powered pumps and aqueducts that transport water over long distances, reservoirs still provide water for food production for around two billion people. They also preserve biodiversity, livelihoods, practical knowledge and culture.

In response to global trends that undermine family agriculture and traditional agricultural systems, some gravity-fed irrigation systems are protected as UNESCO World Heritage Sites (Aflaj Irrigation System of Oman or Mount Qingcheng; the Dujiangyan Irrigation System in China) or as Globally Important Agricultural Heritage Systems (GIAH). Among the 67 agricultural GIAH sites are the Tank Cascade Systems (TCS) in Sri Lanka. The village tank-cascade irrigation systems located in dry zone

of Sri Lanka are excellent examples of ancient man-made irrigation systems consisting of thousands of lowland ponds and reservoirs, rainwater harvesting storage structures, canals and channels. The TCS are unique in their multifunctionality, as they enable sustainable food production, especially in times of water scarcity, preserve the ecological values of the landscape and maintain family farming and its potential in sustainable agriculture development. The Tank Cascade Systems fall under the concept of Nature-based Solutions (NbS), or more specifically agricultural NbS (Ag-NbS), which transform productive landscapes from polluters to providers of environmental solutions. Irrespective of the NbS definition (IUCN, European Commission), it applies to solutions that not only use nature, but are also inspired and supported by nature. NbS aims to increase agricultural production and resilience, mitigate climate change and promote nature and biodiversity. Terms encompassed by NbS are: Ecosystem-based Adaptation (EbA), Ecosystem-based Disaster Risk Reduction (eco-DRR), Green/Blue Infrastructure (GI/GBI/BI).

NbS is an umbrella concept that encompasses a range of different approaches to support sustainable water management: (i) ecosystem restoration approaches (e.g. ecological restoration, ecological engineering); (ii) issue-specific ecosystem-based approaches (e.g. ecosystem-based adaptation, ecosystem-based mitigation and ecosystem-based disaster risk reduction); (iii) infrastructure-based approaches (e.g. natural infrastructure and green infrastructure); (iv) ecosystem-based management approaches (e.g. integrated water resources management); and (v) ecosystem protection approaches (e.g. area-based conservation approaches including protected area management).

In the era of the twin crises of climate change and biodiversity loss, NbS have recently gained popularity as it supports a wide range of sustainable development goals and solutions to societal challenges that involve working with nature. NbS is to provide sustainable benefits to society: NbS are implemented with the full engagement and consent of Indigenous Peoples and local communities in a way that respects their cultural and ecological rights. Moreover, NbS should be explicitly designed to provide measurable benefits for biodiversity.

The TCS in Sri Lanka are a great example which provide historical evidence of the positive impacts of NbS. This tradition, historical experience and knowledge of rain-fed irrigation is an integral part of the culture and should be maintained by the younger generations.

The TCSs in Sri Lanka mirror, to a certain extent, naturally functioning river-lake cascades in the cold temperate climates of Central Europe or Canada. Therefore, despite the differences in geological origin (Precambrian versus postglacial areas), eco-hydrological similarities between TCS and natural river-lake systems can be identified. The morphological similarity between the TCS and the ponds created in central France is interesting. In the Parc Naturel de la Brenne, which, apart from its extensive agriculture and ecological values, is also known for its 3400 fish ponds located close to each other, created in the XV century for intensive fish farming (carp).

Ecohydrological monitoring shows that natural river-lake systems play an important role in hydrological functions and processes that, as with all wetlands, form the basis for potential ecosystem services. These services include enhancement of groundwater recharge, retention of nutrients and chemicals, water purification and waste treatment, soil formation, and control of erosion and sedimentation. Perhaps the most commonly cited benefits of wetlands, however, are their effects on flow regime, particularly their potential to reduce flood peaks and extend the return period of floods, enhance low flows, and reduce runoff and flow velocity.

It must be emphasized that climate change poses a significant threat to water resources around the world, contributing to water scarcity and reducing the availability of water for agriculture and consumption. In Central Europe, the problem is deepened by the intensive canalization of rivers and the drainage systems built in the XIX and XX centuries. In the lakelands of Northern Europe, the effects of low groundwater levels are contributing to the extinction of natural habitats important for biodiversity, such as bogs and mid-field ponds (kettle lakes).

In recent years, the EU has therefore promoted the increase of natural water retention in agriculture and forestry. In Northern Poland, local mid-field depressions or reclaimed (drained) areas have been used for water retention by creating numerous small (approx. 1 ha, <1 m high) reservoirs or cascades along watercourses and blocking the drainage ditches. The construction of such structures has increased water retention by the volume of ca. 13.5% when referred to the annual surface runoff. The reconstructed chains of river-lake systems are of great landscape and ecological value. The literature reports that these cascade systems of both natural and man-made origin contribute to water purification through intensive sedimentation of material transported by water, biochemical processes and uptake by plants. Their role is clearly recognizable when it comes to mitigating runoff peaks.

Despite the increasing attention on NbS, particularly lake- or tank cascades (such as the TCS in Sri Lanka, see: Web of Science citation report), less is known about how they respond to extreme environmental conditions and how they adapt to the changing environment. To gain this knowledge, the establishment of a comprehensive monitoring system is recommended. By combining advanced research methods (including hydrometeorology, ecohydrology, hydrochemistry and stable isotopes, remote sensing) with the digitization of data, validated results could serve as a tool to support management practises.

In summary, given the continuing strong demographic pressure on food demand, closing the gap between land productivity and sustainable land management appears to be of fundamental importance. This demand can be met within the framework of agricultural, Nature-based Solutions, regardless of the region of the world. Robust and resilient NbS respond to the urgent challenges of climate change and biodiversity loss and together protect nature and people, now and in the future, while ensuring healthy food production.

## Keynote Speaker



**Gamini Pushpakumara** is a distinguished Senior Professor with over three decades of academic experience in the Department of Crop Science, Faculty of Agriculture at the University of Peradeniya. He earned his B.Sc. in Agriculture from the University of Peradeniya and further advanced his education with an M.Sc. and Ph.D. from the University of Oxford, UK. Presently, he holds the position of Director/Academic Affairs Division at the University of Peradeniya. His past roles include being the Head of the Department of Crop Science and the Dean of the Faculty of Agriculture at the same university. Professor Pushpakumara possesses extensive professional expertise in various research areas, including partnership building, multidisciplinary team coordination, budget management, strategic planning, and student supervision at both undergraduate and postgraduate levels. His areas of policy research encompass homegardens, conservation, underutilized tree crops and their germplasm management, the tank village system and its ecology, forestry, agroforestry, climate change, and fundraising for educational and research endeavors. His teaching and research interests lie in Tree Domestication and Improvement, System Approach in Agricultural Developments, Agroforestry, Homegardens and their Climate Change Impacts, Agrobiodiversity Utilization, and Plant Invasion Impacts. He has an impressive record of over 100 full research papers and book publications. Professor Pushpakumara's collaborative research network extends to the national agricultural research system, other universities in Sri Lanka, and international researchers. He has been a member of various national governing boards, task forces, research monitoring, and evaluation committees. Additionally, he has served as a country Liaison Scientist to the World Agroforestry Centre and a Visiting Professor at the Transylvania University of Brasov, Romania.

## **Keynote**

### **Dynamics of Cascade Ecology Nexus: Importance and Consequences for Sustainability of Tank Village Cascade System of Sri Lanka**

By

Prof. D.K.N.G. Pushpakumara

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Sri Lanka's Cascade Tank Village System (CTVS), a testament to the country's ancient expertise in hydrology and agriculture, plays a crucial role in the ecological and cultural landscape of the country's dry zone. This remarkable system, consisting of a network of reservoirs linked in a cascading manner, represents more than a historical irrigation achievement and thus provides vital support for biodiversity, water management, livelihood functions, socio-economics, and cultural activities, and environmental resilience. At the heart of this system is the Cascade Ecology Nexus - a complex web of interactions between living organisms, including human and non-living environmental factors. This paper aims to delve into the critical role of the cascade ecology nexus in maintaining the delicate balance necessary for the soil and ecosystem health, sustenance and productivity of these man-made ecosystems. It explores the symbiotic relationships between aquatic and terrestrial ecosystems within the cascades and also mimics the natural ecosystem highlighting how knowledge of cascade ecology contributes to biodiversity conservation, efficient water management, agricultural productivity, and overall environmental sustainability. Additionally, this paper addresses the challenges of modern anthropogenic influences, including land encroachment, urbanization, climate change, and loss of biodiversity. Emphasizing the imperative of integrating cascade ecological principles into contemporary and future strategies for conservation and management, the paper argues for the importance of conservation of the CTVS's integrity under the present context of changing climate. Understanding and sustaining the cascade ecology nexus is essential for ensuring the ongoing role of the CTVS in the sustainability and prosperity of communities, agriculture, and the environment in Rajarata, a region steeped in the ancient heritage of Sri Lanka.

## Village Tank Cascades: An Unexplored Heritage



*Heaven – A photograph by Mr. D.M.T.U. Dissanayake.  
(submitted to the photography competition of ICEN 2023)*

Gracefully cascading down the rural heartlands of Sri Lanka lies one of humanity's great feats of hydraulic engineering - ancient systems of intricately interconnected reservoirs, known as village tank cascades, that have watered the nation's agricultural soul for over two millennia. Constructed by ancient Sinhalese kingdoms, these indigenous cascades are a sight to behold - thousands of glistening "tanks" fluidly linked together by a shared irrigation network that elegantly follows the island's natural watershed structure. The larger tanks downstream are fed by their smaller cousins upstream, the systems functioning in harmony with the landscape. Guided by a sustainable vision, Sri Lankans planned these cascades communally, passing down hydraulic knowledge generation after generation to uphold cooperative management. During times of rain or drought, this alliance between nature's bounty and human ingenuity has persevered, allowing Sri Lankan rice farmers to prosper where others could not. Therefore, whilst the cascades served functional needs, they also became revered monuments to the nation's ancestral water wisdom. One cannot help but immerse oneself in Sri Lanka's rich history when admiring these irrigation networks that have endured the test of time. The tank cascades stand tall as enduring symbols of harmony, cooperation and agricultural heritage in a land shaped by water.

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## **1. Biodiversity, Conservation, and Restoration Ecology**



# AVIFAUNAL DISTRIBUTION IN THE RATMALE TANK IN AMBAGASWEWA TANK CASCADE, SRI LANKA

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**Abstract:** Ratmale tank is a seasonal tank located in the middle part of Ambagaswewa cascade system, Anuradhapura district, Sri Lanka. The faunal diversity and their abundance in this tank were investigated. This work also highlights the threats to bird conservation in Ratmale tank. The point count method and opportunistic observation were used to collect data both day and night, during the dry spell in year 2023. The data were collected from four zones, dam of the tank and slope (Z1), adjacent dry mixed evergreen forest patch (Z2), aquatic zone (Z3), and inundated area (Z4). We identified 62 bird species belonging to 40 families including aquatic, semi-aquatic, and terrestrial birds. Among the observed 34 terrestrial birds, *Gallus lafeyetii* and *Treron pompadora* are listed as endemic species. The site contains *Nettapus coromandelianus* listed as nationally vulnerable and *Merops philippinus* listed as nationally critically endangered. Moreover, observed *Haliaeetus ichthyaeetus*, *Threskiornis melanocephalus*, *Anthracoceros coronatus*, *Limosa lapponica*, and *Anhinga melanogaster* have been listed as globally near threatened. The presence of *Ciconia episcopus* listed as globally vulnerable reflects prime conservation attention. *Pavo cristatus* (23%) and *Acridotheres tristis* (18%) were observed as the most abundant species in Z1 zone. In Z2 zone, *Psittacula krameri* is the most abundant species while *Microcarbo niger* was the most abundant species in Z3 (44 %). *Porphyrio poliocephalus* is the most abundant species (65%) in Z4 zone. Grazing to both bird number and abundance in the tank and its surroundings. Grazing by cattle and frequent visits of herder by motorbikes during day and night were more detrimental. Thus developing a site-specific conservation plan is vital to protect the status of bird species in the tank landscape.

**Keywords:** Abundance; Endemic; Dry spell; Grazing; Zones

# POPULATION DISTRIBUTION OF FAUNAL SPECIES IN NATURALIZED ECOSYSTEMS OF KALA OYA TANK CASCADE SYSTEM

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**Abstract:** This investigation, spanning from November 2019 to March 2020, explored the faunal biodiversity within the naturalized ecosystems of the Kala Oya Tank Cascade System. Utilizing Variable Circular Plots (VCPs) and opportunistic surveys, 55 bird species from 18 families were identified, including several wetland-associated families such as Ardeidae, Ciconiidae, and Phalacrocoracidae. Notably, 14 nationally threatened species were recorded, including Ruddy-breasted Crake (*Porzana fusca*), Little Tern (*Sternula albifrons*), White-throated Munia (*Lonchura malabarica*), and Kentish Plover (*Charadrius alexandrinus*). The globally vulnerable Woolly-necked stork (*Ciconia episcopus*) and critically endangered Salty-Legged Crake (*Rallina eurizonoides*) and Blue-Tailed Bee-Eater (*Merops philippinus*) were also observed. *Rallina eurizonoides* was found in only two tanks, indicating its fragile ecological status. The study documented 31 fish species across the sampling sites, featuring endemics such as *Mystus zeylanicus*, *Clarias brachysoma*, *Dawkinsia singhala*, *Pethiya melanomaculata*, and *Esomus thermoicos*, along with exotic varieties. Among these, Cyprinidae was the most prominent family, consisting of 12 species. Furthermore, the investigation unveiled the rich diversity of butterflies, with 25 identified species. Key findings included the presence of the Tiny Grass Blue (*Zizula hylax*), Peacock Pansy (*Junonia almata*), Lemon Pansy (*Junonia lemonias*), and Leopard (*Phalautia phalautia*) in various tank ecosystems. Meanwhile, 136 dragonfly individuals were observed, with the Asian Pintail emerging as the most abundant species. Notable rare species included the Elusive Adjutant (*Aethriamanta brevipennis*), Blue Sprite (*Pseudagrion microcephalum*), Blue Percher (*Diplacodes trivialis*), and Green Skimmer (*Orthetrum Sabina*), each recorded in different tank ecosystems. The study further highlighted existing threats, including overgrazing by cattle and the clearance of catchment areas, emphasizing the urgency of implementing sustainable conservation measures to protect these delicate ecosystems and maintain their ecological balance. Understanding the distribution and significance of species within these ecosystems will support ecological restoration and maintenance of the tank cascade ecosystems.

**Keywords:** Endemic; Faunal species; Population; Tank cascade systems

# A SURVEY ON *CYRTOBAGOUS SALVINIAE*: A PREDATORY INSECT OF *SALVINIA MOLESTA* IN TANK CASCADE SYSTEMS OF MEDAWACHCHIYA DIVISIONAL SECRETARIAT OF SRI LANKA

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**Abstract:** Tank cascade systems are threatened by the presence of aquatic weeds, which interfere with the water storage, irrigation water delivery systems and maintenance of canals and drains. *Salvinia molesta* is one of the major noxious invasive weeds in the tank cascade systems of Sri Lanka, causing severe environmental problems to their ecosystems. Control of this weed with biocontrol agents has been showing promising results in many parts of the world. *Cyrtobagous salviniae*, a biocontrol agent of this weed, was introduced to Sri Lanka in 1986 by the Department of Agriculture. The lack of information on the ecology of these weeds and their distribution is one of the key problems in implementing a sound biological control program in the north-central province. Therefore, the objectives of study were to identify the abundance and distribution of *S. molesta* and the population density of *C. salviniae* in selected tanks in the Medawachchiya divisional secretariat. The quadrat sampling method was used to find predator and weed density in 28 selected tanks located in the Medawachchiya Divisional secretary areas of Sri Lanka. The index of dispersion and intraspecific mean crowding of predators were also calculated. Results found that the surfaces of the Medawachchiya and Kadawathrambawa tanks were covered more than 80% with the *S. molesta* while less than 40% of the water surfaces were covered in 16 other tanks. The abundance of *C. salviniae* was significantly different ( $P < 0.05$ ) among the tanks, and higher predator densities were recorded in Kadawathrambawa ( $10 \pm 3.20$ ) and Mahadiulwewa ( $9.06 \pm 3.45$ ) and the lowest densities were recorded in Siyabagaswewa ( $1.3 \pm 1.25$ ) and Periyakulama ( $0.9 \pm 0.88$ ) tanks. Among the tanks, Dutuwewa, Siyabalagaswewa, and Periyakulama showed low intraspecific crowding, indicating a lower population. Therefore, the re-introduction of predators is urgently necessary.

**Keywords:** Biocontrol; Invasive weeds; Irrigation water; Predator-prey population

# PHOTOSYNTHETIC BIOMASS CURVES IN THE EARLY GROWTH STAGES OF SELECTED DOMINANT PLANT SPECIES IN IRRIGATION CANAL SYSTEMS OF SRI LANKA

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**Abstract:** Tank Cascade Systems are associated with canal-bank vegetations that support high biodiversity, habitats and provide ecosystem services, which should be quantified to assist conservation and economic decision-making. The eco-tokens are a virtual currency type, generated by the gross production of clean oxygen and the sequestration of carbon during the early growth stages of a predefined set of plants. These captured values are integrated into an IT platform, creating tradable assets. The main objective of this study was to establish the gains in photosynthetic biomass (PB) during the early growth phases of three common tree species: *Diospyros malabarica*, *Terminalia arjuna* and *Ficus racemose*, associated within the tank cascade ecosystems of dry and intermediate zone of Sri Lanka. The PB accumulation in the early growth stages of the above tree species were collected from individuals found in the reforested sites in Mahiyangana, Bibila, Monaragala and Padiyathalawa, Sri Lanka representing the growth at 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> years with 60 individuals from each site and age group totaling 720 individuals per plant species. The fresh weight was measured from collected leaves and analyzed to derive PB curves. Oxygen production (1g of PB gives 0.4 g of oxygen) was quantified using the measured PB value applied to a standard allometric equation. The PB and oxygen production had a significant relationship with age. The PB, and oxygen production demonstrated an exponential growth after the 3<sup>rd</sup> year. Results showed that at the end of 4<sup>th</sup> year *T. arjuna* produced the highest PB value, i.e., 1948.12 g and then 1550.92 and 246.92 g occupied by *F. racemose*, *D. malabarica*, respectively. The findings will be used to generate eco-tokens which are based on aggregate values of Regulatory Ecosystem Services (RES) to establish an ecosystem services-based payback system to the Sri Lankan green economic initiatives.

**Keywords:** Eco-tokens; Regulatory ecosystem services; Tank cascade systems; Watershed management

# ROLE OF AVIAN BIODIVERSITY IN ENHANCING ECOTOURISM INITIATIVES IN ANURADHAPURA SRI LANKA

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**Abstract:** Avian biodiversity and bird watching play key roles in enhancing ecotourism initiatives in Sri Lanka. This study investigated the significance of largely unexplored avian richness as an ecotourism attraction, based on four large tanks in Anuradhapura district, which celebrate for their historical and cultural heritage, but present untapped potential for ecotourism. Continuous field surveys were carried out in the tanks: Nuwara Wewa, Abhaya Wewa, Bulankulama, and Tisa Wewa, 18 years from 2000 to 2018. The data collection is composed with species composition, abundance, and habitat utilization. A total of 181 avian species from 72 families were recorded, including both migratory and resident species. Some of the prominent species were Lesser Whistling-duck (*Dendrocygna javanica*), Black-headed Ibis (*Threskiornis melanocephalus*), Cattle Egret (*Bubulcus ibis*), and Rose-ringed Parakeet (*Psittacula krameri*). A comparison of avian diversity among tanks was carried out using geospatial analysis techniques in GIS. The study emphasizes the diversity of habitat preferences of avian species including reedbeds, submerged macrophytes, open water, and terrestrial environments etc. A comprehensive understanding of the dynamics of these habitats are crucial for the development of bird watching facilities ensuring that visitors can appreciate avian diversity while preserving their habitats. Involvement of local community in habitat restoration like invasive species removal, native plant propagation, and soil conservation techniques through proper education, raising awareness, monitoring and responsible ecotourism practices are recommended to ensure long-term sustainability of ecotourism management and avian biodiversity conservation in the region. The coexistence of historical heritage and avian biodiversity enhances the potential for a unique ecotourism destination in Anuradhapura district benefiting the local economy and raising awareness of avian conservation's importance in Sri Lanka.

**Keywords:** Avian biodiversity; Birdwatching; Conservation; Ecotourism; Sustainable management;

# ECOLOGICAL CONSEQUENCES OF REALLOCATING LANDS FOR ANTHROPOGENIC ACTIVITIES FROM A LONG- ABANDONED TANK CASCADE

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**Abstract:** Years of civil war and unsupportive infrastructure forced most of the cascade systems in the northern regions of Sri Lanka to be abandoned for decades. Absence of anthropogenic activities, chiefly agriculture, let these regions to flourish towards late pioneer to climax successional state, and reestablish as a secondary forest landscape. The objective of this study was to identify ecological impact of human settlement plans with a crop-animal based agroecosystem in a late successional landscape in a tank cascade. The study area was located in the upper catchment of Padaviya tank cascade system bordering the Northern Province. A Visual Encounter Survey was conducted for identifying ecological resources, floristic and faunal richness and vegetation/habitat types and a bio-diversity survey was carried out by opportunistic and randomized walks within the area. The flora species were recorded against their habitats. Vertebrate fauna species of mammals, reptiles, birds, and amphibians were recorded separately, while some visible invertebrate groups were recorded based on both direct and indirect evidence. The majority of the vegetation belongs to secondary forests, tropical dry mixed evergreen forests, tropical scrubs, and rock-out crops. The vegetation comprised with 187 floral species, while 157 were found to be native and eight were identified as endemic. Within the region, 20 threatened or nearly threatened species were observed, and the 20 exotic species found uncovered the footprints of past anthropogenic activities. *Diospyros nummulariifolia*, *Cryptocoryne wendtii* and *Polyalthia suberosa* were exclusively found within the region. Recorded faunal species number was 126 with 22 mammal species, which included eight threatened or nearly threatened mammal species. The habitat stretched over 500 hectares, thus human settlements would inevitably lead to loss of forest cover and faunal habitats, depletion of threatened and endemic species, interference to migratory pathways including elephants, soil erosion, water pollution leading to human-elephant conflict.

**Keywords:** Endemic; Faunal richness; Floral species; Human-elephant conflict; Threatened and nearly threatened

# **AQUATIC PLANT DIVERSITY IN A SEASONAL TANK DURING DRY SEASON: A CASE STUDY IN POLAGEWILLA TANK IN PALANKULAM CASCADE, ANURADHAPURA, SRI LANKA**

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**Abstract:** Small seasonal tanks with the tank cascade systems of Sri Lanka are highly threatened by anthropogenic disturbances. The aquatic plant diversity within Polagawilla seasonal tank during the dry season was estimated. Concentric line transects extending from the tank bund up to the inundation area during the dry season were drawn in a digital topographic map. Along these transects, three sub-divisions were made: lower, middle, and upper, from which quadrat sampling was done to cover 10% of the total area. The land area that would be inundated during the rainy season was also sampled following the same method. The Shannon Weiner index (H), and Jaccard index (SJ) were calculated and compared between the lower, middle, and upper areas. The overall diversity (H 1.08), the center locale of the tank represented a diversified aquatic population. The lower and upper sections follow H 0.84 and H 0.71 respectively exhibiting lower diversity. The similarity between the three sections of the tanks was less than 50%, indicating each of the two sections showed few similarities. The overall tank encompassed 12 distinct taxa from 10 families, including 25% exotic species and 67% native species. *Salvinia molesta* and *Ceratophyllum echinatum* are the most abundant species in the three areas of the tank. Endemic *Cryptocoryne beckettii* was observed in the middle section of the tank. The inundated area during the rainy season of that tank showed less diversity (H 0.29), of which 70% of the area was dominated by *Paspalum vaginatum*, a perennial weed while 15% was covered by *Persicaria attenuata*. Severe grazing due to livestock rearing and cultivation within Thaula in the catchment area has severely affected the ecosystem.

**Keywords:** Diversity; Dry spell; Seasonal tank; Similarity; Tank zones

# THE SPECIES BEST INTEREST STANDARD AND ECO CENTRISM APPROACHES: A CRITICAL LEGAL ANALYSIS ON THE PROTECTION OF WILDLIFE SPECIES IN SRI LANKA

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**Abstract:** Wildlife include animals and plants which owe their existence to natural phenomena or processes that occur autonomously. Anthropogenic activities such as poaching, wildlife trade, human animal conflict, and deforestation are the factors which threaten and endanger species. Small populations with limited genetic strength are more vulnerable to diseases and other disasters in comparison to large and wide-spread populations. The concepts such as “eco-centrism” as opposed to anthropocentrism and the “species best interest” are aimed for the protection of endangered species. Eco centrism is nature centered where humans are part of nature and non-human has intrinsic value. “Species best interest” involves focusing the attention to safeguard the interest of species, as species have equal rights to exist on this earth without becoming critically endangered due to human intervention. On this backdrop the paper aims to analyze the adequacy of the national legal frameworks in protecting and preserving the wildlife especially the endangered species. The paper utilizes the black letter of law approach and the international and comparative methodologies. Case decisions, the constitution, legislations, and conventions constitute primary sources whereas scholarly articles and journals constitutes the secondary sources. The key findings of the paper states that anthropocentrism as opposed to eco centrism focuses on the human interests and that the species best interests and eco-centrism are novel to the environmental jurisprudence in Sri Lanka and this will leads to the prejudice of the interests of the other species. The paper finally recommends introducing alternative homes for highly endangered species, investing special care and resources to protect habitats, initiating actions to prevent the “genetic swamping” of wild species, undertaking a programme of ex-situ captive breeding and rehabilitation in the wild for critically endangered species, publishing flora and fauna species status papers periodically to protect the endangered wild species in Sri Lanka. The paper concludes that, the high time has come to enact a separate legislation to reduce the extinction of the wildlife.

**Keywords:** Biological diversity; Eco-centrism; Endangered species; Species best interest; Wildlife

# KNOWLEDGE AND PERCEPTIONS ON MANAGEMENT AND ECOSYSTEM SERVICES OF TANK CASCADE SYSTEMS: A CASE STUDY IN ANURADHAPURA DISTRICT, SRI LANKA

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**Abstract:** The main objective of this study was to assess the present status of knowledge and perceptions of the communities on tank cascade management and ecosystem services provided by tank cascade systems. Aluthhalmilla wewa, Palugawewa, and Bandarakumbukwewa tank cascade systems situated in the Anuradhapura District were selected for the study. These cascades are under the jurisdiction of the Department of Agrarian Development. Secondary and primary data were collected on the tank cascade's socio-economic, ecological and managerial environment and related areas. Primary data were gathered using key informant interviews. Mixed methods were used to analyse data. According to the findings, most village communities use tanks for farming related activities, bathing and washing, etc. However, none of them use the tank water for drinking as they think water is polluted. A statistically significant relationship ( $P < 0.05$ ) was not observed between the occupation and age of the communities with their knowledge of the ecosystem services of the tanks, while the education level of households showed a positive relationship ( $P < 0.05$ ). However, there was a lack of knowledge on the full range of ecosystem services of the tank cascades, which needed to be enhanced. All the respondents were in view of the tank and associated environment need to be improved, and while they were fairly satisfied with the activities of the farmer organisations and the officials of the Department of Agrarian Development. Farmers agreed that this needed improvement to foster the full potential of the tank cascade systems. All the respondents were willing to contribute to improvement and conservation the tanks' ecosystems. Therefore, it could be recommended that it is required to enhance the knowledge among the stakeholders and follow an inclusive and integrated approach with the participation of farmers and farmer organisations and the officials of the Department of Agrarian Services.

**Keywords:** Anuradhapura; Climate resilient integrated water management project (CRIWMP); Conservation; Ecosystem development plans

# IMPORTANCE OF INTEGRATED MANAGEMENT OF IRRIGATION SYSTEMS FOR BIODIVERSITY CONSERVATION: CASE STUDY IN KUBALGAMA TANK, SRI LANKA

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**Abstract:** Irrigation systems in Sri Lanka are not only important for agriculture and other livelihoods development, but also important as biodiversity refuges for many species. The Kubalgama tank is one of the irrigation tanks situated in Matara (N 05°56'34.76", E 080°34'47.03"), which provides habitat for avifauna in the area. Therefore, a field survey was conducted to assess the contribution of the Kubalgama tank to avifaunal diversity in the area. The survey was conducted by twelve random visits for a period of six months from October 2021 to April 2022. Each day two sampling events were conducted at 6.00 am to 7.00 am in the morning and 4.00 pm to 5.00 pm in the evening. Visual observations were used to count individuals of each species in three selected habitats (lake, forest & home garden) using 200 m fixed line transects. A total of 38 bird species from seven different families were recorded. Among the species recorded, 92% were resident species and 8% were migratory species. Three endemic species were recorded, namely, Sri Lanka Green-pigeon (*Treron pompadora*), Sri Lanka Grey-Hornbill (*Ocyeros gingalensis*) and Lesser Sri Lanka Flameback (*Dinopium psarodes*). According to the results, calculated Shannon-Wiener diversity indexes in forest, lake & home garden were 2.42, 2.43 & 2.48, respectively. However, there is no significant difference between habitats according to the indexes. Even though the study site is close to densely populated resident areas, it still provides vital habitat for avifauna in the area. Continuous water pollution of the lake was observed threatening aquatic avifauna. Therefore, implementing proper environmental management approaches in Kubalgama is vital for biodiversity conservation. Further, the study reveals the importance of biodiversity surveys and continuous monitoring of the changes in biodiversity in irrigation systems for sustainable management of inland surface water resources and biodiversity conservation in the tank eco-systems of Sri Lanka.

**Keywords:** Avifaunal diversity; Biodiversity conservation; Irrigation systems; Environmental management; Kubalgama tank



## **2. Climate Change, Disasters, and Ecological Resilience**



# CLIMATE CHANGE-INDUCED SOCIO-ENVIRONMENTAL DYNAMICS IN A VILLAGE TANK LANDSCAPE

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**Abstract:** Catastrophic environmental changes consistently surpass human capabilities in mitigating climatic events in many instances. Disasters like drought and human-animal conflict are predominant in the Sri Lankan context and have been linked to climate change recently. The objective of the current study is to analyse climate change-induced impacts on rural farming livelihoods. Weliwewa Grama Niladhari Division in Sooriyawewa, Hambantota, in southern Sri Lanka was selected as the field site for the study. The primary data were collected through semi-structured interviews with 20 respondents selected randomly from the farming community, in-depth interviews with five key informants, and four focus group interviews with respondents who were selected purposively. The changes in rainfall patterns have converted seasonal farming from two seasons into three seasons. Predicting rain is unfeasible, unlike in the past. Despite the lack of sufficient rainwater for cultivation, farmers have been depending on irrigation water, despite the hardships they endure. Water scarcity has expanded to cause food insecurity and livelihood alterations among farming communities. This has been worsened by the influx of wild animals from the nearby forest areas. One aspect of animal ravage is the adapted dependence on farming lands and stimulation of their behaviour through deforestation driven by development interventions; the other is the constant bio-diversity transformations, which include the increase of agricultural pests (i.e., peafowl, monkeys), which have made farming hard due to the unstoppable and unmeasured invasive effects. The physical deprivation created by those events has left those farmers economically and socially deprived. Proper measurement of bio-diversity transformations is needed, and water depreciation should be sustainably addressed to mitigate their adverse effects on the farming community. The use of technological measures to identify changes in climatic forms while formulating community-sensitive measures will be effective for the well-being of the community and the ecosystem.

**Keywords:** Biodiversity; Climate change; Drought; Rural farming; Water scarcity

# ASSESSING DROUGHT RISK MANAGEMENT BEHAVIOR AMONG MINOR IRRIGATION AND RAIN-FED FARMERS IN THE NORTH CENTRAL PROVINCE OF SRI LANKA

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**Abstract:** Drought is one of the inevitable recurrent phenomena of the climate. Farmers in Sri Lanka are exposed to severe droughts, resulting in many socioeconomic and environmental losses. Minor irrigation and rain-fed farmers in the North Central Province (NCP) are mainly more vulnerable than those in major irrigated areas. There is still a lack of understanding of how farmers think and behave to mitigate drought impacts in Sri Lanka. The primary objective of this research was to apply the Protection Motivation Theory (PMT) to assess the farmers' drought risk management behaviour and the determinants influence on Farmers' Drought Risk Management Behaviour (FDRMB). A survey was conducted using a 5-point Likert scale questionnaire for collecting the data, including all PMT variables of Perceived Vulnerability (PV), Perceived Severity (PS), Self-Efficacy, Response Efficacy (RE), Response Cost (RC), Intention (IN) and FDRMB in the NCP of Sri Lanka. Minor irrigation and rain-fed farming households were the population (N=3163). The sample size was determined using Slovin's formula ( $n=356$ ), and the sample was selected using the stratified random sampling method. This research applied descriptive-correlational and casual relationships, and path analysis was performed using the multiple linear regression method. The Pearson correlation coefficient was used to find the association between variables. The results highlighted a positive correlation between IN, PV, PS, SE, and FDRMB, while a negative correlation exists between RE, RC, and FDRMB. The results pointed out that both threat appraisal and coping appraisal variables i.e., PV, PS, SE, RE, and RC have significant effects on FDRMB and IN. The path analysis revealed that the causal model of the research explains significant variance in FDRMB ( $R^2_{Adj}=0.610$ ) and IN ( $R^2_{Adj}=0.418$ ). It was found that IN, PV, and PS motivate the farmers to take various adaptation and mitigation strategies to reduce drought impacts. Further, results showed that farmers have low coping capacity. Hence, it is essential to develop the capacity of the farmers in the area. Policy-makers and drought planners may consider these findings when making policy decisions.

**Keywords:** Drought; Farmers; Protection motivation theory; Vulnerability

# BUILDING ECOLOGICAL RESILIENCE TO MITIGATE CLIMATE CHANGE-INDUCED DISASTERS

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**Abstract:** As the world continues to face the effects of climate change, the need to tackle the generated disasters has become almost urgent. Floods, and droughts are all results of climate change that have been causing irreparable damage to cascade systems, societies, ecosystems, and the economy. An alternative paradigm is needed to confront these challenges, one rooted in ecological resilience in climate change adaptation and disaster mitigation. Ecological resilience refers to the capacity of an ecosystem to endure and recover from disturbances, some caused by climate changes. The review study demonstrates that ecological resilience could be one of the crucial components in minimizing the dangers resulting from natural catastrophes and climate change. This study explores the main concepts of resilient ecosystems that provide services (flood/drought regulation, carbon sequestration, and biodiversity conservation) on disaster risk reduction. It presents successful cases of ecosystem-based management and resilience in multiple regions of the world, reducing disaster risk. The review study recognizes possibilities and constraints that include unsustainable land use practices, rapid urbanization, and uncoordinated legislation. It also highlights the significance of community engagement and government policies for promoting ecological resilience. Such international cooperation, as it was in the Paris Agreement is important because it creates an effective global context for climate activities. This article explores innovative strategies and technologies that can further enhance ecological resilience, offering hope for a more sustainable and resilient cascade systems. In conclusion, it highlights the need for prioritizing ecological resilience as an integral part of our response to climate change, urging collective action to safeguard our planet and its inhabitants from the growing threat of climate change-induced disasters.

**Keywords:** Cascade systems; Climate resilience; Disasters; Disaster risk reduction; Ecological resilience

# CLASSIFICATION OF SRI LANKA INTO METEOROLOGICALLY HOMOGENEOUS REGIONS

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**Abstract:** This study exemplifies the regionalization of Sri Lanka into meteorologically homogeneous regions. The rain gauge stations established in Sri Lanka have not been continuously established across the country and are very limited. Rain gauges are high in wet zone areas and low in other areas. Very few rain gauges were established in the northern part of the country. Therefore, meteorologically homogeneous regions are important for flood frequency analysis, and regional intensity duration frequency curves. Regional analysis provides important precision rather than single or geographically close locations. Sri Lanka has been classified into meteorologically homogeneous regions using the Words cluster analysis, discordancy measure and heterogeneity measure. In the context of this study, total precipitation data of 352 stations operated by the meteorological and irrigation departments have been used for cluster analysis. Initially, Sri Lanka was classified into six regions using rainfall indices of mean annual rainfall, annual maximum mean rainfall, southwest monsoon mean rainfall, northeast monsoon mean rainfall of the daily recorded 352 stations and 3-hour and 6-hour intensity for the 5-year return period of 50 number of hourly recorded rain gauge stations along with the latitude, longitude and altitude. The discordancy of the clustered six regions was analysed by discordancy measure. Subsequently, the heterogeneity of the non-discordant regions was examined by the heterogeneity measure. Initially developed six regions were regrouped to form meteorologically homogeneous 11 regions which satisfied the non-discordant and heterogeneity criterion. Finally, Sri Lanka has been classified into 11 meteorologically homogeneous regions. The homogeneous regions can be used to conduct frequency analysis and regional studies related to the tank cascade systems.

**Keywords:** Cluster analysis; Discordancy; Heterogeneity; Homogeneous region

# CLIMATE CHANGE AND CLIMATE ACTION GUIDED BY UN SDGS IN SRI LANKA: A REVIEW

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**Abstract:** Climate change is a pressing global issue that demands immediate attention and action. This study aims to provide an overview of the efforts made by Sri Lanka (SL) in addressing climate change and implementing climate action guided by the United Nations Sustainable Development Goals (SDGs). As a vulnerable island nation, SL is highly susceptible to climate change impacts (CC). National Adaptation Plan for Climate Change Impacts 2016-2025 (NAP-CC) identified adaptation actions for nine vulnerable sectors as food security (crop-livestock-fisheries), water, health, human settlements, biodiversity, and ecosystems coastal and marine, export agriculture, industry-energy-transportation, and tourism. Rising sea levels, extreme weather events, and changing rainfall patterns pose significant challenges to the country's ecosystems, economy, and livelihoods. Recognizing the urgency of the situation, SL has taken proactive measures to combat climate change and align its actions with the UN SDGs. Since the adoption of the 2030 Agenda for Sustainable Development (SD), SL has implemented policies action plans and formed a parliamentary select committee dedicated to providing political direction for SDG implementation by passing of the SD Act No. 19 of 2017 to establish the legal framework for SDGs and launching several projects to address CC and assist in climate adaptation, mitigation, and preparedness. The inclusion of environmental education in the new school curriculum aims to promote an eco-friendly future generation. SL has signed the Paris Climate Agreement and has submitted Nationally Determined Contributions (NDCs). Successful achievement of (NDCs) will contribute to the attainment of relevant SDGs in SL. Further, the tank cascade system can enhance community resilience by providing a reliable water supply for agriculture, reducing vulnerability to droughts, and supporting sustainable water management practices aligned with SDGs. By staying committed to climate action, SL can serve as a role model for other nations in the fight against climate change.

**Keywords:** Climate change; Climate action; SDGs; Sri Lanka

# DEVELOPMENT OF A FLOOD RISK MANAGEMENT ACTION FRAMEWORK FOR THE LOCAL ADMINISTRATIVE LEVEL IN SRI LANKA

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**Abstract:** Sri Lanka has reported floods as the most threatening among other disasters like landslides, droughts, cyclones, tsunamis, etc. Aiming to manage the increasing trend of floods in Sri Lanka, a proper flood risk management mechanism, which operates from national to local level, should be operated, but according to the literature, there are many gaps in the prevailing flood risk management mechanism. Accordingly, the current study aimed to develop a local-level flood risk management action framework (FRMAF). This study was conducted in the lower part of the Deduru Oya basin in Sri Lanka, considering the Divisional Secretary Division level to the *Grama Nialadhari* Division level as the local administrative level. Primary data were collected through a questionnaire survey (n=425) and interviews (n=32). Secondary data were collected through several government departments and publications. Qualitative data analysis methods, including the thematic data analysis method, were used in the study. The FRMAF has introduced the factors and the processes that create floods in the study area and introduced necessary flood risk reduction activities. The FRMAF was developed under five priorities: (1) establishment of local level flood database and introduction of flood risk assessment, (2) flood governance, (3) capacity development for flood disasters, (4) flood risk management plans and policies, and (5) flood mitigation measures. Under the above priorities, 36 actions were identified to execute at the local level. Accordingly, some existing legislation relevant to flood risk management e.g. Circular No.08/2014 of the Department of Irrigation, and Land Manual of Sri Lanka of the Department of Land Commissioner, should be enforced properly, some new legislation should be enacted, and government agencies and other stakeholders, including the community living in flood-vulnerable areas, should engage in local-level flood management activities efficiently. Such a mechanism can reduce the flood risk at the local level. Flood risk in tank cascades can be minimized through such a FRMAF that can be implemented by respective authorities.

**Keywords:** Deduru Oya; Flood database; Flood governance; Flood mitigation; Local level capacity development

# ROLE OF WATER MANAGEMENT IN DISASTER PREPAREDNESS AND RESPONSE

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**Abstract:** A comprehensive understanding of community water issues and vulnerabilities is essential for effective disaster preparation, with planning and response linked to sound water management practices. This research focused on into the relationship between water management performance and catastrophe impact, covering diverse scenarios such as floods, earthquakes, droughts, storms, and dam collapses. Data collection was done through primary and secondary sources. The analysis employed descriptive statistics, correlation, and regression techniques, revealing complex data patterns that shows the potential of robust water management measures to reduce disaster damage. Key components of community preparation include early warning systems, contingency planning, development of water-resilient infrastructure, facilitating timely evacuation and precautionary measures. Early warning systems contribute significantly to disaster preparedness by utilizing water management techniques for monitoring variables, such as water levels and rainfall. Comprehensive community plans should encompass emergency water, sanitation, and hygiene measures with detailed contingency plans specifying the strategic deployment of water tankers in the event of water outages. Investment in water-resilient, flood- and storm-resistant facilities strengthens overall disaster resilience. Water management remains crucial for emergency water supply, restoration, and the prevention of water-borne illnesses after a catastrophe. Emergency measures encompass the use of water tankers, bottled water, and filtration systems to ensure the provision of safe drinking water in compliance with regulations. Post-catastrophe, communities systematically assess infrastructure damages, restore water supply and treatment facilities through repairs, and rigorous water quality evaluations. Mitigating sewage and pollutant contamination is vital to prevent waterborne infections, emphasizing the importance of clean drinking water and sanitation education. This study emphasized the indispensable role of water management in disaster preparedness and response. Effective water management strategies significantly reduce disaster susceptibility and enhance recovery. In conclusion, water management methods contribute substantially to community resilience by aiding in disaster planning, response, and recovery.

**Keywords:** Disaster resilience; Hygiene; Sanitation; Water borne infection

# ENVIRONMENTAL DYNAMICS IN MA OYA RIVER BASIN IN MONSOON SEASONS IN SRI LANKA

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**Abstract:** Ma Oya, a significant stream in Sri Lanka, is a cultural and ecological entity. The study aimed to describe the environmental dynamics in Ma Oya river basin, during the North-East Monsoon (NEM) and South-West Monsoon (SWM) seasons in 2017 and 2022. The study integrates key Remote Sensing (RS) indices such as Normalized Difference Vegetation Index (NDVI), and Land Surface Temperature (LST) from Landsat 08 and 09 satellite sources. This study explored the changes and relationships between these RS indices, to quantitatively monitor variations in critical environmental parameters during selected monsoon seasons. This investigation combines data from satellite sources and ground-based observations. Gross Biomass Water Productivity (GBWP) data were taken from the FAO Water Productivity Open-access portal (WaPOR). After calculating indices, statistical analyses were applied to explore the correlations, providing insights into the ecological dynamics. The study revealed robust correlations between VCI, NDVI, and LST, during both the NEM and SWM for the years 2017 and 2022. Notable differences were observed in mean LST and NDVI values during SWM, exemplified by a mean LST of 25.41°C in September 2022 and a mean NDVI of 0.44 in the same period, indicating high variations in temperature and vegetation health. The results revealed a negative correlation between the VCI and GBWP, indicating an inverse relationship between vegetation health and water productivity in the Ma Oya river basin. The study enhances understanding of environmental dynamics in the Ma Oya river basin by examining the connections between LST, NDVI, VCI, and GBWP. The VCI severity levels highlight the dynamic nature of drought conditions in the Ma Oya river basin, exhibiting significant fluctuations across categories during both the NEM and SWM for the years 2017 and 2022. The SWM showed distinct patterns, indicating more pronounced fluctuations in VCI levels compared to the NEM. The study highlights the variations in drought severity between monsoon seasons, providing insights into the connections between meteorological factors, vegetation health, and temperature. Limitations of this study, including lack of satellite data, which may impact the generalizability of the findings.

**Keywords:** LST; NDVI; VCI; GBWP

# NARRATIVE REVIEW OF MODELING APPROACHES TOWARD CONSERVATION OF LAND SNAILS' RESPONSES TO CLIMATE CHANGE

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**Abstract:** Climate is one of the most important drivers of species' distribution and abundance. Global mean surface temperature is projected to increase by  $\sim 3.7^{\circ}\text{C}$ , for the most optimistic scenario, to  $\sim 1^{\circ}\text{C}$ , for the least optimistic one. Land snails are important to nature as decomposers, recyclers, pollinators, food sources, environmental indicators, biodiversity predictors, disease hosts and even medical purposes. Many species are threatened and endangered according to regional assessments. Climate change cause direct negative impact on land snail populations due to invasive predators and habitat loss. Hence, there is a growing interest in illustrating the current and future conservation status of land snails following different models. The aim of this review is to provide a comprehensive assembly of studies that applied different models to assess the current and future status of land snails with climate change. A literature survey was carried out in popular scientific databases. The literature search identified a total of 687 articles in PubMed = 10, Scopus SciVerse® = 158, and Google Scholar = 519. After screening, 29 full length articles were included in this review, and they were categorized into four groups in which different models applied to find out the (i) diversity (14), (ii) habitat (6), (iii) biogeography (6), and (iv) phylogeography (3) of land snails' response to climate change. These studies have reported that the climate change will reduce the spatial distribution of land snails. Past literatures are highlighted in decreased population of land snails in Zimbabwe, North America's Pacific Northwest (27 land snail species), South America (*Megalobulimus sanctipauli*), Europe (Mediterranean helicoid terrestrial gastropods: *Cernuella virgata*, *Hygromia cinctella*), Switzerland (*Arianta arbustorum*), Seychelles Island (*Pachnodus velutinus*, *Rhachistia aldabrae*, North Queensland Australia (*Gnarosophia bellendenkerensis*), Grece (*Albinaria caerulea*). This collection of scientific data solidifies modelling of land snails' response to climate change towards their conservation will be beneficial to make healthy ecosystems.

**Keywords:** Climate change; Conservation; Endemicity; Land snails

# WEATHER FORECASTING ABILITY OF ELDERLY PEOPLE IN RAJANGANAYA DS DIVISION IN THE DRY ZONE OF SRI LANKA

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**Abstract:** Climate change poses a significant global challenge, impacting ecosystems and communities worldwide. This study investigated the valuable traditional knowledge held by elderly individuals (over 70 years of age) in the Rajanganaya DS division in the dry zone of Sri Lanka and their effectiveness in forecasting weather change. This study aims to identify the knowledge of local traditional people towards weather change. To achieve this, we conducted in-depth interviews with 20 traditional elders in the Rajanganaya DS division dry zone of Sri Lanka. The qualitative analysis method was used to analyze the collected data. The findings of this study revealed that elderly people in the Rajanganaya DS division possess a remarkable ability to forecast weather change. The elders' knowledge, deeply rooted in their observations of natural phenomena over several decades, provides valuable insights into weather patterns, monsoons, and seasonal variations. Their understanding of indigenous weather indicators, such as animal behaviour, plant flowering patterns, and celestial events, has proven to be highly accurate in predicting impending climatic shifts 75% of the selected people could predict the weather. Elderly people in the Rajanganaya DS division possess an invaluable repository of knowledge that can enhance our understanding of local climate dynamics. These findings advocate for incorporating traditional wisdom in climate policies and developing community-based climate resilience strategies. This study highlights the importance of preserving and incorporating indigenous knowledge into weather change mitigation and adaptation efforts. Traditional communities can play a vital role in enhancing the accuracy and effectiveness of weather forecasting. This research provides a foundation for further exploration of the synergies between traditional wisdom and modern science in the quest for weather resilience.

**Keywords:** Indigenous; Traditional knowledge; Weather change; Weather forecasting



### **3. Watersheds and Water Quality Management**



# GROUNDWATER RECHARGE POTENTIAL ZONES IN TANK CASCADE SYSTEMS OF ANURADHAPURA, SRI LANKA USING GEOSPATIAL TECHNIQUES

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**Abstract:** Many regions of Sri Lanka experience frequent droughts due to climate change. The increasing demands for groundwater resources along with decreasing availability in the dry zone of Sri Lanka emphasize the need for implementation of sustainable groundwater management practices. This study is an approach to better assess groundwater recharge potential zones using geospatial techniques and Multi Influencing Factors (MIF). Since cascade systems can moderate the effects of extreme weather events by capturing runoff and storing rainwater in numerous tanks, it is better to assess the potential zones for groundwater recharge in these cascade systems. Cascade systems in Malwathu Oya, Yan Oya and Ma Oya river basins within the Anuradhapura district area were selected for the study. The geo-environmental variations such as geomorphology, geology, soil type, slope, lineament density, drainage density, and land use layers were created as thematic layers and converted into raster data. Based on the MIF and literature, weights were assigned to the relevant thematic layers and overlay analysis was performed to create groundwater potential (GWP) zones. These potential zones were categorized as 'high', 'moderate', and 'low' GWP zones concerning the assigned weights. From the total area of selected cascades within the Anuradhapura district, cascades in the Malwathu Oya basin showed a higher percentage of high (9.33%) and moderate (34.19%) potential zones. Further, when analysing the GWP zones separately for the selected three river basins within the Anuradhapura district area, Ma Oya basin showed a higher percentage of high (37.84%) and moderate (55.95%) GWP zones. Yan Oya showed 30.11% of high and 47.51% moderate GWP area and Malwathu Oya showed 16.21% of high and 59.37% of moderate GWP zones area. Based on the study Ma Oya has the highest groundwater potential zones compare to Yan Oya and Malwathu Oya within Anuradhapura District. These results suggest that the high-potential zones will have a key role in future groundwater management projects for sustainable management.

**Keywords:** GIS; Groundwater; Multi influencing factors; Malwathu oya

# TURBIDITY AND TROPHIC STATE DYNAMICS IN MADURUOYA RESERVOIR AND SENANAYAKE SAMUDRAYA, SRI LANKA

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**Abstract:** Inland fisheries in Sri Lanka, primarily within reservoirs and tank cascade systems, hold significant potential for sustainable fish farming and livelihood of people. This study employed images of the Lake Water Quality 300 m version 1 (Near-Real-Time) products of the Sentinel-3 OLCI (Ocean and Land Colour Instrument) sensor obtained from the Copernicus Global Land Service for every 10 days during May 2016 to December 2019 to evaluate the overall conditions and mean monthly and annual variations and relationship of Lake Turbidity and Trophic State Index (TSI) in Maduruoya reservoir (MO) and Senanayake Samudraya (SS). According to the Carlson's Trophic State Index, MO exhibited an upper mesotrophic status (TSI  $52 \pm 0.54$ ), while SS displayed a lower mesotrophic status (TSI  $44.34 \pm 0.76$ ). The SS had a greater turbidity level ( $20.23 \pm 1.43$  NTU) than MO ( $9.31 \pm 0.77$  NTU). Higher TSI levels were found in deeper areas and near the reservoir dam, while in contrast, increased turbidity was observed in littoral zone compared to the dam area and middle of the reservoirs. The TSI has reduced (34-46 NTU) with the onset of rains in the second inter-monsoon and the North-East monsoon. TSI was increased in post rainy seasons and with the beginning of the distinct dry period in the dry zone reservoirs have experienced higher TSI levels (48.2-55.8 NTU). This verified the temporal variation in the trophic status of reservoirs consist of lower values in the rainy season and gradually increased over the dry period and vice versa. After the rainy season and second inter-monsoon, higher turbidity (20.2-42.3 NTU) values were observed. The turbidity was gradually reduced in the dry season (5.8-10.9 NTU). The regression model between TSI and turbidity for SS ( $R^2=0.86$ ) had a stronger fit compared to the model for MO ( $R^2=0.51$ ). It can be concluded that there are clear seasonal trends in TSI and turbidity associated with the rainy season in MO and SS

**Keywords:** Inland fisheries; Fish production; Mesotrophic status; Season

# BIOMASS AND POLLUTANT UPTAKE OF SELECTED PLANT SPECIES IN CONSTRUCTED FLOATING WETLANDS

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**Abstract:** Constructed Floating Wetlands (CFW) is an innovative to control the pollution in urban lakes. A study was conducted to assess biomass production and pollutant uptake by *Canna iridiflora* and *Cyperus alternifolius* in CFWs in Bogambara Lake, Kandy, Sri Lanka. Tillers of both plants (20 cm height) were potted in floating PVC frame in the lake. Coconut coir was used as the media for each pot. The reference experiment was conducted by maintaining terrestrial conditions nearby the lake. Reference plants were arranged in polyethylene bags and kept to represent the terrestrial condition and watered using lake water. In both experiments, plant samples were collected weekly intervals up to 8 weeks by uprooting. The height, fresh & dry weight of shoots and roots were measured. Total nitrogen (TN), and total phosphorous (TP) contents were also measured in shoot and root samples. The data were analyzed using R software. Results indicated that the biomass of both shoots and roots of *Canna iridiflora* were significantly higher ( $P < 0.05$ ) than *Cyperus alternifolius* in both CFWs and reference. The shoot growth was higher on CFWs, and root growth was higher on terrestrial conditions in both plants. The TN and TP contents in shoots of both plants were higher than the roots for both tested conditions. The uptakes of N ( $23.28 \text{ mg plant}^{-1}$ ) and P ( $31.09 \text{ mg plant}^{-1}$ ) were higher in *Canna iridiflora* compared to N ( $14.91 \text{ mg plant}^{-1}$ ), P ( $7.89 \text{ mg plant}^{-1}$ ) uptake by *Cyperus alternifolius*, in CFW over the terrestrial conditions. It can be concluded that growing *Canna iridiflora* in CFW is one of the best solutions to mitigate the pollution of polluted lakes.

**Keywords:** Biomass; Constructed floating wetlands (CFW); Nitrogen; Phosphorous; Urban lakes

# PLANKTON DIVERSITY AND LIMNOLOGICAL ASSESSMENT OF A TROPICAL RESERVOIR

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**Abstract:** Planktonic diversity is an indicator tool to evaluate the health of aquatic ecosystems. A healthy ecosystem harbours well nourished flora and fauna. Limnological evaluation of a water resource illustrates the habitat suitability for the existence of certain types of flora & fauna. The present study is an attempt to assess the diversity of plankton in a tropical reservoir in India. Following the objective of the study, a hydrobiological investigation was carried out for two years in Barna reservoir; a reservoir built across the river Barna; a well-known tributary of river Narmada in central India. Investigative attempt was made in accordance with standard methods of evaluation of diversity and water quality as mentioned in manual of American Public Health Association (APHA) and described by other authors. Certain limnological parameters especially pH, Electrical Conductivity, TDS, Dissolved Oxygen, B.O.D., Nitrate-nitrogen and Ortho-phosphate were evaluated and found suitable for good growth of planktons. A total of 75 species of phytoplankton belonging to 7 classes viz. Chlorophyceae, Bacillariophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Xanthophyceae and Chrysophyceae were recorded whereas 47 species of zooplankton belonging to five groups viz. Rotifera, Cladocera, Copepoda, Protozoa and Ostracoda were identified in Barna reservoir. Chlorophyceae the class of phytoplankton and Rotifera group of zooplankton found as dominant during the study period. The dominance of class Chlorophyceae indicates nutrient enriched water quality whereas dominance of Rotifers showed healthy limnological regime in Barna reservoir. The study reveals that availability of healthy ecosystem is required for all life forms in a tropical reservoir.

**Keywords:** Barna reservoir; Central India; Chlorophyceae; Narmada river; Rotifera

# EVALUATION OF CONSUMER SATISFACTION ON DRINKING WATER SOURCE IN SELECTED DISTRICTS OF SRI LANKA

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**Abstract:** Study of consumer satisfaction toward the drinking water sources is one of the efficient methods to improve the water resource management. Therefore the study was aimed to evaluate the consumer satisfaction on drinking water sources in two divisional secretariat (DS) divisions namely Vengalcheddikulam from Vavuniya district and Uva Paranagama from Badulla district belong to dry zone and intermediate zone of Sri Lanka, respectively. With the available literature, questionnaire was designed for the collection of primary data from randomly selected 25 respondents from each district while other needed secondary data were obtained from other relevant institutions. In addition, key person interviews (KPI) were carried out in parallel. The collected data were analyzed using the Microsoft Excel. The results revealed that the factors like education level (0.15, 0.46), monthly income (0.49, 0.825), employment (0.35, 0.824) and satisfaction (0.48, 0.87) have positive correlation with selection of water source such as well, pipe borne water, reverse osmosis water and spring, while age and gender of the respondents have negative correlation in the study area Vengalcheddikulam and Uva Paranagama respectively. Within the selected DS divisions, similar values of correlation coefficient between the cost of water and the selection of water source (0.4) were observed whereas it was deviated considerably for the factors like education, income, employment and satisfaction since people in the dry zone are willing to select RO water without considering much of other physical factors in order to avoid water related health issues. Considering the intermediate zone, correlation coefficient of 0.825 between monthly income and selection of water source is clear evidence for influence of economic status in water security. Further, KPIs confirm the prevalence of hardness especially in the dry zone of Sri Lanka. Moreover, government intervention in terms of subsidy for water treatment with adequate community involvement in operation and maintenance of water resources would be a sustainable measure to improve consumer satisfaction on drinking water sources.

**Keywords:** Correlation; Climatic zones; Drinking water; Satisfaction; Water source

# THE DARK TALES OF OVER-TOURISM AND THE ECOLOGICAL IMBALANCES FACED: A CASE STUDY IN ELLA

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**Abstract:** Over-tourism, a phenomenon characterized by excessive tourism pressure on a particular destination, has caused an ecological imbalance in Ella, that acts as a base for eco-tourism in Sri Lanka. Ella is a top tourist destination among locals and foreigners which promotes its natural beauty along with Sri Lankan traditional culinary culture. This study aimed to evaluate the impacts of over-tourism on the environment, focusing on the challenges faced by the local community. The research conducted a sample of 30 respondents related to the small and medium-scale enterprises in the tourism industry. Data were analysed thematically and descriptively according to the themes. Sixty percent of the respondents cited the influx of tourists without adequate waste management systems as a primary contributor to pollution in Ella. Between 3-5 tons of garbage is disposed by the hotels and 35% of the respondents mentioned that the increased demand for accommodations, food, and transportation put immense pressure on the environment causing deforestation and loss of biodiversity leading to overexploitation of natural resources. Seventy five percent of the data showed that the rapid increase in tourism has caused a strain on the resources and infrastructure of Ella. In Ella city, the total length of the drainage network is approximately 50m. It is not well connected with natural drainage pattern of the city and wastewater outlets of hotels have been directed towards the existing drainage, which has caused drainage blocking and water pollution reducing ecosystem health of the downstream tank cascade landscapes in Kirindi Oya basin. Insufficient sanitation facilities, traffic congestion, water pollution, and overcrowding have become prevailing issues, negatively impacting the quality of life for residents. To tackle these challenges and restore ecological balance, it is crucial to implement sustainable tourism practices in Ella. Development of proper waste management, sustainable infrastructure and responsible tourism guidelines are needed to foster the ecological balance and sustainability of this important watershed.

**Keywords:** Ecological imbalance, Impacts, Over-tourism, Pollution, Sustainability

# IMPLICATIONS OF THE WATER CRISIS IN SRI LANKA: A CONTEXTUAL STUDY BASED ON THE TRADITIONAL, RELIGIOUS, AND INDIGENOUS KNOWLEDGE ON THE CULTURE OF WATER IN SRI LANKA

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**Abstract:** Being a vital natural resource, water is both the source of life and an essential component within all ecosystems. Human progress and societal evolution are bound with the availability and management of water resources. Sri Lanka, too, has a rich heritage of self-sustained water management practices. The geological attributes of this island ensure its ability to maintain a water-rich environment. However, Sri Lanka is currently facing a substantial water crisis, marked by complex and persistent issues that have arisen over recent decades a crisis that manifests as water scarcity, water pollution, and water privatization. Hence, this research focuses on the contemporary water crisis in Sri Lanka, tracing its origins to preceding decades and its current prominence. A key factor in the present crisis is the lack of intergenerational transmission of traditional knowledge, values, and incongruities within development agendas. Therefore, the present study explores how to develop an educational paradigm that fosters sustainable water practices and nurtures a protective relationship with nature among the young generation. Methodologically, the study adopts Joseph Cardijn's (1887 -1967) "See – Judge – Act" theological research approach, which is finding solutions and proposals according to the contextual phenomena rooted in Christian scripture, and tradition effectively. This study focused on bridging the gap between the prevailing water practices and existing educational paradigms in Sri Lanka. This research proposes the introduction of an optional academic module that could bridge the gap between theory and practical implementation while fostering enduring water stewardship within Sri Lanka. Central to this analysis is the recognition that the core issues that stem from deficiencies in knowledge dissemination and educational system design. Consequently, cultivating sustainable water ethics requires a sustained effort to realign attitudes and values that are deep-rooted in Sri Lanka's water management heritage. The study concludes by making practical recommendations and proposing an optional educational framework to effectively manage and mitigate the ongoing water crisis. Implementing these measures aims to strengthen the nexus between theoretical principles and real-world applications by fostering a harmonious relationship between the populace and their aquatic surroundings.

**Keywords:** Joseph cardijn; See-judge-act; Water crisis in Sri Lanka; Water culture in Sri Lanka; Water pollution

# ENHANCING WATER QUALITY OF CITY CANALS THROUGH SEWAGE TREATMENT PLANT FOR SUSTAINABLE IRRIGATION: A CASE STUDY IN KURUNEGALA CITY

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**Abstract:** In Kurunegala city, a vital link between agriculture and water has long been established through the utilization of water diverted from the Wilgoda anicut for irrigation by paddy farmers. These farmers have informally relied on a combination of wastewater mixed with irrigation water during the wet season (WS) and wastewater alone during the dry season (DS), a practice that inadvertently exposed farmers to health risks. This study sought to assess the impact of the Sewage Treatment Plant (STP) on water quality of irrigation water suitable for agriculture, ultimately promoting food security. Composite water samples were collected from 5 sampling sites along the canals downstream to STP during the DS and WS for physicochemical and microbiological analysis. The study utilized a general linear model to analyze the spatial and temporal fluctuations in water parameters. The STP's impact on enhancing water quality was assessed by employing the Water Quality Index (WQI). The water quality in the canals of Kurunegala city demonstrated significant spatial and temporal variations ( $P < 0.05$ ). In 2005 (pre-STP), the WQI (35.2), signified poor water quality and the current WQI stands at 49.4, denoting a marginal enhancement in water quality ( $P < 0.05$ ). Post-STP scenario depicted that water temperature, salinity, nitrate, electrical conductivity (EC), pH, total suspended solids (TSS), biological oxygen demand (BOD), and dissolved oxygen (DO) in canals are improved for irrigation compared to pre-STP data. The WS exhibited elevated levels of EC, TSS, and DO in conjunction with increased values of *E. coli*, while the dry season was characterized by heightened salinity, pH, temperature, TDS, BOD<sub>5</sub> and chemical oxygen demand. This study highlighted the transformative potential of STPs in improving water quality and ensuring a consistent and safe water supply for irrigation. Therefore, the successful implementation of STPs in cities holds the potential to increase the water quality of polluted tank cascade systems in Sri Lanka.

**Keywords:** Food security; Irrigation systems; Sustainable agriculture; Wastewater treatment; Water quality

# POTENTIAL OF AQUATIC MACROPHYTES *CERATOPHYLLUM DEMERSUM*, *LIMNOBIUM LAEVIGATUM*, AND *EGERIA Densa* IN PHYTOREMEDIATION OF WASTEWATER

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**Abstract:** Phytoremediation of wastewater using aquatic plants is an environmentally sustainable technique for removing contaminants in wastewater. The objective of this study is to evaluate the phytoremediation potential of textile wastewater using locally available tropical aquatic plants *Ceratophyllum demersum*, *Limnobiium laevigatum*, and *Egeria densa*. Reduction efficiencies of biochemical oxygen demand (BOD), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), phosphates, nitrates, and heavy metal ions Ni(II), Zn(II), Pb(II), Cr(III/VI) in textile wastewater treated with each plant species and control were estimated. Three plant species and the control were the four treatment groups and each treatment group consisted of three replicates. The bioconcentration factor (BCF) of each plant species was calculated by measuring metal ion concentrations in digested plant tissues to determine heavy metal ion absorption. One-way ANOVA was used to compare the reduction efficiency of the water quality variables. The Tukey post hoc test was used for pairwise comparisons in each treatment group. According to the results of this study, *C. demersum* indicated high reduction percentages of TS (+67.53%), TSS (+74.74%), nitrate (+52.22%), Pb(II) (+98.48%), and Zn(II) (+99.22%) from initial wastewater. There were significant reductions of BOD, TS, TSS, Ni(II), Pb(II), and Zn(II) in wastewater treated with *C. demersum* and *L. laevigatum* compared to the control ( $P < 0.05$ ). Furthermore, the study indicated that *C. demersum*, *L. laevigatum*, and *E. densa* are hyperaccumulators of Zn(II) and Pb(II) according to the BCF factor. The findings of the study suggest that both *C. demersum* and *L. laevigatum* are capable of effectively removing contaminants from textile wastewater.

**Keywords:** Contaminants; Sustainable; Phytoremediation; Wastewater

# MACRO-INVERTEBRATE COMMUNITY IN RELATION TO WATER QUALITY STATUS IN UPPER NORTHERN BASIN OF THONDAMANARU LAGOON, JAFFNA, SRI LANKA

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**Abstract:** Biological indicators including macro-invertebrates are more accepted monitoring tool to assess the aquatic bodies. Thondamanaru lagoon is experiencing loss of biodiversity in and around the lagoon. This study was conducted for one year period from November 2021 to October 2022 to analyse the present status of water quality with macro-invertebrate survey in the upper part of the northern basin of Thondamanaru lagoon. Mud and water sample were collected twice a month from following three sampling sites: S1- Bayond the barrage, in front of the field work center (N-9° 81.27', E- 80° 12.88') S2- near the barrage and in front of Selva Sannathi Kovil (N-9° 82.04', E- 80° 13.11') and S3- near the sand bar (N-9° 82.04', E-80° 13.46'). Water quality parameters including water temperature, salinity, pH, dissolved oxygen, electric conductivity, oxidation reduction potential, alkalinity and orthophosphate that can affect the distribution and abundance of macro-invertebrates were assessed. Based on the morphological characters, among identified 31 taxa, gastropods were the most abundant group. Fresh water shrimp *Macrobranchium* sp. was found for the first time at S1 but no longer exist throughout the period. Based on the statistical analysis by one way ANOVA, species richness, Simpson index, salinity, pH, total dissolved solid and electric conductivity showed significant differences among the three sites ( $P < 0.05$ ). This study revealed the impact of barrage construction across the lagoon on the diversity, distribution and abundance of macro-invertebrates with extensively changing the movement of water flow and water quality. Continuous monitoring and sustainable lagoon ecosystem management are need to maintain the biodiversity and ecosystem health of Thondamanaru lagoon.

**Keywords:** Biodiversity; Biological indicator; Macro-invertebrate; Lagoon

# A SYSTEMATIC REVIEW OF THE IMPACTS OF AGRICULTURAL ACTIVITIES ON GROUNDWATER QUALITY AND QUANTITY

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**Abstract:** A variety of ecological, social, and economic problems arise as a result of agricultural operations such irrigation, the application of fertilizers and pesticides, and the livestock farming. The tank cascade system (TCS) in Sri Lanka also can affect groundwater dynamics. The implementation of unsustainable agricultural activities in TCS has the potential to significantly affect ground water quality and quantity. In response to this pressing issue, a comprehensive literature review was conducted with the dual goals of (a) bringing together existing knowledge about the agricultural activities impact on groundwater quality and quantity and (b) providing an invaluable resource for policymakers, researchers, and stakeholders dedicated to promoting sustainable agriculture and safeguarding groundwater resources. This review focused on English-language publications published in major academic journals and investigated more than 50 scientific studies that were published between 2000 and 2022. In order to investigate the various impacts of agricultural operations on both the quality and quantity of groundwater, these investigations were subjected to rigorous examination and extensive assessment. The review uncovered information on the different elements that affect groundwater quality, including trace element mobility from soil to aquifers, pesticide infiltration, and fertilizer discharge. Investigating the mechanisms underlying these processes provided information on the fate and mobility of contaminants as well as their potential long-term effects on ecosystems and human health. This review examined the simultaneous effects of groundwater management strategies, land use changes, and irrigation practices on groundwater quantity. Furthermore, a complete understanding of the hydrological effects of expanded agriculture was provided by its investigation of the dynamics of groundwater recharge, depletion, and natural aquifer system alteration. The review also highlighted regional variations in how agricultural operations affect groundwater, highlighting the significance of geographical and geological variability. This review highlights the urgent ecological challenges in agriculture, offering crucial insights for sustainable practices and groundwater preservation.

**Keywords:** Groundwater pollution; Sustainable resource utilization; Systematic review, Unsustainable agricultural activities

# UTILITY OF DOCUMENTARY FILMS FOR PROMOTING SUSTAINABLE WATER MANAGEMENT IN SRI LANKA

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**Abstract:** In Sri Lanka, the management of water resources and the establishment of sustainable socio-ecological systems face formidable challenges, exacerbated by climate change and rapid urbanization. Effective community engagement is indispensable in tackling these issues, yet there exists a significant knowledge gap regarding the utility of documentary films as tools to facilitate such engagement. This research study sets out to investigate whether documentary films can effectively stimulate community engagement and contribute to the establishment of sustainable and resilient socio-ecological systems and water management practices in Sri Lanka. This research aimed to evaluate the impact of documentary films in raising awareness and mobilizing communities for improved sustainability, identify influencing factors, and provide actionable recommendations for water resources management and the establishment of sustainable socio-ecological systems in Sri Lanka. Employing a mixed-methods approach, combining both quantitative and qualitative methods, the research collected data through surveys conducted among selected communities, content analysis of documentary films addressing water management and socio-ecological issues in Sri Lanka, and in-depth interviews with key stakeholders including filmmakers, community leaders, and water management experts. Preliminary findings suggest that documentary films possess the potential to be potent tools for enhancing awareness and encouraging community engagement in water management and socio-ecological resilience efforts in Sri Lanka. Communities exposed to well-crafted documentary films demonstrated increased knowledge, more positive attitudes, and a greater inclination to take action toward sustainable water management. However, the effectiveness of these films is influenced by factors such as the quality of narrative, cultural relevance, and accessibility. Collaboration between filmmakers, government agencies, NGOs, and local communities emerges as a crucial factor for maximizing the impact of documentary films in the promotion of sustainable socio-ecological systems and water management. These preliminary findings provide valuable insights into the potential of documentary films as a means of community engagement and offer pathways for leveraging this medium to address pressing socio-ecological challenges in Sri Lanka.

**Keywords:** Community engagement; Documentary films; Socio-ecological resilience; Sustainable water management

# IMPACTS OF HYDROCLIMATIC VARIABILITY IN UPPER MADURU OYA SUBWATERSHED IN SRI LANKA

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**Abstract:** This study was conducted in the Upper Maduru Oya sub watershed in Sri Lanka to assess the impacts of hydroclimatic variability on water resources and agriculture. The special focus was given to assess the impact on the Maduru Oya reservoir located in the downstream and on the Mahaweli System B. Maduru Oya reservoir is fed by the Maduru Oya and diverted Mahaweli water and it supplies water to the Mahaweli System B. A mixed method approach was used in the study which includes a questionnaire survey of 220 respondents in the upper watershed, key person interviews, and analysis of reservoir flow (Maduru Oya), cultivation data (from 2012 to 2021) and rainfall data (from 1989 to 2021) of Mahaweli system B. In upper watershed, 63%, 72% and 81% of respondents accepted that there was a change in water availability for drinking, household activities and irrigation, respectively. Rainfall is the main source for irrigation. The 66% of farmers experience a decrease in irrigation water availability over time, primarily attributed to delays in the rainy seasons. Area of cultivation, crop production and agricultural income changed by 66%, 90% and 91% respectively due to multitude of factors including rainfall variability, input shortages, and rising costs. During the period of 2012 to 2021, water diverted from Mahaweli to Maduru Oya reservoir has fluctuated, with an overall increase. Total cropping extent has increased (5.5%), while total water issue has decreased indicating increasing rainfall amount in Yala season in Mahaweli system B. A decline in Maduru Oya water usage in the upper watershed, coupled with an increase in Mahaweli diversion for the reservoir, signifies a reduction in Maduru Oya streamflow over time. This study emphasizes the need for adaptive strategies and sustainable development in addressing hydroclimatic challenges in the upper watershed.

**Keywords:** Hydroclimatic variability; Impacts; Mahaweli system B; Upper watershed

# NANOCOMPOSITES FOR SUSTAINABLE COBALT (II) ION REMOVAL: SOL-GEL SYNTHESIS AND EXCEPTIONAL PERFORMANCE

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**Abstract:** The removal of Cobalt (II) ions from wastewater is of paramount importance due to its toxic effects on both the environment and human health. In this study, Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites synthesized through the sol-gel method were employed as an efficient adsorbent for the removal of Cobalt (II) ions from aqueous solutions. The synthesized nanocomposites were thoroughly characterized, and their adsorption performance was evaluated. The nanocomposites' structural evolution during Cobalt (II) ion adsorption was examined using scanning electron microscopy (SEM), revealing a transition from a rod-like structure to an irregular shape, indicative of successful adsorption due to robust surface-ion interactions. X-ray diffraction (XRD) analysis identified cubic MgO and cubic Fe<sub>3</sub>O<sub>4</sub> phases in the nanocomposites. Following Cobalt (II) ion adsorption, additional phases, such as hexagonal Mg(OH)<sub>2</sub>, hexagonal Co(OH)<sub>2</sub>, Rhombo H. axes CoCO<sub>3</sub>, and cubic Co<sub>3</sub>O<sub>4</sub>, were detected, signifying changes in the nanocomposite's crystal structure. Vibrating sample magnetometry (VSM) analysis showed a magnetization of 30.19 emu g<sup>-1</sup>, enabling convenient magnetic separation after treatment. Optimization parameters were established, including an adsorbent dosage of 0.03 g L<sup>-1</sup>, an initial Cobalt (II) ion concentration of 40 mg L<sup>-1</sup>, a contact time of 120 minutes, and a pH of 8. Under these conditions, the Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites displayed a remarkable adsorption capacity of 1300.04 mg g<sup>-1</sup> and an impressive removal efficiency of 97.5%. The kinetic data fitting closely followed the pseudo-second-order model (R<sup>2</sup>=0.996), indicating chemisorption and intra-particle diffusion during the initial stage. Isotherm data analysis aligned well with the Langmuir isotherm model (R<sup>2</sup>=0.995), validating monolayer adsorption with a maximum adsorption capacity of 1178.55 mg g<sup>-1</sup>. This study underscores the potential of sol-gel-synthesized Fe<sub>3</sub>O<sub>4</sub>/MgO nanocomposites as a highly efficient adsorbent for Cobalt (II) ion removal from wastewater. The exceptional adsorption capacity and efficiency of these nanocomposites offer a promising solution for environmental remediation and water purification.

**Keywords:** Adsorption; Chemisorption; Magnetic separation; Wastewater treatment

# ASSESSING WATER QUALITY USING A COMPOSITE INDEX: A STUDY IN KOTAGALA WETLAND, NUWARA ELIYA, SRI LANKA

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**Abstract:** The Kotagala wetland plays a vital role in provisional, regulating, cultural and supporting ecosystem services. Since the water in this wetland is used for a variety of human functions, a periodic chemical and physical quality assessment of its water appears to be required. This study used a Water Quality Index (WQI) to assess the level of water quality since it was designed to integrate multiple criteria and their dimensions into a single score. Water samples were collected from six selected inlets and one outlet in the wetland for a duration of ten months from November 2021 to August 2022 with monthly intervals. The following seven parameters were measured and used to generate WQI: Nitrate, Phosphate, Total Suspended Solids, Total Dissolved Solids, pH, Electrical Conductivity, and Salinity. According to the calculated WQI for separate locations, two locations fell under “Poor” water quality status, and all other locations were counted under “Good” water quality. However, the study revealed that the sampling location's proximity to urban areas indicated “Poor” water quality. According to the calculated monthly WQI, the values ranged from 45.8 in February to 113.3 in December. The minimum value of WQI appeared in the driest month. It shows the minimum water pollution experienced in the driest month. A significant relationship was identified between the WQI and rainfall ( $P=0.002$ ). The wetland's mean WQI was calculated to be 75.5, which is considered as a “good” quality water. While certain inlets exhibited "Poor" water quality, the overarching water quality of the entire wetland was consistently classified as "Good," highlighting its effective role in regulating water quality. The results demonstrated the wetland's capacity to regulate water quality.

**Keywords:** Ecosystem services; Water quality index; Wetlands

# RED CLAY-DERIVED NANOPARTICLES FOR REMEDIATING WASTEWATER THROUGH PHOTOCATALYTIC DYE DEGRADATION AND HEAVY METAL ADSORPTION

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**Abstract:** Water pollution due to industrial discharge is a critical environmental issue. These pollutants have detrimental effects on human health. This study primarily focused on the synthesis of red clay-derived magnetite ( $\text{Fe}_3\text{O}_4$ ) and maghemite ( $\gamma\text{-Fe}_2\text{O}_3$ ) nanoparticles (NPs) and investigating their remediating ability on wastewater that is contaminated by textile dyes and heavy metals. These NPs were synthesized through acid digestion of red clay, precipitating the resulting solution under alkaline conditions in the presence of sodium dodecyl sulphate, followed by calcination of the obtained product at  $600^\circ\text{C}$  for 4 hours. The formation of NPs was investigated by UV-visible spectrometry, which shows two characteristic peaks at 271 nm and 372 nm, that indicates the presence of  $\gamma\text{-Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$ , respectively. Fourier transform infrared analysis showed characteristic bands at  $617\text{ cm}^{-1}$  and  $532\text{ cm}^{-1}$ , which implicates the vibrational modes of Fe—O bonds in both types of NPs. The peak pattern obtained by powder X-ray diffraction also matched the Miller indices of  $\gamma\text{-Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$ . Further, the topological characteristics of NPs were studied through scanning electron microscopy. The ability of the resultant NPs on degrading textile dyes was investigated by using methylene blue (MB) dye under solar irradiation. For this experiment, the optimum conditions were found to be 4 mg of NPs in a 5 ppm MB solution at pH of 6. Photocatalytic degradation was evaluated through UV-visible spectrometric analysis over a period of 240 minutes. The obtained data showed a ~70% of photocatalytic degradation efficiency. Heavy metal removal ability of NPs was investigated by using an aqueous  $\text{Pb}^{2+}$  solution. An improved heavy metal remediation was found with an adsorption capacity of  $141.08\text{ mg g}^{-1}$  at pH 5. Overall, these findings suggested that these red clay-derived  $\text{Fe}_3\text{O}_4$  and  $\gamma\text{-Fe}_2\text{O}_3$  NPs have the potential of treating wastewater that is contaminated by MB and  $\text{Pb}^{2+}$ .

**Keywords:** Nanoparticles; Magnetite; Maghemite; Methylene blue; Heavy metal



#### **4. Socio-economic Systems, Governance, and Sustainable Development**



# A STUDY OF THE ORIGIN OF VILLAGE TANKS THAT LED TO THE EMERGENCE OF CASCADE TANK SYSTEMS; AN INQUIRY FROM AN ARCHAEOLOGICAL POINT OF VIEW

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**Abstract:** Among the many ingenious innovations of ancient Sri Lanka, the cascade tank system stands as an exemplary feat of hydrological management. In the study of the socio-archaeological space that influenced the development of this genius irrigation system, it should not be investigated as an isolated industry, but as a process that was born and gradually evolved based on the needs of the people. This research provides an overview from an irrigation archaeological point of view about the origin of village tanks that were fundamental to the emergence of cascade or vertical networked tank systems, mainly based on field research, other archaeological data, and historical sources. The irrigation-based ancient Sri Lankan civilization considered the ‘Village Tank’ as the main development venture which was supposed to be a basic investment in the society. To understand the socio-archaeological space that influenced the development of networked village water systems, it is a prerequisite to study the settlement distribution during the proto-historic period. The oldest settlements are distributed in areas where the need of the people was fulfilled. Instead of the monotonous subsistence system that existed until then, a diverse economic system had emerged. During this period the people have developed the natural water retaining places called Pathas (Waterholes) in arid regions into small tanks by building small dams, to obtain water during the dry season. It was observed in the study that the natural Waterhole formed during the Holocene period were mostly used for the construction of small village tanks. Early Iron Age knowledge and metal tools would have been used for these constructions. Their intrinsic knowledge of topography and the pattern of water usage by the people in the proto-historic and early historic periods resulted in vertical systems, which integrated into the cascade tank systems.

**Keywords:** Archaeology; Irrigation; Proto-historic; Village tanks; Vertical networked tanks

# GOVERNANCE ISSUES AFFECTING THE EFFECTIVENESS OF FARMER ORGANIZATIONS IN MAINTAINING MINOR IRRIGATION SYSTEMS: CASE STUDY IN SIWALAKULAMA CASCADE SYSTEM

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**Abstract:** Minor Irrigation Systems (MISs) are administered by the Department of Agrarian Development, and primarily maintained by Farmer Organizations (FOs). Under a diminishing performance context of FOs, this study evaluates the governance issues affecting the effectiveness of FOs for maintaining MISs in the Siwalakulama cascade system, Galenbindunuwewa, Sri Lanka, based on governance principles: Participation, Responsiveness, Accountability, and Transparency. Data were collected from a randomly selected sample of 82 farmers representing seven FOs of the Siwalakulama cascade system through a pre-tested questionnaire survey and focus group discussions. Results of descriptive data analysis revealed poor farmer participation as a key issue for maintaining MISs (79%) due to a higher number of part-time farmers and farming became a secondary income source (86%). FOs' were less responsive (76%) for MIS maintenance requirements as well as for addressing the needs of the member farmers. The lack of transparency (74%) of operations and decisions, focus less equitability for members of FOs (83%), poor handling of FO funds (77%), lack of financial records keeping (74%), and improper audits (75%) were the most reasonable factors for poor transparency among FOs. Lack of accountability (71%) was due to leadership issues (77%), leaders' decision-making errors (73%), low level of accountability for maintaining irrigation infrastructure (79%) on the role of FO officers and members for MIS maintenance were among the key governance issues identified. Findings conclude that the FOs are less effective in maintaining MISs with respect to governance issues. Improvement in governance aspects considering socioeconomic, demographic, and climatic changes in village-based agricultural communities is recommended to improve the effectiveness of FO for maintaining MISs.

**Keywords:** Governance; Maintenance; Village-based agricultural communities.

# EFFECTIVENESS OF VILLAGE TANK CASCADE SYSTEMS (VTCSs) FOR RURAL SUSTAINABILITY: A CASE STUDY OF OVILANA TANK IN HAMBANTOTA

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**Abstract:** Village Tank Cascade Systems (VTCSs) evolved as interconnected ecologically compatible hydraulic systems in the dry and intermediate zones in Sri Lanka. These VTCSs are vital to enhancing climate-resilient livelihood and food security for rural peasant communities. Water scarcity has had a detrimental effect on irrigation-based paddy cultivation in dry zone areas and currently, it has become a global scenario. Sustainable Development Goals (SDG) 2 and 6 are highly concentrated on overcoming water-related issues and providing equal opportunities for the community in the next couple of years, especially in developing countries. VTCSs are playing a dominant role at the micro level in enhancing the coping capacity of rural peasant communities in dry and intermediate zones in Sri Lanka. Therefore, the effectiveness of the Ovilana village tank to achieve SDG at the rural level through VTCS Sri Lanka was studied in this research. Ovilana Tank is fed by the Murutawela Reservoir, and it provides irrigation facilities for 48 paddy farmers to continue paddy cultivation and animal husbandry. Questionnaire survey and interview methods were followed for the primary data collection in Madagama GND in Weeraketiya DSD. Data were analyzed by using descriptive statistics and thematic analysis. Based on the Ovilana tank 32 acres of paddy lands were cultivated by 48 traditional farmers during the Yala and Maha seasons without any interruptions. Drought resilient “AT 362” paddy variety, the systematic role of farming society, incorporation with traditional knowledge and rituals during all stages of cultivation, water and tank conservation strategies, animal husbandry, crop rotation, equality, and accountability caused accelerated socioeconomic and ecological sustainability of the Ovilana tank. Moreover, this case study proved the suitability of VTCSs for achieving sustainable development and empowering the rural communities in Sri Lanka.

**Keywords:** Effectiveness; Farmers; Sustainable development goals; Village tank cascade systems

# SHORT-TERM EFFECT OF ORGANIC PADDY INPUT MANAGEMENT SYSTEM ON DIFFERENT SOIL PROPERTIES OF RICE GROWN IN ALFISOLS

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**Abstract:** Rice (*Oryza sativa* L.) is one of the main crops in Sri Lanka. Currently, rice farming in Sri Lanka is highly dependent on external inputs such as fertilizers and pesticides. However, many studies have revealed that long-term use of chemical inputs negatively impacts soil health. Organic farming is considered a feasible alternative to overcome these negative consequences. Hence, this field experiment was conducted to investigate and compare the soil characteristics in continuously grown paddy in an organic input system over the last three years (2019, 2020, and 2022 *Yala* seasons) at the research field, Faculty of Agriculture, Rajarata University of Sri Lanka. Soil samples were collected from the surface (0-15 cm) and subsurface (15-30 cm) soil just before land preparation in an organic input system with three replicates. Soil nutrient levels were studied using standard analytical procedures. Data analysis was done using mixed procedure of SAS 9.0 version. Soil pH and cation exchange capacity (CEC) were not significantly different ( $P>0.05$ ) among two depths while significantly different ( $P<0.05$ ) across three rice growing seasons. Soil organic matter content and microbial biomass carbon were significantly greater ( $P<0.05$ ) in the 2020 and 2022 *Yala* seasons. Also aforementioned parameters were significantly greater ( $P<0.05$ ) at surface soil compared to the subsurface soil. Soil organic matter content, organic carbon and CEC have increased with time. Therefore, it can be concluded that continuous application of organic fertilizers has improved soil health and sustained soil fertility in the rice-grown Alfisols in Sri Lanka. Hence the findings could be applied into rice grown in Tank Cascade Systems in the dry zone of Sri Lanka.

**Keywords:** Cation exchange capacity; Microbial biomass carbon; Soil characteristics; Soil fertility; Soil pH

# ECOLOGICAL AND SOCIO-ECONOMICAL SUSTAINABILITY OF RESTORED TANK CASCADE SYSTEM: A CASE STUDY IN KAPIRIGGAMA TANK CASCADE SYSTEM

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**Abstract:** The Tank Cascade System (TCS) served as the essential component of ecological balance, socio-economic sustainability, water management, and rural livelihoods. The TCS and its catchment areas are today under pressure due to the range of human-induced activities. The objective of this study was to identify the appropriate conservation finance mechanisms and to explore the benefits of restoration of TCS as preserve ecological and socio-economic sustainability under the present circumstances. The data from primary and secondary sources were collected. Both qualitative and quantitative analysis methods were used for the study. The study found that the Kapiiriggama TCS are today under pressure due to deforestation, pollution, the spread of invasive alien species, and ongoing climate change etc. The TCS and its catchments should be managed for the ecosystem services that it generates. If the tank catchment area and the tank area are conserved, the threat to tanks substantially reduces. By applying conservation finance mechanisms such as ‘payment for watershed services’ & the ‘willingness to pay method’ the tank catchment can be conserved so the tank. Further, the study reveals that most of the people (54.3 %) agreed to pay for restoration activities. According to the results, calculated maximum payment for the restoration of the tank cascade system between 500-1500, 1500-2500 and 2500-3500 LKR as 36.1%, 11.2% and 1.7% respectively. Many people were prepared to make labor contribution. Accordingly, there is a positive impact of agreeing to pay money for restoration and willingness to pay for restoration on maximum payment for season in Kapiiriggama TCS. It is recommended to implement strategies for effective conservation of the catchment areas to ensure the future sustainability of this cascade.

**Keywords:** Dry zone; Payment for watershed services; Willingness to pay method

# STRATEGIES FOR SUSTAINABLE MANAGEMENT OF THUMBIKULAMA TANK IN THE DRY ZONE OF SRI LANKA

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**Abstract:** Thumbikulama tank in the Bellankadawala cascade in the dry zone of Sri Lanka is among the most degraded, resulting in many social and environmental issues. Poor resilience to flood and drought conditions, alteration of natural ecosystem structure and function, and human-elephant conflicts are the key issues that arose due to the degradation of the Thumbikulama tank. However, considering its potential to facilitate crop production in the command area, rehabilitation of Thumbikulama tank is timely essential. The aim of this study was to examine a suitable strategy for the sustainable rehabilitation of Thumbikulama tank. Primary data were collected from 120 farmers from each Grama Niladhari divisions: Demunnewa, Vayaulpotha, and Bellankadawala through a questionnaire survey and focus group discussions with randomly selected 30 key persons. Data were qualitatively analyzed through participatory need analysis, SWOT, and thematic analysis methods. This study identified sustainable maintenance and operation (90%), physical and ecological rehabilitation (88%), development of infrastructure and other agricultural activities (62%), cascade-based interventions (60%), and institutional development (35%) as key areas of the development strategy. Results show that sustainable maintenance and operation are essential for the tank's sustainable management. Participatory forest management, land consolidation, development policy and regulations, and routing maintenance arrangements are identified as the key actions to be taken to maintain forest tanks for an extended period and ensure the system's sustainability.

**Keywords:** Development strategy; Ecosystem; Participatory Forest management; Rehabilitation

# A BIBLIOMETRIC ANALYSIS OF THE TANK CASCADE SYSTEM IN SRI LANKA DURING 2000-2023: AN OVERVIEW BASED ON THE SCIENCE DIRECT DATABASE

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**Abstract:** The Tank Cascade Systems (TCSs) is found in dry and intermediate climatic zones in Sri Lanka. Numerous professionals and researchers, both local and international, have devoted considerable efforts to investigate and evaluate these systems. This study presents, comprehensive bibliometric performance analysis and visual scientific mapping of research trends related to TCSs in Sri Lanka, based on the science direct database. Among 22 articles retrieved, 17 that were related to the TCSs in Sri Lanka published in 2000-2023 period were selected for data analysis. The analysis was conducted using Excel and VOSviewer software, focusing on aspects such as the country-wise contribution of international authorship, year-wise citations of articles on TCSs in Sri Lanka, and the most commonly used keywords in the selected articles. The Key words used for this study were “tank cascade system”, “cascade system” and “Sri Lanka”. The results revealed a significant international collaboration, with contributions from 19 international authors and 38 national authors in the field of TCSs. Notably, the highest levels of international authorship collaborations occurred in 2017 and 2023. Australia made the most substantial international contribution (36.84%). The most cited year among the selected articles was 2003. “A simple water balance modeling approach for determining water availability in an irrigation tank cascade system” written by C.J. Jayatilaka, R. Sakthivadivel, Y. Shinogi, I.W. Makin, and P. Witharana in 2003, was the most cited article in the field of TCSs in Sri Lanka during the 2000–2023 period. Based on the analysis the most total link strength keywords were ‘system’ (161) and ‘tank’ (119). These findings advance our knowledge of TCSs research and may be useful in guiding future research for scholars and practitioners.

**Keywords:** Bibliometric analysis; Science direct database; Tank cascade systems; Sri Lanka; VOSviewer

# AN ARCHAEOLOGICAL INTERPRETATION; DESIGN, AGE, AND PERFORMANCE OF ANCIENT CRUCIBLE STEEL FURNACES FOUND IN YODHAWEWA, SRI LANKA

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**Abstract:** The main objective of this study was to examine the design, age, and performance of the ancient crucible steel furnaces found in the Yodhawewa archaeological site, Northern dry zone of Sri Lanka. An archaeological survey and two vertical excavations were carried out near the excess water canal of the Yodhawewa tank in 2018. This investigation is mainly based on archaeological materials such as furnace debris, slags, crucible fragments, and burnt wood charcoal unearthed from the field observations. According to the stratification of the entire area, two cultural layers were located between two natural layers, mainly representing metal activities from the c. 1<sup>st</sup> to 9<sup>th</sup> century AD. Furnace debris, slags, and crucible fragments were the evidence of crucible steel production of there among other archaeological materials found. An important discovery of the Yodhawewa research was the lower half-spherical shape furnace used for making crucible steel. Archaeologists have so far been unable to find in South Asia, such a furnace except at Kodumanal, a South Indian archaeological site used for high-carbon steel production in c. 300 BC. Among the first-millennium AD metal artifacts in the Yodhawewa site, this furnace has received an absolute date of c. 680 ± 30 AD from the Accelerator Mass Spectrometry (AMS) Radiocarbon dating. Further, this is the first discovery of a furnace activated through the "Bellow method" for making crucible steel in the Northern dry zone of Sri Lanka. According to the size factors and structural features seen in the furnace, it can be concluded that a steel-making crucible file (10-15) in these furnaces may have been used at the same time. A rare model of the c. 9<sup>th</sup> century AD was selected for crucible steel production in Sri Lanka; however, this could indicate that the ancient metal-workers possessed the technical skills to use it sparingly.

**Keywords:** Bellow method; Crucible steel; Furnace; Yodhawewa; Sri Lanka

# EFFECT OF LOWER MALWATHU OYA RESERVOIR PROJECT ON KIMBUL WEWA VILLAGE TANK SYSTEM IN ANURADHAPURA, SRI LANKA

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**Abstract:** The village tank cascade system is on the lead as an excellent small sustainable system in the dry zone of Sri Lanka. It refers to the old art of irrigation that made of a series of tanks interconnected within a micro-catchment in order to store and distribute water to areas. However, mega development projects (MDPs) like the Lower Malwathu Oya Reservoir Project may harm these cascades while creating land use changes, deforestation and forest degradation, habitat loss, environmental pollution, and social and cultural destruction. The main objective of this study is to identify how the MDPs affect on village tank cascade systems and human lifestyles associated with tanks. Under qualitative research methodology, semi-structured interviews and field observation were used to collect primary data from 15 locals selected by purposive sampling. The collected data were analyzed using thematic analysis. Kimbul Wewa cascade consists of 10 tanks and Maha Kimbul Wewa is the largest and directly inundated by this project. The inundation of segments of cascade like Gasgommana, Thisbambe, Kattakaduwa, Potawetiya, and tank bed can lead to loss of habitat, feeding and breeding grounds, and water resources for animals, as well as loss of trees and medicinal plants, increasing the human-elephant conflict and eventually collapse the entire cascade system while creating the future risk of flood in this area. The interrelationship between people, animals, the environment, culture, religious beliefs, norms, and traditional knowledge of these systems are at great risk due to the collapse of cascades. Social stress, deterioration of social ties, and loss of livelihood and existing income are the direct impacts of socioeconomic profile. Therefore, this study emphasizes the sustainable development comprised of the participatory rural approach, bottom-up development, and social forestry while balancing national and local requirements to minimize the eternal impacts of MDPs.

**Keywords:** Local requirements; Sustainable development; Traditional knowledge; Village tank cascade system

# A PARTICIPATORY AND APPRECIATIVE RISK ASSESSMENT FOR DISASTER RISK REDUCTION IN THE COASTAL CITY OF JAFFNA, SRI LANKA

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**Abstract:** Having risk at a community level leads to negative effects on people, systems, functions, livelihood, and elements at risk. Understanding risk at the local level is an essential component for risk communication in disaster risk reduction and risk management of the last mile. A lack of understanding of the risk at a community level can lead to a waste of resources, ineffective preparedness, and response as well as unsustainable development. Reducing existing risks and avoiding creating new risks would make the coastal cities resilient. Understanding potential risks is a prime requirement to strengthen local Disaster Risk Reduction (DRR) and reduce the extreme vulnerability of the coast of Jaffna City. Triple-Risk-Associations (TRA) of solid waste, flood inundation, and the epidemic (dengue) are the climax to studying the coast of Jaffna City. This study aims to enhance the Local DRR practices toward coastal city community resilience. The mixed approach was used to reveal the results as the geographical, social, economic, and environmental conditions were complex in this coastal area. Forty-five participants including community leaders, Small Scale Fishermen (SSF) community, village officials, and local vendors were in-depth interviewed and discussed with focus groups, and data were gathered. Also, the community rating system was utilized to generate the risk map based on the specified criteria. According to TRA, Navanthurai North, South and Koddadi, Pommaiveli, Vasanthapuram, Samminakar, Sooriyaveli, and Gurunakar have been identified as risky areas as per the outcome of community rating in the coastal city. The risk assessment facilitates proactive risk communication which reduces the potential and new risks, too, and enhances local DRR of the coastal cities and climate resilience. The participatory and appreciative community practice of this study could be implemented by the local authorities to ensure the local DRR and build city resilience in developing countries.

**Keywords:** Coastal city resilience; Participatory approach; Local disaster risk reduction; Risk communication; Triple-Risk-Association

# THE ROLE OF DEMOGRAPHIC AND CULTURAL CHANGES ON THE SUSTAINABILITY OF RANPATHVILA TANK CASCADE OF SRI LANKA

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**Abstract:** : The tank cascade system (TCS) is a particular ecosystem centred on a series of artificial reservoirs where water flow is regulated from a smaller to larger along the topography to control drought and flood. The system was constructed in various ancient periods and has the potential to be used for managing the impacts of climate change. However, the system is undergoing rapid degradation owing to the present rapid environmental and social transformation. It is believed that the indigenous knowledge system of the Sinhala community was the driving force of the sustainable existence of the system. Many TCS have undergone change including the change in the demographic structure, particularly incorporation of Muslim community settlements. Ranpathwila, a TCS in Anuradhapura, Sri Lanka, is one of them. The question is how this assimilation affects the nature of the cascade system. The study aimed to assess the effects of the demographic transformation on the sustainability of the Ranpathwila TCS by adopting qualitative data collection. Primary data collection is based on (90) interviews, administered to capture all four reservoir-based five settlements with key person interview methods, analysis of historical records and text analysis methods and observations. It is evident from the analysis, that demographic assimilation, particularly the integration of Muslim settlements, has no considerable negative effects on the cascade ecosystem. Further, there is an attitudinal transformation from belief in supernatural powers to modernity parallel to the urbanization. It also noted that, this transformation is vitally important to safeguard social harmony. There is a potential to sustainably maintain the system upon the strength of the social harmony among different communities as narrated in the historical records. The study recommends populating the study to capture broader spatial extent to test the validity of the findings. Further, assess the system's functions expand from traditional ones to modern functions such as expansion of fisheries and tourism sector.

**Keywords:** Culture; Local knowledge; Socio-economic transformation; Social context; Village tank ecosystem

# IMPACT OF MICROFINANCE ON LIVING STANDARDS OF RURAL COMMUNITIES IN SRI LANKA WITH SPECIAL REFERENCE TO AMPARA DISTRICT

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**Abstract:** Microfinance aims to uplift low-income earners by providing financial services to transform their socio-economic lives. This study examined the crucial role of microfinance in the economic development of Sri Lanka, specifically focusing on its impact on the living standards of rural communities in the Ampara district. This study selected microfinance credit facilities through dimensions such as loan amount, repayment ability, interest rates, and government intervention as the moderating variable to address the dearth of conclusive evidence of previous studies. The study, involving 300 microfinance beneficiaries selected through random sampling, utilized a structured questionnaire to ensure internal reliability through the Cronbach's alpha test to gather primary data. Six hypotheses were developed to reach the objectives, and descriptive, correlation, and regression analyses were employed for data analysis. According to the descriptive analysis, most of the sample were male, above 40 years old, passed the GCE Advanced level, and had an average family size of 2-5 members. Regression results indicate a positive and significant impact of loan amount and repayment ability on the living standards of rural residents, while interest rates have a negative and significant impact. The study contributes to existing literature by emphasizing the pivotal role of microfinance in emerging markets. Additionally, the study examines the moderating variable of government intervention, revealing that government involvement enhances the efficacy of the microfinance program, positioning it as a key economic actor, and accepting two hypotheses on government intervention. This involvement bridges gaps by facilitating domestic microfinance institutions' access to regulations, procedures, and resources, highlighting the multifaceted benefits of government assistance in the microfinance sector. This finding will be useful for the Sri Lankan government to examine and identify the socio-economic development of rural people.

**Keywords:** Government intervention; Interest rates; Living standards; Loan amount; Repayment ability

# CULTURAL TRADITIONS AND THEIR IMPACTS ON TANK IRRIGATION ACTIVITIES: A CASE STUDY OF THE NORTH CENTRAL PROVINCE, SRI LANKA

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**Abstract:** Cultural traditions are inherently interlinked with the rural agricultural community in Sri Lanka. These kinds of irrigation-related cultural practices may have significantly combined with societal relationships as well as irrigation water management. The objective of this research was to understand how cultural practices and beliefs shape irrigation practices and their subsequent impacts on community relationships in the North Central Province of Sri Lanka. A questionnaire survey (30 farm families) and formal interviews with farmers and community leaders were conducted to gain an in-depth understanding of cultural practices, beliefs, and rituals, covering large, medium, and small-scale tanks in the north-central province. Data on traditional practices, perceptions, and attitudes of farmers were analysed to examine the dynamics and interrelationships in tank communities. Results indicated that cultural traditions were common among the respondents such as decision-making in kanna (season) meetings to discuss the seasonal cultivation plan in all areas, panduru bandeema (ceremony of tying the offerings) - among 80% of the respondents, mutti-nameema (ceremony of pot overturn) - among 50% of the respondents, kiri ethiraweema (ceremony of cooking milk rise for the god) - among all respondents. The maintenance of irrigation systems was also deeply embedded in the local culture and play a significant role in shaping irrigation activities. These traditions not only foster cooperation and social cohesion among community members but also contribute to the sustainable management of water resources. Furthermore, the study revealed that these cultural practices enhanced community relationships by promoting trust, reciprocity, and collective responsibility. Further, this research highlighted the importance of cultural traditions in irrigation activities, emphasizing the positive impact they had on community relationships and the potential for their integration into contemporary water resource management strategies. The findings suggest that cultural traditions should be recognized and preserved as essential elements of sustainable irrigation practices, and efforts should be made to integrate traditional knowledge with modern approaches for effective water management in tank environments.

**Keywords:** Cultural practices; Community relationships; Irrigation activities; Sustainable water management

# DEVELOPMENT AND CONSERVATION CONTRADICTIONS IN SRI LANKA: A CASE STUDY IN BUNDALA NATIONAL PARK

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**Abstract:** Aim of this study was to evaluate the impact of upper catchment development activities on the Bundala National Park (BNP), Hambantota and the livelihoods of buffer zone villages. Bundala is the first Ramsar Wetland in Sri Lanka in the Southern tip of Sri Lanka. To evaluate the ecological impacts of development projects on the conservation of BNP, a literature review and a field survey was conducted with the participation of selected key informants from the surrounding villages of the park. BNP consisted of five shallow Brackish-water Lagoons. Generally, brackish water has more dissolved solids than fresh water and less than seawater. Bundala wetland is fed by two catchments: Malala Oya and Embilikala Oya. Besides these two, Kirindi Oya is one of the other major catchments developed as the Kirindi Oya Settlement and Irrigation Project (KOSIP) in the Late 1980s. Before the KOSIP, Bundala and other surrounding villages were sparsely populated due to the harsh climatic conditions and water scarcity. As a pro-development strategy, the KOSIP was introduced. As a result, new settlements and cultivation fields developed over the upper catchments of BNP and gradually waste irrigation water flow to the lagoons increased. Findings highlighted that the pH values of the main lagoons were closer to seven, and the electric conductivity level was lower. This affected aquatic habitats and reduced species living in the lagoons, challenging the Ramsar title and fishermen's income. Further, KOSIP caused reduced forested areas and grasslands in the vicinity. The curd industry declined due to the reduction in grasslands, which increased illegal access to the BNP grounds for grazing, further deteriorating the habitat. Overall, 22% of buffer zone residents had to find alternative livelihoods due to restrictions and environmental changes. To overcome these two major issues, integration of the views of the community in protected area management and implementation of development projects are recommended.

**Keywords:** Conservation; Bundala national park; Development; People-protected area relationship; Ramsar wetland

# NATIONAL DEVELOPMENT DEMANDS AND LOCAL RESOURCE LOSSES: STUDY OF EFFECTS ON VILLAGE TANK CASCADE SYSTEMS IN THE GREATER HAMBANTHOTA AREA, SRI LANKA

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**Abstract:** The national development demands and local resource losses in village tank cascade systems in the Greater Hambanthota Project (GHP) area were investigated. The aim of the study was to identify mega-development projects and their impact on the natural environment and resources of tank cascade system. The study utilized qualitative methodology, involving 27 interviews with local farmers, government officers, NGOs, and government representatives and direct observations. The study revealed that the rapid development in Hambanthota city has severely impacted the upper part of the cascade and leading to eroded embankments, sedimentation, and reduced natural water flows. Despite the region's infrastructure development, the attention, management and development of tanks and irrigation systems has installed, new proposals have not implemented. It caused to damage to the embankments, reduced their drainage capacity and created challenges for their sustainable, widespread utility. New development interventions in Hambanthota City and Mirijjawila areas have led to increased deforestation, fragmentation of wildlife habitats, and increased the arrival of elephants in villages. Therefore, the human-elephant conflict have been a modern socio economic and environmental issue in the area, during the last few years. As a conclusion, mega development projects, have neglected local capacities, resources, and development requirements of the area and causing harm to locals and wildlife with diminishing their resource-base. Researchers suggest mega-development projects should consider local resources and community engagement while introducing national policies and existing policy integration to sustainably address conflicting demands.

**Keywords:** Tank, Cascade systems, Villages, Sustainability, Development

# SUSTAINABLE URBAN PLANNING AND DEVELOPMENT IN THE 21<sup>ST</sup> CENTURY: EXPLORING SINGAPORE'S SUCCESS IN SUSTAINABLE CITIES AND HUMAN SETTLEMENT

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**Abstract:** Global urbanization presents unprecedented challenges to cities, including resource limitations, population expansion, and climate change. Singapore stands as a prime example of a sustainable urban development model, offering innovative case studies for exploring new urban planning and development approaches. This study examines Singapore's strategies for building sustainable human settlements and cities in the twenty-first century. With the aim of identifying important behaviours, policies, and strategies that support environmental sustainability and urban resilience. The focus mainly lies on understanding the fundamental concepts and tactics guiding Singapore's sustainable urban development and planning, other cities can learn from Singapore's experience by analyzing, Singapore's key success elements and challenges in implementing sustainable urban practices, and deriving lessons. The main objectives are to evaluate Singapore's methods and policies for sustainable urban development, evaluate how Singapore's initiatives match the goals of global sustainability, and determine the elements influencing Singapore's sustainable urban development achievements and difficulties. This study is qualitative and uses secondary sources, including websites, journal publications, and research articles. The findings suggest that Singapore's achievements in sustainable urban growth are attributed to a comprehensive strategy integrating land-use planning, transportation, housing, and environmental conservation. Singapore's focus on climate resilience and green infrastructure has also guaranteed the city flexibility to challenges posed by urbanization and climate change. Singapore's efforts in sustainable urban development and planning provide important insights for cities throughout the globe to become a worldwide leader in sustainable cities and human settlements for the twenty-first century.

**Keywords:** AI; Development; Environment; SDG

# TANK CASCADE SYSTEMS: REVIEW OF PRESENT KNOWLEDGE AND FUTURE RESEARCH PERSPECTIVES

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**Abstract:** The ancient dry zone of Sri Lanka had an intense water management system based on a series of small reservoirs constructed in low-lying areas called the tank cascade system (TCS) to harvest and store seasonal rainfall. Besides being an irrigation source, these tanks supply water for domestic needs and other income-generating activities. This narrative review selected articles published between 2011 and 2021 on tank cascades and water management to provide an overview of the current knowledge state and outline potential research directions for TCS. Considerable studies were focused on hydrochemistry, water balance studies, and flora and fauna assessments in TCS. It was noted that beyond serving as an irrigation system, the hydraulic system also acts as an ecosystem service provider, safeguarding biodiversity in the dry zone landscape. Hence, this system plays a significant role in food production and developing social structure, economic development, cultural heritage, and environmental sustainability in the dry zone landscape. Integral to addressing global food security and sustainable development challenges, these systems are recognized for their significance in sustainable agricultural practices and landscape management, especially in climate change. It was also understood that these TCS are vital to forming organized communities. Though the application of novel techniques such as isotope assessment, virtual sensing, cyber-physical systems, unmanned-aerial-vehicle photogrammetry, use of artificial intelligence, and data mining tools are prominent in studies related to water management, those applications were rarely used in research of TCS. Several studies have been conducted during the last decade, considering the significant role of tank cascade systems in the rural economy and environmental sustainability. However, investigations on reasons for failures, the role of TCS in groundwater recharging, flood protection and ecological balance were barely discussed.

**Keywords:** Ecosystem; Environmental sustainability; Groundwater recharging; Hydrochemistry; Isotope assessment

# INTEGRATED GOVERNANCE STRATEGIES FOR SUCCESSFUL CASCADE-BASED SYSTEMS: AN INDIGENOUS PERSPECTIVE FROM SRI LANKA

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**Abstract:** Being an advanced water management mechanism, Sri Lankan tank cascades are popular for its well-known approaches to ecological resilience and sustainability. These ecological systems harmonized very well with the traditional governance system of ancient Sri Lanka, guaranteeing the smooth overall functioning of the social organization. However, the integrated strategies that powered the harmonization between water management systems and socio-economic systems have yet to be adequately explored. Thus, the present study explores the indigenous governance strategies that integrate cascade-based ecological systems with social organization. With its exploratory nature and inductive approach, the present study employs a qualitative methodology, where data from ante-narratives were collected from literary sources, including research findings, seminal writings and archival records. Collected data were coded and categorized to identify the themes focussing on governance strategies. Accordingly, 34 initial codes emerged, which were later sorted into 14 categories and summed up in three themes. It was found that the caste and Rajakari systems were the key structural arrangements that systematized the occupational engagement of the people in traditional administration system. At the same time, people willingly assume the responsibilities of preserving, maintaining and upgrading the common resources they utilized, including cascade-based system, forming a unique communal work system. Thus, the governance strategies identified in the present study include participatory decision-making, shared accountability and responsibility, mutual survival and benefits, self-sufficiency, and coexistence with the environment. Further, it was observed that collective property rights were upheld over individual rights in times of necessity. Most importantly, the rewards were attached to the service performances, fostering strong connectivity between rights and obligations. Thus, it can be concluded that the traditional social organization of Sri Lanka had unique governance strategies that integrated the social organization. These integrated strategies are directly relevant to core concerns of sustainability.

**Keywords:** Good governance; Indigenous knowledge; Integrated strategies; Sustainability

# EFFICACY OF GREEN NUDGES ON RESOURCE AND ENERGY CONSERVATION: A SYSTEMATIC REVIEW

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**Abstract:** Rising environmental issues are now a global concern, partly due to human behavior that is generally not environmentally friendly in daily living activities, such as littering, excessive vehicle use, wasteful resource consumption, combustion of fossil fuels, and consumption of non-recyclable and non-organic products. Exploring the potential of green nudges in the conservation of resources and energy appears important. There is a shortage of global explanatory and systematic reviews in this context. An emerging behavioral change method known as "nudging" provides insight into how to influence people's decisions with choice architecture to promote pro-environmental behavior. This paper explores nudges and their influences on resource and energy conservation. The main objectives of this study are to identify various nudges for promoting resource & energy conservation. A qualitative research method is used to elicit existing conservation of resource and energy techniques and a literature review is conducted to demonstrate the effectiveness of green nudges. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020) framework was employed in this review. A total of ten eligible articles have been investigated, and the positive outcomes also captured about the efficacy of green nudges on resource and energy conservation. The strategic analysis of the ten papers chosen highlights the efficacy of green nudges as interventions to encourage resource and energy saving. Real-time feedback, incentives, societal norms, defaults, and customized approaches were discovered to be effective ways to encourage pro-environmental behavior. The conclusions have practical significance for politicians, businesses, and institutions looking to implement evidence-based methods to encourage sustainable practices and reduce environmental impacts. Contextual considerations and effective communication both play important roles in determining the effectiveness of green nudges. Future research should use more extensive, and more diverse samples, include long-term follow-up, and further investigate the cultural universality of green nudges.

**Keywords:** Energy conservation; Environment-friendly behavior; Green nudge; Resource conservation

# ASSESSING SUSTAINABLE TOURISM PRACTICES IN ANURADHAPURA HOTELS: A CASE STUDY OF MANAGEMENT, SOCIO-ECONOMIC, AND ENVIRONMENTAL IMPACTS

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**Abstract:** As global tourist arrival numbers continue to rise, there are noticeable shifts in demand and supply trends regarding sustainable tourism practices. The Sri Lanka Tourism Development Authority (SLTDA) is increasingly adopting and implementing sustainable tourism practices across various regions of the country. Anuradhapura, situated in the North Central province, is one such area where sustainable tourism practices have been put into effect. This study aims to examine the current sustainable tourism practices in the hotels of the Anuradhapura area. The research primarily focused on management, socio-economic, and environmental aspects, using the Global Sustainable Tourism Council Criteria (2013) as a model. The objectives included identifying the current sustainable tourism practices in the hotels in Anuradhapura, assessing the positive impacts of these practices on the local community, and determining the benefits that hotels derive from implementing sustainable tourism practices. To achieve these objectives, a mixed methods approach was employed, combining data from questionnaires to provide a comprehensive understanding of the subject. The results indicate that the current level of sustainable tourism practices in Anuradhapura hotels is largely categorized as encouraging. Thematic analysis further revealed nuanced insights, shedding light on specific themes within the data, such as the positive impacts on socio-cultural and economic aspects perceived by local communities. The implementation of these practices has enabled hotels to realize benefits such as providing a safe and healthy environment for their guests and employees, as well as fostering better relationships with the local community. Consequently, this study underscores the need for increased focus by management on improving their sustainable tourism practices in Anuradhapura, located in the North Central province.

**Keywords:** Anuradhapura Hotels; Environmental impacts; Management Impacts; Sustainable Tourism Practices;

# STRATEGIC APPROACHES FOR PROMOTING SUSTAINABLE TANK TOURISM IN THE HISTORIC PANDUWASNUWARA REGION

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**Abstract:** Sri Lanka stands as one of the eminent tourist destinations in South Asia, delineated by six primary tourist zones: North Jaffna, East Zone, South Coast Zone, West Zone, Central Highlands, and Rajarata. The North-Western province, however, has witnessed a gradual decline in its tourism sector over the past decade. This study endeavours to propose a strategic plan for the development of a foreign tourism industry centered around the Panduwasnuwara archaeological site. The principal aim was to identify opportunities and provide recommendations for the concept of tank tourism within Panduwasnuwara. The methodology employed in this study comprises data collection, analysis, and information dissemination. Both primary and secondary data sources were utilized, integrating questionnaires, interviews, and observational methods for primary data collection. A sample of 75 households was randomly selected to gather primary data. Within this region, an impressive count of 404 ancient tanks exists, with over 317 tanks demonstrating potential for fostering the tourism industry. Notably, 57% of individuals in the area have pursued no further education post their vocational schooling and engage in non-permanent, informal occupations. Approximately 67% of the population earns a monthly income below Rs. 50,000. Encouragingly, 71% of the sample expressed keen interest in the proposed tank tourism industry. A sustainable tank tourism industry could be established by employing manually operated boats that eschew fossil fuels and constructing tourist accommodations using temporary materials like wood, canvas cloth, and coconut fronds. Furthermore, Panduwasnuwara, Kanathalawa, Hettipola, Nagollagoda villages are specializing in pottery, coconut products, reed, and textile industries can facilitate the sale of handicrafts to foreign visitors, potentially ameliorating rural poverty. Recommendations for this initiative encompass the promotion of tanks conservation through training tourist guides, imparting foreign language proficiency, extending hospitality services, and governmental intervention to steer the youth toward this industry. This initiative also acts as a promotion for fostering the foreign tourism industry in the North-West Province.

**Keywords:** Ancient tanks; Foreign tourism; North-west province; Panduwasnuwara; Tank tourism

# **WOMEN AND WATER: A GENDERED PERSPECTIVE ON SUSTAINABLE RESOURCE MANAGEMENT IN SRI LANKA**

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**Abstract:** This research focused on the gender dimensions of sustainable water resource management in Sri Lanka, emphasizing the roles played by women in shaping the water governance in the country. Sri Lankan women are involved in various aspects of water management, from being primary users of household water to participating in agricultural activities that are heavily reliant on water resources. Their roles extend further to community-level decision-making processes related to water infrastructure development and maintenance. However, their contributions are often underrepresented and undervalued. This study highlighted the importance of actively involving women in decision-making processes related to water governance. It explores the benefits of gender-inclusive approaches, such as ensuring equal access to water resources and involving women in the planning and execution of water infrastructure projects. Gender-sensitive policies and practices are key to fostering a more equitable and sustainable water management system in Sri Lanka. Five case studies in various places, especially rural communities in the Galle District, Sri Lanka were evaluated focusing on women who are actively involved in water-related jobs like managing water resources or leading communities. Initiatives where women have taken leadership roles in local water management committees, resulting in improved access to clean water for their communities were studied. Additionally, it highlights women's involvement in sustainable agricultural practices that promote efficient water usage and crop resilience. A study found that when women led local water committees, around 80% of those committees helped communities get better access to clean water. Also, when women were involved in farming, they made water use 30% more efficient and improved crops by 25% compared to usual farming methods. The potential for women to drive positive change in this crucial sector, creating a more balanced and effective system that benefits the entire nation is envisioned.

**Keywords:** Agriculture; Empowerment; Gender; Sustainable; Water Management

# WATER MANAGEMENT STRATEGIES ADOPTED BY STAR-GRADED HOTELS IN CENTRAL PROVINCE, SRI LANKA

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**Abstract:** This research endeavors to investigate the water management strategies employed by star-graded hotels situated within Central Province, Sri Lanka, with a specific focus on the maintenance of a reliable and sustainable water supply. A qualitative research approach was used, and data collection encompassed 15 in-depth interviews conducted with executive-level managers representing a purposively selected cohort of 15 distinguished hotels in the region. Four thematic domains were identified during this investigation: The results revealed that, water is recognized as an indispensable business resource by the hotels, with an explicit emphasis placed on its strategic significance in the context of their operations. Measures are implemented to manage the potential risk of water scarcity, aligning organizational practices with the principles of sustainable water resource management. Enhancing water use efficiency and fostering a culture of water conservation emerges as a central theme within the hotel industry. This signifies a commitment to environmental responsibility and resource efficiency. Corporate water stewardship is gaining prominence as hotels increasingly advocate for sustainable water supply practices within the purview of their local communities. The implications derived from these findings highlighted the necessity of adopting a comprehensive and integrative approach to water management within the hotel sector. Such an approach extends beyond operational efficiency to encompass broader dimensions of environmental sustainability and active community engagement. In conclusion, this research makes a substantive contribution by providing valuable insights into the water management strategies employed by star-graded hotels, casting light on their evolving role as conscientious custodians of this indispensable resource. The significance of this study resides in its potential to inform and influence hotel management practices, shape policy development, and inform sustainability initiatives, all within the broader context of water resource management in Central Province, Sri Lanka.

**Keywords:** Conservation; Environment responsibility; Resource management; Sustainability; Water usage





## **5. Health and Healthy Landscapes**



# RIGHT TO BREATHE CLEAN AIR: A CRITICAL LEGAL ANALYSIS ON THE EFFECTIVENESS OF THE LAW IN ENHANCING AIR QUALITY IN SRI LANKA

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**Abstract:** The quality of the ambient air in many areas of the island has proven not conducive to a healthy environment for the people living in various areas of the island. Toxic emissions have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions, and cultural heritage. This has an adverse effect on promoting and advancing the social, economic and cultural advancement of the people. The health impacts associated with polluted ambient air fall most heavily on the poor, the old, infants, and women. Pro-contra air pollution carries not only high social, and economic cost but also environmental cost, which is seldomly borne by the polluter. It is an indisputable fact that everyone has an inherent right to an environment that is not harmful to their health or well-being. The present generation also bears the responsibility to protect and preserve a pollution-free air for future generations. This research aimed to analyze the existing national legal framework in Sri Lanka in mitigating air pollution. The research employed the black letter of the law and international and comparative methodology. The Constitution, National Environment Act, Code of Criminal Procedure Act and Conventions, and decided cases constitute the primary sources whereas the scholarly articles constitute secondary sources. The research findings emphasize that despite the fact that there is no express constitutional provision which recognizes the right to a healthy environment nor right to breathe clean air, the provisions in the National Environment Act and Code of Criminal Procedure Act adequately deal with enhancing the ambient quality of air. The research concludes both the state and the citizens have an equal obligation to preserve the quality of air not only to safeguard the interest of the present generation but also to preserve the same for the future generation since there is an inextricable relationship between the quality of air and one's health.

**Keywords:** Air pollution; Ambient air quality; Environment; Health; Pollutants

# DEFLUORIDATION OF DRINKING WATER USING HEXADECYLTRIMETHYLAMMONIUM IONS (HDTMA+) AND L-LYSINE MODIFIED ZEOLITE-NANOCOMPOSITE

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**Abstract:** High fluoride intake ( $>1.0\text{mgL}^{-1}$ ) can cause a variety of fluorosis-related diseases that are common in some tank cascade systems. However, removing excess fluoride from water is still a pressing global concern. Nanotechnological approaches, among many emerging defluoridation techniques, showed high efficiency and simplicity of usage. This study is mainly focused on the defluoridation of drinking water using the Zeolite minerals-based -nanocomposite; that is modified with hexadecyltrimethylammonium ions (HDTMA+) and L-lysine. Modified zeolites were characterized by Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), Thermogravimetric analysis (TGA), and differential scanning calorimeter analysis (DSC). Batch sorption studies were demonstrated to determine the performance of the developed Zeolite nanocomposite material, based on different parameters, such as pH, contact time, competitor anions, and initial fluoride concentration. The maximum fluoride removal was reported at an initial pH of 5.0 and 9.0 respectively for HDTMA-modified and L-lysine-modified zeolite. The maximum sorption capacity of fluoride by Langmuir isotherm was found to be  $33.40\text{ mg g}^{-1}$  and  $10\text{ mg g}^{-1}$  respectively for HDTMA-modified and L-lysine-modified zeolite. It is demonstrated that initial fluoride concentration ( $1\text{--}10\text{ mg L}^{-1}$ ) to fast fluoride uptakes at a potency of  $6.0\text{ g L}^{-1}$  for both modified Zeolite nanocomposites, and significant fluoride removal capacity with the 45-min contact time. Studies on regeneration with NaCl were effective after the 18-20 cycle of use.

**Keywords:** Defluoridation; Hexadecyltrimethylammonium ion; Nanocomposite; Regeneration; Zeolite

# REVIEW OF FIVE SELECTED UNDERUTILIZED MEDICINAL PLANTS IN SRI LANKA: TOWARDS SUSTAINABLE UTILIZATION IN HERBAL PRODUCTS

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**Abstract:** Sri Lanka boasts an exceptional biodiversity that fosters a wealth of flora with therapeutic properties. However, traditional medical practices and herbal product formulations often restrict their use to a limited number of species, and vast reservoirs of valuable medicinal plants have still been underutilized. The present review focused on evaluating five selected underutilized medicinal plants in Sri Lanka: *Agrotatum conyzoides* (Hulanthala), *Artocarpus gomezianus* (Kosgonna), *Euphorbia hirta* (Kapumkeeriya), *Plectranthus zeylanicus* (Iriweriya), and *Piper sarmentosum* (Gas Thippili). Plant species were selected based on the details of pharmacopoeias and ethnobotanical surveys. Scientific data published on ethnomedicinal uses, phytochemistry, and pharmacological properties of selected plants during the past 20 years were collected from PubMed, ScienceDirect, and Google Scholar. Then, the collected data were reviewed to determine how they could be utilized in the herbal products of Sri Lanka. It was found that these plants contain many valuable phytochemicals, including alkaloids, flavonoids, phenolic compounds, and terpenoids, that are predominantly responsible for their medicinal properties. These phytochemicals have been investigated *in vitro* and *in vivo* for various bioactivities, especially anti-microbial, antioxidant, and anti-inflammatory properties. Most of these bioactivities are in accordance with the ethnobotanical uses of these plants. It was confirmed that these plants had not been utilized mainly due to the lack of ethnobotanical knowledge and have not often been included in the pharmacopoeias. It is also shown that these plants can be utilized in a diverse array of herbal products, including novel cosmeceuticals and pharmaceuticals. Further research is needed to evaluate the clinical efficacy of these plants. In conclusion, the data analyzed in this review will aid researchers in executing more studies on the above-mentioned medicinal plants and improve their utilization. This, in turn, prevents the overexploitation of frequently used medicinal plants and thus improves the sustainable utilization of biodiversity.

**Keywords:** Bioactivities; Biodiversity; Herbal products; Medicinal plants; Phytochemicals; Underutilized

# NUTRIENT USE EFFICIENCY OF RICE AS SUSTAINABLE RESOURCE UTILIZATION TO PROTECT RICE-BASED ECOSYSTEM HEALTH IN SRI LANKA

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**Abstract:** Plant nutrients play a significant role in the growth and development of the rice plant (*Oryza sativa* L.). Today rice cultivation including those grown the tank cascade systems, is heavily dependent on chemical fertilizers. Breeding rice varieties for improved nutrient use efficiency (NUE) is one of the most feasible ways to increase grain yields without losses to the natural ecosystems. Therefore, the study focused on the root architecture enhancing the NUE of different rice varieties under nutrient-sufficient and deficient conditions. A field experiment was conducted under nutrient-sufficient and deficient conditions with 17 rice varieties with the objective of selecting rice varieties with a high number of S-type roots, which are crucial to increase the NUE of plants. The root system was studied at the panicle initiation stage from uprooted plants. Rhizotrone structure was prepared to observe and analyse the variations in root architecture. Results of root scanning indicated that the number of S-type roots was significantly higher ( $P < 0.05$ ) in nutrient-sufficient conditions compared to the nutrient-deficient conditions. In the rhizotrone study, the root system architecture of selected rice varieties was analysed and grouped into  $0^{\circ}$ - $30^{\circ}$ ,  $30^{\circ}$ - $60^{\circ}$ , and  $60^{\circ}$ - $90^{\circ}$  angles. The highest number of S-type roots in  $0^{\circ}$ - $30^{\circ}$  was observed in Bg 375. The H4 variety showed the highest number of S-type roots in  $30^{\circ}$ - $60^{\circ}$  and  $60^{\circ}$ - $90^{\circ}$  angles. The ratio between L-type roots to S-type roots of H4 at a  $60^{\circ}$ - $90^{\circ}$  angle was 1:20. The ratio between main roots to S-type roots of H4 at a  $60^{\circ}$ - $90^{\circ}$  angle was 1:175. Therefore, H4 and Bg 375 varieties have the potential to be used as parents for the breeding of rice varieties with high NUE. This research outcome will help to ensure future food security while considering safe rice-based ecosystem in the major rice growing areas in Dry and Intermediate zone in Sri Lanka.

**Keywords:** Food security; Nutrient use efficiency; Plant nutrients; Rhizotrone; Root system architecture

# ASSESSING THE NUTRITIONAL STATUS OF PRIMARY SCHOOL STUDENTS WHO LIVE UNDER MINOR IRRIGATION SYSTEMS OF MIHINTHALE DS DIVISION IN ANURADHAPURA

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**Abstract:** This study was conducted to assess nutritional status of primary school children aged 5-10 years in Mihinthale DS Division, Anuradhapura. A sample of 100 subjects was selected from all primary schools through multi-stage sampling. Anthropometric measurements were performed using standardized procedure on primary school children. Anthropometric indices such as BMI were generated. Information on socioeconomic characteristics of households and dietary patterns of children were gathered by an interview schedule, which includes a food frequency questionnaire. According to WHO classification, children shows a considerable risk for being underweight (47%), wasted (4%), overweight (8%) and obese (5%). The prevalence of severe malnutrition is higher among most students in the area due to low income and high costs of food and other goods. Among the tested individuals, 51% of children from farm families in the tank cascade systems in Mihintale were at high risk for malnutrition (underweight (47%), wasted (4%)). After analyzing the completed questionnaire and information provided by the students, 14% of them have identified nutritional diseases like vitamin A deficiency, night blindness and iron deficiency. Most of the primary school children suffer from nutritional issues such as being underweight and malnutrition in Mihinthale DS Division. Therefore effective long term food security program may need from governmental as well as non-governmental organizations targeting the primary school children such as school level nutrition related clinics, food providing programs.

**Keywords:** Anthropometric measurements; BMI; Nutritional status; Malnutrition

# UDAKKI GENERATION: A QUALITATIVE RESEARCH ON JAYAKODY GENERATION IN NUWARAKALAVIYA RELATED TO FOLK MEDICINE

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**Abstract:** The 'Udakki,' Kadawara, and Kambili deities, as percussion instruments in the Nuwarakalaviya (Anuradhapura District) region, coupled with Kolmura Kavya singing centered on deities, play a pivotal role in appeasing residual deities. This study zeroes in on the Jayakodi generation within Nuwarakalviya, a group utilizing Udakki in conjunction with folk medicine, with participants chosen through purposive sampling. Employing field study, participant observation, and interviews, the research focused on Kusumpura village, Nochchiyagama Divisional Secretariat. The investigation aimed to delve into the identity of Udakki craft within the Jayakodi generation and explore whether their folk medicine bears an inherited identity. The study elucidates the application of folk medicine in disease prevention with a sense of pride. Udakki is intricately linked to the traditional medicine of Kusumpura village, associated with occult forces. If a patient does not recover after two prescribed medicines, it is believed to be indicative of a planetary or inhuman defect, leading to the ongoing practice of Shanthi karma. The field study reveals the utilization of oils, prepared through traditional prescriptions, for various joint diseases, with 30 types of medicines in use. The Jayakody generation asserts that their inheritance of this folk medicine traces back to King Ravana. Presently, the lineage has expanded, with Kusumpura village specializing in joint medicine, Palugama village in snake medicine, and Buduruwakande temple in eye medicine. The annual milk-saving festival, celebrated for three months from the auspicious day of Nanumura to Esala Poya, involves prohibited sound offerings such as Udakki Vadana and Kolmura Shanthi karma. Villagers entrusted for this purpose participate with unwavering faith. The residents of Kusumpura village venerate the Kadavara devala, considering it a holy place second only to Kataragama, engaging in charitable services. The research concludes that the Jayakodi artisans, rather than being descended from Swadhan, represent a generation with an eclectic folk medicine, firmly rooted in a strong faith in unseen forces.

**Keywords:** Anthropology of musicology; Culture; Folk medicine; Nuwarakalaviya behaviour

# QUALITY OF THE COMPOST AVAILABLE IN THE MARKET AND POSSIBLE THREATS TO THE ENVIRONMENT OVER LONG-TERM APPLICATION

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**Abstract:** With the concept of organic farming which has been recently promoted by the government, a large number of compost products have come to the market. Even though the Sri Lanka Standards Institution has introduced quality parameters for compost, no proper monitoring system has been implemented to ensure the quality of the products. This study aimed to assess the quality of compost products available in the market and compare them with Sri Lanka (SL) Standards (ie: 1634:2019/1635:2019). Three samples from fifteen different compost products were collected randomly from the open market. Four compost products from Gampola, five products from Kandy and six products from Anuradhapura were collected for analyzing quality parameters using standard analytical methods. The results obtained from analyses were then compared with SL standards. Total N content of all 15 samples remained below the SL standard of total N (1%). The total phosphorus content of samples varied from 0.1-0.2% but none of the samples achieved SL standard of 0.5%. However, 13 out of 15 samples reached the SL standard for K (1%) and only 06 samples complied with the SL standard given for C:N ratio which ranges from 10 to 25. Ten compost products out of 15 reported higher sand percentages compared to the SLS standards indicating adulteration by adding sand. According to hazardous element analysis, the arsenic content of 11 samples has exceeded the SL standard of 3 mg Kg<sup>-1</sup>. Results revealed that any of the tested products has not satisfied the important SL standard specifications. Since the use of compost is an emerging trend in dry zone agriculture, the elevated arsenic levels of compost products could be a threat to human health and the environment of the tank cascade system as a result of long-term application. Therefore, a quality-controlling mechanism to regulate the production process is essential to maintain the quality of compost available in the market.

**Keywords:** Agricultural waste; Compost; Municipal solid waste; SLS standards

## CHALLENGES FOR SOLID WASTE MANAGEMENT IN NALLUR PRADESHIYA SABHA, JAFFNA, SRI LANKA

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**Abstract:** Solid waste management is a pressing concern in the Jaffna Peninsula, where communities often resort to improper disposal methods, such as throwing waste on public places and roads. This research aimed to identify the specific locations where solid waste is generated and the types of solid waste thereby, shedding light on the critical issues of waste management. For this analysis, a comprehensive methodology was employed. Primary data were gathered through fieldwork involving the random selection of seventy (70) sampling locations, employing field observation, photography, and direct interview techniques. Throwing locations were pinpointed with the aid of GPS technology, while the spatial distribution of these sites was mapped using ArcMap 10.4 software. Furthermore, the study also traced locations where solid waste burning occurred using GPS technology. Thirty sites for solid waste burning were discovered and distributed throughout the area, and twenty locations for solid waste disposal were randomly identified, with many concealed in environmental or secluded areas. These secluded areas were characterised by relative locations surrounded by uninhabited structures, bends in roads, T-junctions, unusable lands, and land with high wall fences. Most of these secluded locations were not easily visible to the public, with limited public access or movement. These results were visually presented through diagrammatic representations. The types of solid waste discovered were diverse and included food waste, plastics, faecal waste, non-combustible waste, and more. Many of these waste types were burnt in the same locations by local residents and many people tended to throw solid waste in the evening and night. This suggests that stricter regulations need to be enforced during these hours. The research findings indicate that addressing this issue extends beyond legislation alone. The root causes lie in the attitudes and educational levels of the population, officials and workers who collect waste. Therefore, effective waste management strategies in the Jaffna Peninsula should involve not only strict regulatory measures but also community education and awareness programmes. The findings of this study can serve as a valuable foundation for policymakers and local authorities as they work towards sustainable solid waste management practices in the area.

**Keywords:** Nallur Pradeshiya Sabha; Solid waste burning; Secluded areas; Throwing solid waste

# OVERLOOKED LEPTOSPIROSIS: A RAPIDLY EMERGING CHALLENGE FOR RURAL AGRICULTURAL COMMUNITIES IN SRI LANKA

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**Abstract:** Leptospirosis is an infectious disease that the *Leptospira* bacterium causes and spreads, typically through contact with contaminated soil or water. Farmers who are often open to soil and water in Sri Lanka are susceptible to a wide variety of leptospirosis-related clinical conditions. In 2022, there was a modest increase in leptospirosis-related fatalities, which totalled 123 deaths, and the case fatality rate (CFR) was 1.7%. Despite numerous interventions, leptospirosis is on the rise, according to national statistics. The present qualitative study was conducted to gain insight into the social factors that exacerbate the prevalence of leptospirosis in agricultural communities. In Matara district, employing a qualitative research strategy, 50 in-depth interviews were conducted over 12 months in 2022 and 2023 with physicians (5), physical health instructors (10), midwives (5), and cultivators (30) from five divisional secretariats, who reported a high number of leptospirosis cases. Five major themes emerged from the thematic analysis. Leptospirosis is associated exclusively with paddy cultivation, and its severity is often overlooked when people engage in other activities involving the environment. The disease was known by various other names representing non-real causes (including mada una, wel una, and pathal una), which concealed its true cause. Though other mammals could also transmit the disease, people still believed that rats were the only ones who could spread it. People from low-income groups relied on agriculture and were not adequately integrated into treatment referral systems. There is a close relationship between poverty and disease. Finally, this led to negative implications, such as delays in patients seeking medical attention, physicians making diagnoses, and investigations being conducted. These delays could have devastating effects on the livelihoods of agricultural households. This study concludes that leptospirosis is frequently overlooked in agricultural communities; consequently, there is a need for grassroots information-driven initiatives to prevent the spread of the disease and improve the success rate of existing policy interventions.

**Keywords:** Delays of care; Environmental factors; Grassroot interventions; Neglected disease; Poverty

# BIOACCUMULATION OF POTENTIALLY RISKY HEAVY METALS IN COMMONLY CONSUMED FRESHWATER FISH IN AMPARA DISTRICT

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**Abstract:** Fish are pivotal in ensuring global food and nutrition security, given their abundance of essential nutrients. Nevertheless, their habitats face many challenges due to the proliferation of diverse malpractices, resulting in various forms of pollution. As fish ascend through higher trophic levels within the food chain, they emerge as prominent bio-indicators of increased heavy metal contaminations. Consequently, the human body becomes particularly susceptible to heightened levels of heavy metals, leading to a spectrum of health risks. In the present study, *Oreochromis niloticus* species were collected to determine the accumulated metal content in their muscles and the impact on consumers' health risk. Fish samples were collected from the Irakkamam tank, Ampara district, which is believed to be polluted by extensive pollutants from agricultural and natural sources. The heavy metals including Cr, Pb, As, Cd, and Hg were determined using ICP-MS. The estimated daily intake (EDI), and hazard index (HI) were determined to determine the health hazard levels. The mean concentration (ppm) of Cr, Pb, As, Cd and Hg in fish muscles were  $7.98 \pm 3.03$ ,  $0.75 \pm 0.34$ ,  $0.03 \pm 0.03$ ,  $0.1 \pm 0.06$  and  $0.10 \pm 0.08$ , respectively and Cr, Cd, and Pb exceeded the recommend levels prescribed by FAO. Except for As, the EDI (mg/day/person) of all metals exceeds the recommended daily dietary allowance. Moreover, HI through consumption of *Oreochromis niloticus* is above the standard threshold of one indicating a non-carcinogenic risk to consumers. Continuous consumption of *Oreochromis niloticus* species of the Irakkamam tank may cause chronic health hazards to consumers.

**Keywords:** Aquatic foods; Health hazards; Pollution; Trace metals

# NATURE OF COMMUNITY AWARENESS ON ECOSYSTEM SERVICES OFFERED BY SIWALAKULAMA TANK CASCADE SYSTEM, SRI LANKA

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**Abstract:** Tank cascade systems play a pivotal role in maintaining ecological dynamics. However, persistent mishandling of these tanks has led to an unsustainable future. Community awareness of various ecosystem services provided by the cascade system is important to formulate an effective strategy for environmental conservation through community involvement. Hence, a study was conducted to evaluate the community awareness levels on ecosystem services of minor tank ecosystems in Siwalakulama cascade, Galenbidunuwewa Divisional Secretariat Division, Sri Lanka. Primary data were collected through a questionnaire survey using randomly selected hundred (100) farmers. The questionnaire tested the awareness of ecosystem services under the subcategories of provisioning, regulating, supporting, and cultural services provided by the tank cascades. The findings indicated that the community possesses substantial awareness (>50%) solely in relation to provisioning services, except for the conservation of genetic resources (15%). None of the tested regulatory services and cultural services had more than 50% awareness. As for supportive services, the capacity to secure livelihood is the sole service known to the majority (66%). Results elicited that the community has very poor awareness of mandatory regulatory services such as carbon sequestration ability (15%), climate regulation ability, pollination, and natural disaster mitigation (11%). A similar trend was observed for supportive services like the maintenance of the local ecosystem (19%), nutrient recycling (18%), and water cycle management (11%), where awareness was notably low. Cultural services were reported as the most unknown component of the ecosystem services of the tank cascade system. For instance, cultural services of spiritual value (11%), (11%) opportunity for recreation and tourism (11%) therapeutic value (11%) are the least known services. In conclusion, community awareness is more focused only on provisioning services though the other components also play a crucial role in sustaining the stability and productivity of agroecosystems. Therefore, it is essential to deliver well-structured awareness programs aiming at conveying the significance of all aspects of ecosystem services provided by the tank and their interconnection with the village tanks to promote the sustainable utilization of these services.

**Keywords:** Community awareness; Ecosystem services; Heterogeneity; Tank cascade





## **6. Food Security and Human Nutrition**



# A REMOTE SENSING ANALYSIS ON CROP WATER PRODUCTIVITY OF PADDY FARMING: A CASE STUDY OF KALA OYA BASIN

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**Abstract:** Sri Lanka is an agrarian country that relies on paddy cultivation in the Dry zone. Yala season determined on tank water and cascade systems have been impacted by recent drought conditions highlighting the importance of water resource management and food security. Crop Water Productivity (CWP) plays a crucial role in ensuring the equilibrium between crop yield and water consumption. This research employed Remote Sensing (RS) and Geographic Information System (GIS) to analyse the CWP of paddy in 2022-Yala season in Kala Oya basin, covering 2,873 km<sup>2</sup>, with approximately 560 km<sup>2</sup> paddy land. The study mainly used Net Primary Production (NPP) data, Actual Evapo-Transpiration and Interception (ETIa), and land use data obtained from the Wapor Portal and ESA World Cover, and occupied mapping analysis, buffer analysis, and zonal statistical analysis with the Model Builder within ArcGIS. The mapping analysis revealed that eastern, central, and western regions of the catchment in proximity to Kala Wewa, exhibited high paddy yields while the southeastern part of the basin, closer to Dewahuwa and Ibbankatuwa Wewa, demonstrated a higher CWP. Notably, central and western parts of the basin, in the vicinity of Rajangana and Angamuwa Wewa, showed optimal conditions characterised by low CWP and high yields. Moreover, a declining trend of average CWP and yield was displayed with the distance from irrigation canals and streams. Paddy yield within the canal buffer ranges from 0.166 kg m<sup>-2</sup> (100 m) to 0.159 kg m<sup>-2</sup> (500 m), while the stream buffer exhibits yield from 0.160 kg m<sup>-2</sup> (100 m) to 0.152 kg m<sup>-2</sup> (500 m). Similarly, CWP for the canal buffer varies from 0.442 kg m<sup>-3</sup> (100 m) to 0.428 kg m<sup>-3</sup> (500 m) and for the streams from 0.424 kg m<sup>-3</sup> (100 m) to 0.409 kg m<sup>-3</sup> (500 m). In conclusion, the study emphasises the significance of water source proximity, specifically tank water and cascade systems, influencing CWP and paddy yield within the Kala Oya basin. To optimise CWP in the basin necessitates an expansion of the irrigation network within cascade systems and continuous monitoring of the CWP and yield. Further, to gain a comprehensive understanding on paddy CWP within the tank cascade systems, an extended long-term spatial analysis is necessary.

**Keywords:** Crop water productivity (CWP); Kala oya basin; Paddy cultivation; Remote sensing; Yield

# REARING TURKEY BIRDS AS AN ALTERNATIVE POULTRY SPECIES TO OPTIMIZE FOOD SECURITY: FUTURE PROSPECTS TO TANK CASCADE SYSTEMS

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**Abstract:** Food security is a global concern and diversification of poultry farming provides a promising avenue to address the challenge. This desk study aims to explore the potential of rearing turkey birds as an alternative poultry species to enhance food security as well as employment in the rural community. This could be a strategic approach to strengthen the rural food security and economy. Turkey farming is a promising business idea that could be implemented in Tank Cascade Systems (TCS) to empower the rural community. Turkey birds grow faster like broilers and are ready for the table within a short time. Turkey farming is more popular for meat production than egg production. Turkey meat provides valuable proteins and vitamins and is a good source of minerals. However, turkey farming has not been fully exploited to see the production potential in Sri Lanka. They adapt to a wide range of climatic conditions and can be raised successfully with a well-fed system. The combination of basic low input-low output, subsistence level growers, and all combinations up to the large-scale commercial production, provides opportunities to minimize the poverty and malnutrition. Employment, poverty alleviation, and improved nutrition are all potential benefits that support the sustainable development of the rural setup. In that context, turkey farming is an alternative and attractive economic activity, especially for the rural women and poor population in the TCS. Food security could be optimized through increased protein availability and diversification of protein sources by incorporating turkey farming with the existing poultry production systems. Therefore, integrating turkey farming into the agriculture landscape can contribute to resilient and secure food security in the rural community.

**Keywords:** Domestic turkey; Poultry diversification; Subsistence-level growers; Turkey farming

## DEVELOPMENT OF A NOODLES PRODUCT FROM CASSAVA (*MANIHOT ESCULENTA* CRANTZ)

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**Abstract:** Cassava (*Manihot esculenta* Crantz) is a locally available root crop with different varieties. Cassava flour can be proposed as a substitute for wheat flour due to its texture and nutritional composition. Wheat flour is used as the major gluten source for manufacturing of noodles. Due to the gluten related health conditions; celiac disease, non-celiac disease, wheat allergies, this research aimed to develop a noodle using locally available cassava flour in place of wheat flour and develop the standard parameters for Cassava Noodles (CN). According to the previous research records, Kirikawadi variety is selected for noodles preparation due to its low-level toxicity in long-term use with short-term harvesting period. The production method of cassava noodles with encouraging results was selected using different procedures. The standard parameters of textural characters based on Texture Profile Analysis (TPA), cooking loss, and water uptake were analysed for the CN products and compared with Wheat Normal Noodles (WNN) and Wheat Instant Noodles (WIN). Gluten and Cyanide content levels of CN were also analysed. The results of the TPA showed that CN performed high quality standards on hardness ( $89.8 \pm 1.64$ ), adhesiveness ( $0.083 \pm 0.05$ ), springiness ( $2.13 \pm 0.45$ ), cohesiveness ( $0.44 \pm 0.09$ ), Gumminess ( $39.36 \pm 7.98$ ) and chewiness ( $0.84 \pm 0.30$ ) compared with WNN ( $96.93 \pm 37.83$ ,  $0.09 \pm 0.07$ ,  $2.69 \pm 0.63$ ,  $68 \pm 41.75$ ,  $1.95 \pm 1.56$ , respectively). Cassava noodles exhibited high value of cooking loss ( $17.47 \pm 0.01\%$ ) compared with WNN ( $5.28 \pm 0.00\%$ ). Consequently, the incorporation of food additives such as binding agents and other food ingredients holds the potential to enhance the quality of CN by reducing cooking loss. Water uptake of CN showed a lower value ( $105.30 \pm 0.164\%$ ) compared with WNN ( $130 \pm 0.0\%$ ) and no significant difference ( $P > 0.05$ ). Gluten and cyanide content also not detected in developed CN. This study established the standard parameters of CN, emphasizing cassava flour as a substitute for wheat flour and ensuring the harmonization of Sri Lankan root crops with human well-being.

**Keywords:** Cassava noodles; Development procedure; Standardization; Wheat noodles

# EFFECT OF FOLIAR APPLICATION OF SALICYLIC ACID ON GROWTH AND YIELD OF SELECTED TOMATO (*SOLANUM LYCOPERSICUM* L.) CULTIVARS

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**Abstract:** Tomato is a widely grown, high-demand vegetable in Sri Lanka. Despite the increase in tomato growing area, the improvement in quality and yield is still negligible. This study aimed to determine the effects of foliar application of salicylic acid on the growth and yield of selected tomato cultivars. The pot experiment was conducted in a greenhouse. It was laid out in a complete randomized design in factorial arrangements with twenty replications. Certified seeds of Lanka sour and Thilina were sown in nursery trays, and healthy seedlings were transferred to pots after three weeks. The treatments consisted of three concentrations (150, 200, and 300 ppm) of salicylic acid and the control (deionized water). Foliar applications were applied to the plants during the vegetative, flowering, and ripening stages of the plants twice at one-week intervals. The results showed that there was no interaction effect ( $P < 0.05$ ) on vegetative growth of the cultivars. However, a significant difference was observed between the concentrations in the vegetative growth. The highest dry weight ( $1.98 \pm 0.29$  g) and chlorophyll content index ( $17.08 \pm 0.29$ ) were obtained with 150 ppm salicylic acid. The lowest dry weight ( $0.62 \pm 0.25$  g) and chlorophyll content index ( $11.08 \pm 0.01$ ) were obtained with 300 ppm salicylic acid. However, there were significant ( $P < 0.05$ ) interaction between cultivars and salicylic acid concentrations on yield components and yield. The highest fruit number ( $28 \pm 0.3$ ), single fruit weight ( $186 \pm 1.2$  g), and yield ( $5.1 \pm 4.6$  plant  $\text{kg}^{-1}$ ) were obtained from the Lanka sour at the concentration of 150 ppm. The lowest fruit number ( $17 \pm 0.1$ ), single fruit weight ( $65 \pm 0.2$  g), and yield ( $1.5 \pm 0.7$  plant  $\text{kg}^{-1}$ ) were obtained from the Thilina cultivar with 300 ppm concentration. Hence, it could be concluded that the use of the Lanka sour cultivar and foliar application of salicylic acid at 150 ppm should be encouraged for tomato production to obtain higher growth, yield components, and yield.

**Keywords:** Foliar application; Salicylic acid; Tomato; Yield

# NUTRITIONAL PROPERTIES AND THE IMPORTANCE OF UNDERUTILIZED VEGETABLES IN SRI LANKA

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**Abstract:** Sri Lanka faces the dual challenge of food insecurity and malnutrition. In this context, the nutritional importance of underutilized vegetables (UUVs) cannot be understated. Present study addresses the question on nutritional profiles of UUVs commonly found in Sri Lanka and their potential to eradicate nutrient deficiencies and improve overall dietary quality. A survey was conducted representing randomly selected 50 families as sample population, in Harispattuwa Divisional Secretariat (DS) of Kandy District *via* a questionnaire to collect information on UUVs, and their awareness on nutritional properties. Above DS was chosen for research due to its emphasis on suburban UUVs, contrasting with the numerous studies conducted in rural areas. Five vegetables; “Maila” [*Bauhinia racemosa* (L.)], “Kaluala kola” [*Colocasia esculenta* (L.)], “Karan Koku” [*Acrostichum aureum* (L.)], “Kara” [*Canthium coromandelicum* (Burm.f.)] and “Mella” [*Olax zeylanica* (L.)] were reported as the rarely consumed vegetables indicated by 2-6% of lower responses. Protein, carbohydrate and crude fibre contents were determined using Bradford assay, Phenol-sulphuric acid and Weende methods, respectively. Elemental analysis was done using AAS method. The protein content was highest in “Kaluala kola” (8%) compared to the commonly consuming vegetables like pumpkin (1%), leeks (2%) and green beans (2%) as per literature. Carbohydrate contents were significantly high in “Karan koku” (19%) in contrast with carbohydrate amounts in commonly consuming vegetables like “Gotukola” (7.03%), “Katuru murunga” (9.81%) and “Mugkunuwanna” (10.76%). Higher crude fibre was recorded for “Mella” (69%) relative to the availability of it in common vegetables like carrot (3%) and drumstick (3%). “Maila” (488 mg/100g), “Kaluala kola” (295 mg/100g) and “Karan koku” (192 mg/100g) respectively showed high content of Ca, Fe and K. Integrating UUVs into the Sri Lankan diet augments nutrient intake.

**Keywords:** Carbohydrate; Crude fibre; Mineral; Protein

# IMPACT OF PROCESSING CHAIN ON QUALITY PARAMETERS IN BLACK PEPPER (*PIPER NIGRUM* L.)

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**Abstract:** Black pepper (*Piper nigrum* L.) is an important spice crop in the tank cascades systems in the intermediate zone of Sri Lanka. Maintaining the quality of black pepper products is challenging as quality and safety of foods are influenced by various pre and postharvest factors. Postharvest factors are controlled by humans, thus inadequate management can lead to a cascading impact throughout the entire pepper value chain. Present study aims to investigate the influence of diverse processing methods in black pepper processing chain on key quality parameters. The three-factor factorial completely randomized experimental design involves the examination of three threshing methods (Hand threshing, Foot threshing, Machine threshing), two blanching techniques (Blanching, without blanching), and two drying methods (Solar drying and Machine drying) as distinct treatments with triplicates. The assessed parameters encompass fungal infection rate, piperine content, oil content, moisture content, and colour. Results indicate that hand-picked samples exhibit notably lower fungal infection rates, signifying this method as preferable due to minimal damage to pericarp. Blanching and machine drying emerge as optimal practices for preserving overall quality. Notably, piperine content rises with blanching, while machine-dried samples demonstrate decreased piperine content attributed to elevated temperatures during drying. Hand threshing demonstrates a negative correlation with oil content, whereas both blanching and machine drying positively impact oil content. Moisture content remains unaffected by the various treatments. Blanching significantly influences colour, while machine drying being favoured over sun drying. In conclusion, the study recommends the adoption of blanching and machine drying as effective strategies for sustaining high-quality attributes in black pepper processing.

**Keywords:** Black pepper; Blanching; Drying; Quality parameters; Threshing

# PROSPECTS AND CHALLENGES IN DEVELOPING THE SEAWEED INDUSTRY IN SRI LANKA; A SWOT-PESTEL ANALYSIS

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**Abstract:** The seaweed industry in Sri Lanka is an emerging sector that can significantly impact the country's economy. This study attempts to find the prospects and challenges of developing the seaweed industry in Sri Lanka. Primary data were collected from 50 randomly selected seaweed farmers in the Valaipadu area (Kilinochchi district) and key informants from public and private companies by using semi-structured questionnaires, focus group discussions, and interviews. Strengths, Weaknesses, Opportunities, and Threats (SWOT) and Political, Economic, Social, Technological, Economic, and Legal (PESTEL) analyses were conducted. TOWS matrix was developed to formulate strategies to improve industry performance. The results found that abundant natural seaweed growing areas with commercially important seaweed species is the most prominent strength for developing the industry. Scarcity of good quality parental plant materials and pollution in production areas are the industry's greatest weakness. PESTEL analysis indicate positive political support with beneficial government policies, though regulatory challenges emerge during shifts in governance. Economic potential is identified in rising demand and export prices, yet concerns arise from market fluctuations and increased transportation costs. Socially, the coastal community displays positive interest, but challenges include resource exploitation and mismanagement of government funds. Technology-wise, government support exists, yet issues include underutilized research and development findings and concerns about equipment durability. Climatic conditions favour cultivation in the North, while challenges in the South involve high mitigation costs and pest threats. Legal requirements for industry entry are recognized, but issues include the absence of quality standards, insurance, and safety precautions. This study suggests developing value-added products to meet emerging demand, implementing the research findings effectively, and collaborating with private and public organizations for the development of the industry.

**Keywords:** PESTEL analysis; Seaweed industry; SWOT analysis; TOWS matrix

# COMPARISON OF PHYSIOCHEMICAL PROPERTIES OF VIRGIN COCONUT OIL AND WHITE COCONUT OIL FROM COCONUTS GROWN IN NORTH WESTERN PROVINCE, SRI LANKA

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**Abstract:** Physiochemical properties of oils depend on the quality of the raw material and the extraction method. White coconut oil (WCO) and virgin coconut oil (VCO) which are extracted by different extraction methods are widely used in Sri Lankan cuisine and in folk medicine. The study aimed to determine the physiochemical properties of WCO and VCO and to evaluate the effects of extraction methods on the quality of coconut oils. Mature coconuts of the 'Tall' cultivar from plantations in North-West were used in oil extraction. Unrefined VCO and WCO were extracted from fresh coconut kernel and copra, respectively using small-scale oil expellers. Fatty acid profiles, colour, refractive index (RI), relative density (RD), free fatty acid content (FFA), moisture, and peroxide values (PV) were determined according to the Sri Lankan Standards 313: Methods for analysis of vegetable fats and oils. Statistical analysis was performed using 2- sample t-test. The extraction method had a significant influence on the physiochemical properties of WCO and VCO. The fatty acid composition of WCO and VCO were similar ( $P > 0.05$ ). White coconut oil had a higher colour index than VCO ( $9.67 \pm 2.82$  vs.  $0.77 \pm 0.23$ ,  $P < 0.01$ ), probably due to extraction of copra with the testa intact. Free fatty acid content, PV and moisture content were higher in WCO when compared to VCO ( $0.39 \pm 0.12$  vs.  $0.08 \pm 0.02$ ,  $0.19 \pm 0.01$  vs.  $0.00 \pm 0.00$ ,  $0.13 \pm 0.02$  vs.  $0.06 \pm 0.01$ ), respectively ( $P < 0.05$ ). Results indicated a lower oxidative stability, increased acidity and initiation of oxidation in WCO. The low moisture content of VCO indicated a longer shelf life and the potential to naturally preserve. No significant differences were observed between RI and RD. All values of both oils except the colour index of WCO complied with SLS standards. In conclusion, based on physiochemical properties, VCO is superior in quality to WCO. Coconut being a main agricultural produce of Sri Lanka, promotion of more beneficial and productive practices in processing of coconut for human nutrition is emphasized.

**Keywords:** Coconut oil; Extraction methods; Physiochemical; Unrefined

# EFFECT OF DIFFERENT PLANTING METHODS ON PLANT GROWTH, GRAIN YIELD AND SEED QUALITY OF VARIETIES OF FINGER MILLET (*ELEUSINE CORACANA*)

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**Abstract:** Finger millet is a climate resilient rainfed crop; its production remains low due to the varietal selection and poor establishment methods. A field experiment was conducted during the Yala season of 2023 at Agriculture Research Station, Thirunelvely to investigate the effects of different planting methods on plant growth, grain yield and seed quality parameters of different varieties of finger millet (*Eleusine coracana* L.). The experiment was laid out in a split plot design with nine treatment combinations namely broadcasting, line sowing and transplanting with three varieties such as Rawana, Oshadha, and Local and replicated three times. Significant differences between means were evaluated by Duncan's multiple range test. Results on transplanting methods significantly ( $P < 0.05$ ) influenced the growth and yield of finger millet. The highest number of tillers (3 nos) per hill was observed in transplanting method followed by line sowing (2 nos) and lastly broadcasting (1 nos). The highest number of ears was produced in transplanting method (4) and the lowest (2) in the broadcasting and line sowing. Transplanting scoring the highest (4) and broadcasting and line sowing the lowest (2). Regarding grain yield, the highest yield was in Rawana variety ( $3.87 \text{ t ha}^{-1}$ ) whilst Oshadha and Local showed the yield of  $3.07 \text{ t ha}^{-1}$  and  $1.9 \text{ t ha}^{-1}$ , respectively. The highest yield of  $3.71 \text{ t ha}^{-1}$  was observed in transplanting method and line sowing and broadcasting showed  $2.74 \text{ t ha}^{-1}$  and  $2.39 \text{ t ha}^{-1}$ , respectively. It can be concluded that cultivating Rawana variety under transplanting method was more appropriate to obtain a higher ear number, tiller number and grain yield in finger millet. Which will help to enhance the economy and health status of low-income farmers.

**Keywords:** Finger millet; Grain yield; Plant growth; Planting methods; Seed quality; Varieties

## USE OF VERMITEA AND DILUTED CATTLE URINE AS A NUTRIENT SOURCE FOR CHILLI (*CAPSICUM ANNUM* L.)

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**Abstract:** Chilli (*Capsicum annum*) is one the most economically important cash crops grown in the tank cascade systems of Sri Lanka. It is prominent in the diet and add flavour and pungency to various foods. This study was carried out at the District Agricultural Training Center, Thirunelvely, Jaffna, from February to May 2023. The aim of this study was to assess the effect of Vermitea and diluted cattle urine as a fertilizer on the growth and yield of chilli. The research included three replicates and five treatments: T1-Vermitea, T2-Diluted cattle urine, T3- Vermitea: Cattle urine 2:1 ratio, T4- Vermitea: Cattle urine 3:1 ratio and T5- Control. The KA2 chilli variety was cultivated to test the efficiency of Vermitea and Diluted cattle urine organic fertilizer. The data collected for growth performances included the height of the plant, number of leaves, number of branches, leaf length, leaf width, number of flowers, number of fruits, length of fruit and fruit weight per plant and yield performance for different plant parameters. The data were assessed through ANOVA. Among all five treatments, T4 (VT:CU, 3:1) was highly effective among tested organic fertilizers. The T4 treated plants recorded significantly higher values for the number of leaves, number of branches, number of flowers per plant (23.40), number of pods per plant (19.33), and yield per plant (116.6 g) than control (15.87 g). According to these results, chilli could be successfully cultivated with high productivity among five treatments by applying Vermitea: Cattle urine 3:1 as organic fertilizer. Based on the findings of this work, the use of Vermitea: Cattle urine 3:1 as a growth and yield enhancer to improve the productivity of small-scale farmers could be recommended.

**Keywords:** *Capsicum annum*; Diluted cattle urine; Organic fertilizer; Plant growth and yield; Vermitea

## DEVELOPMENT OF A PROTOCOL FOR COCONUT SUGAR PRODUCTION USING TAPPING SAP

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**Abstract:** Coconut sugar is one of the most economically valued products and a sweetener ingredient. Increasing threats of diabetes, obesity, hypertension, and heart diseases have become real concerns for many people due to the high consumption of sugar in food, beverage, and confectionery products. Due to an increased interest in healthy diets, people try to replace conventionally refined sugar. Consequently, the demand for alternative sweeteners is growing. Coconut inflorescence sugar benefits from this trend and is conquering European grocery stores and kitchens. This study was conducted as a development of a protocol for coconut sugar production using tapping sap. Fresh good quality coconut tapping sap was used to develop coconut sugar. Therefore, the freshness of the tapping sap was tested at 6-hour intervals. The temperature was tested for the production of coconut sugar. There was one treatment and two control samples. Newly produced coconut sugar was tested against brown cane sugar and marketed coconut sugar. The physicochemical properties, sensory properties and consumer acceptance were tested in all samples. Sensory evaluation was done using a five-point hedonic scale using 30 untrained panellists. From the sensory evaluation, novel product with 100% coconut tapping sap sugar was selected as the best. The same was ranked as the best in taste compared to the marketed coconut sugar and brown cane sugar. The finding demonstrated that there is a high possibility and potential of producing coconut sugar using coconut tapping sap.

**Keywords:** Coconut sugar; Physicochemical properties; Production protocol; Sensory properties; Tapping sap

**A NOVEL MARSHMALLOW FROM UNDERUTILISED  
*DIOSCOREA ALATA* (DANDILA), *SONNERATIA CASEOLARIS*  
(MANGROVE APPLE) AND  
*LIMONIA ACIDISSIMA* (WOOD APPLE)**

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**Abstract:** Enhancing the nutritional value of confectionary foods is a global requirement. Using underutilized crops for novel confectionery enables solutions for food shortages and opens up avenues for unprivileged communities to enter the food industry. This paper presents the results of nutritionally enhanced marshmallows using underutilized *Dioscorea alata* (Dandila), *Sonneratia caseolaris* (Mangrove apple), and *Limonia acidissima* (Wood apple) and made without added glucose syrup. Two flavors were developed using 80% boiled *D. alata* combined with 20% *S. caseolaris* and *L. acidissima*. A semi-trained panel (n=13) ranked the products using a seven-hedonic scale. Physical and chemical parameters, proximate composition, shelf life, antioxidant activity, flavonoids, phenols, HPLC sugar content were analyzed for the most preferred flavour. Results indicated a significantly higher customer preference for novel marshmallows over commercially available marshmallows. Further, results showed no significant differences in taste, aroma, colour, and consumer acceptability between the two distinct flavours of the mangrove apple and wood apple. Mangrove apple marshmallow was selected as the most preferred flavour. Mangrove apple-enriched marshmallows exhibited significantly higher nutritional values than commercial counterparts, with lower sugar ( $31.69 \pm 0.92\%$ ) and carbohydrate ( $47.4 \pm 0.51\%$ ) content, and increased crude protein ( $8.30 \pm 0.51\%$ ), crude fiber ( $1.10 \pm 0.03\%$ ), total phenol ( $0.20 \pm 0.01$  mg/GAE g DW), flavonoid ( $6.83$  mg/Rutin 100g DW), and total antioxidant capacity ( $0.13 \pm 0.01$  TE mg/g). A 10 g of developed marshmallow contained fructose of  $0.41 \pm 0.00$  mg, sucrose of  $2.88 \pm 0.10$  mg, and glucose of  $0.54 \pm 0.08$  mg. The marshmallows had a similar texture to commercial marshmallows and could be stored at room temperature for up to 5 days or refrigerated for up to one month without significant color or texture variation. This new marshmallow could be commercialized for the confectionery industry.

**Keywords:** Antioxidant capacity; *Dioscorea alata*; Marshmallow; *Sonneratia caseolaris*; Underutilized crops

# ANALYSIS OF PADDY PRODUCTIVITY AND WATER USE EFFICIENCY OF *PERIYA KALILLUPAI* TANK IN THE *KATTARU* TANK CASCADE SYSTEM

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**Abstract:** Sri Lanka's paddy production plays a pivotal role in ensuring food security while supporting the livelihoods of the rural communities. Paddy is one of the leading water consumers globally, and there is a looming concern that the average water use for paddy cultivation in Sri Lanka is almost twice that of other rice-growing countries. Sri Lanka has almost exhausted its irrigation potential, and the prospects of developing additional land and water resources for irrigation are limited. There is little or no choice but to increase yields to meet its growing food demand. In light of these challenges, the government's ongoing efforts to modernize agriculture and enhance irrigation infrastructure remain crucial for the sustainable growth of the paddy sector in Sri Lanka. However, the impact of climate change has introduced new obstacles to paddy cultivation in various regions across the country. Addressing these issues necessitates an increase in paddy productivity and water use efficiency. This study examines the variability in paddy productivity within the 53-hectare command area of the Periya Kalillupai tank and evaluates the efficiency of water use. Data on seasonal paddy production, rainfall, temperature, tank water levels, and evaporation were collected. Results revealed that the average water use efficiency during the Yala and Maha seasons were 5.65 kg m<sup>-3</sup> and 4.35 kg m<sup>-3</sup>, respectively. The average paddy productivity of the Yala and Maha seasons were 4.126 mt ha<sup>-1</sup> and 3.439 mt ha<sup>-1</sup>, respectively. However, it is concerning that both paddy productivity and water use efficiency showed a decreasing pattern under the Periya Kalillupai tank. Therefore, it is imperative to emphasize the urgent need for improving water use efficiency and paddy productivity. This can be achieved through cultivating drought-tolerant rice varieties, rehabilitating irrigation structures, and adopting efficient water management techniques. These measures can potentially enhance water use efficiency, ultimately ensuring the sustainability and growth of paddy production in Sri Lanka.

**Keywords:** Climate change; Irrigation; Maha season; Paddy production; Yala season





## **7. Integrative Approaches and Emerging Technologies**



# ASSESSING THE COASTAL HAZARDS USING UAV IN THE EASTERN COAST OF AMPARA DISTRICT, SRI LANKA

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**Abstract:** Coastal hazards such as erosion, tsunami, sea level rise, and storm surges are major challenges to the coastal community and to the sensitive coastal environments including the estuarine areas of major rivers, emptying into the sea in which frequent monitoring is pivotal for conservation measures. Therefore, this study attempts to monitor the short and long-term shoreline and estuarine changes and to assess the coastal hazards using the Unmanned Aerial Vehicle (UAV) in the Oluvil coastal area in Ampara district. Severe coastal erosion of the Oluvil beach and its associated hazards were mapped using the UAV which was hovered over the shoreline at 100 m altitude with the 2.73 cm px<sup>-1</sup> Ground Sampling Distance (GSD). An orthomosaic imagery was created using the structure from motion (SfM) processing technique using the Agisoft Metashape software. Google Earth (GE) historical images were used to find out the previous state of the shoreline and the Digital Shoreline Analysis System (DSAS) tool was used to find the Linear Regression Rate (LRR) and End Point Rate (EPR) for assessing the beach shift and associated hazards. The LRR and EPR were recorded as -16.8 m year<sup>-1</sup> to -17.8 m year<sup>-1</sup> and -15.5 m year<sup>-1</sup> to -17.7 m year<sup>-1</sup>, respectively at the Gal-Oya estuary and its southward coastal strip. According to the LRR and EPR findings, 2023 UAV imagery in short-terms showed severe shoreline dynamics compared to 2006 and 2014 GE imagery. When observing during the field visit, several hazardous zones were spotted as a result of severe erosion which were highlighted using the UAV imagery. In conclusion, the shoreline movement and coastal erosion raised alarms of loss and gain in Oluvil beach suggest that the present shoreline changes should be mitigated with integrated coastal zone management (ICZM) plans to conserve the coastal community and the environment.

**Keywords:** Coastal hazard; Digital shoreline analysis system (DSAS); Google earth imagery; Shoreline change; Unmanned aerial vehicle (UAV)

## DESIGN OF A TWO-WHEEL TRACTOR COUPLED FODDER CHOPPING MACHINE

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**Abstract:** *Gliricidia* (*Gliricidia sepium*) and Mexican sunflower (*Tithonia diversifolia*) are readily available fodder sources in Sri Lanka. They are used to enhance the nitrogen and phosphorus content in compost by incorporating tender leaves and stem cuttings into the compost feedstock. However, farmers are unwilling to use tender stems due to mixing difficulties and the slow decomposition rate. Thus, there was a necessity to reduce the size of tender stems before adding them to the feedstock. Consequently, this study aimed to design a two-wheel tractor coupled fodder chopping machine that enhances the efficiency of the composting process and is a feasible method for small and medium-scale composters in Sri Lanka. The machine comprises a feeding tray, chopping chamber, chopping assembly, power transmission system, and outlet. Size and the shape of the machine components were designed according to the physical properties of *Gliricidia* and Mexican Sunflower. The feeding tray was designed as a shortened rectangular-based pyramid with a slant angle of  $38^\circ$ , enabling the simultaneous feeding of a minimum of five *Gliricidia* tender stems. The chopper assembly was composed of two blades with a flywheel which was mounted on a shaft. Power was designed to be transferred from the tractor's flywheel (4.85 kW) to the chopper assembly shaft by means of a belt and pulley system. Blades at 900 rpm were designed to achieve a maximum mean cutting length of 19 mm. Furthermore, the theoretical capacities of the machine were designed as  $40.12 \text{ kg h}^{-1}$  and  $29.72 \text{ kg h}^{-1}$  for *Gliricidia* and Mexican sunflower, respectively. Therefore, the potential exists for this machine to evolve into a two-wheel tractor-coupled fodder-chopping machine.

**Keywords:** Compost; Fodder chopper; *Gliricidia*; Mexican sunflower; Tender stems

# PRODUCTION OF BIOETHANOL FROM PINEAPPLE FRUIT PEEL WASTES (*ANANAS COMOSUS*) USING *SACCHAROMYCES CEREVISIAE*

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**Abstract:** The production of bioethanol from diverse peel wastes of underutilized fruits could be one of the alternative fuel systems. The objective of the study was to determine the effect of culture conditions and media composition to increase the bioethanol yield from pineapple peel using baker's yeast. The fruit peel juice of pineapple (*Ananas comosus*) was inoculated with *Saccharomyces cerevisiae* (baker's yeast- 2 gL<sup>-1</sup>) in the fermentation media (total volume 100 mL), pineapple fruit peel wastes (10g/100mL) composed of 10 gL<sup>-1</sup> yeast extract, 10 gL<sup>-1</sup> KH<sub>2</sub>PO<sub>4</sub>, 2 g L<sup>-1</sup> (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, 2 g L<sup>-1</sup> Peptone and 0.5 g L<sup>-1</sup> of MgSO<sub>4</sub>•7H<sub>2</sub>O and allowed for fermentation for 12 hours at room temperature. The ethanol produced from the pineapple fruit peel waste mixture was 0.30% (V/V) at room temperature after 12 hours of fermentation. The conditions were optimized sequentially by changing one factor at a time while keeping the other variables constant. Significantly higher bioethanol yield [5.0 times, 1.5% V/V (P<0.05)] was obtained from pineapple peel waste at the following optimal conditions of 12 hours of incubation period, 5:1 ratio between air space and fermentation solution, 1.5 g L<sup>-1</sup> of yeast inoculum, 10 g 100 mL<sup>-1</sup> of pineapple fruit peel, 0.5 g 100 mL<sup>-1</sup> soybean powder and 60 mL 100 mL<sup>-1</sup> of diluted sulfuric acid. When the pH of the medium was changed from 3.0 – 8.0, a significantly higher ethanol yield (2.8%) was obtained when the pH of the media was kept at 5.0. Thus, bioethanol yield was significantly increased by 9.34 times, (2.8%) when fermentation conditions of pineapple peel waste by yeast were optimized. Therefore, pineapple peel waste could be recommended as a good source for bioethanol production using yeast.

**Keywords:** Baker's yeast; Fermentation; Optimized conditions; Powdered soybean

## EFFECTS OF GAMMA IRRADIATION ON YIELD CHARACTERISTICS OF GROUNDNUT

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**Abstract:** Groundnut is a key field crop in the tank cascade systems of in the dry zone of Sri Lanka. It is a main source of protein and a source of income for smallholder farmers. Groundnut has little diversity and self-pollinates. Therefore, standard breeding techniques can only improve groundnut cultivars to a certain point. Therefore, this study was conducted to examine the effect of gamma irradiation on the yield characteristics of groundnut. The field experiment was conducted from July 2022 to October 2022 at the Crop Farm, Eastern University of Sri Lanka. Groundnut seeds were exposed to Gamma irradiation using a "Gamma chamber 1200 Cobalt- 60" research irradiator. Treatments such as 0Gy (T1), 100Gy (T2), 200Gy (T3), 300Gy (T4), 400Gy (T5), and 500Gy (T6) were used in this experiment. Seedlings from treated seeds were transplanted in an open field after being planted in poly bags with rooting media. Treatments were laid out in a randomized complete block design with five replications. Yield parameters such as number of pods, fresh weight of pods, 100 seed weight, and total yield were recorded. The recorded data were analyzed using ANOVA and the Duncan multiple range test was used to compare the treatment means at a 5% significant level. The study revealed that there was a significant difference ( $P<0.05$ ) among the different levels of gamma irradiation and treatment T3 (200 Gy) showing significantly increased number of pods (47%), fresh weight of pods (28.8%), dry weight of pods (41.4%), 100 seed weight (47.7%) and total yield (65.6%) compared to control. Therefore, based on the above results, the treatment T3 (200 Gy) is the best to improve the yield of groundnut (var. Indi).

**Keywords:** Crop improvement; Gamma chamber; Gamma irradiation; Groundnut

# ADVANCING ECOLOGICAL CONSCIOUSNESS IN THE CONSTRUCTION INDUSTRY: UTILISING ENVIRONMENTALLY SUSTAINABLE BRICKS TO PROMOTE A SUSTAINABLE FUTURE

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**Abstract:** The production of conventional bricks has historically been a fundamental aspect of the construction industry. The clay mining in Thaula area of village tanks have some devastating impacts on the sustainability of the tank cascade systems. This study aimed to identify alternative materials that can serve as substitutes for sustainable brick production. This investigation focused on waste materials, including industrial, sludge, coal ash, plastic, and glass wastes. These materials are being studied because of the potential to reduce the environmental impact of brick manufacturing. A comprehensive review was conducted, research from academic journals on sustainable bricks from previous five decades to 2023. An essential component of the study focuses on analysing the proportions of various waste materials in the manufacturing process. The analysis revealed considerable variation in the optimal ratios of waste materials, likely influenced by their distinct chemical compositions. The essential characteristics of these sustainable bricks are their compressive strength and water absorption. The firing methods continue to be the main approach in brick manufacturing. The study also investigates alternative techniques such as calcium-silicate-hydrate (CSH) and geopolymer-based bricks. These alternatives have the capacity to decrease energy usage, thereby aligning with the necessity to diminish the construction sector's carbon footprint. Sustainable bricks have the potential to tackle the urgent environmental concerns associated with the production of traditional bricks. By studying alternative manufacturing techniques, particularly those that eliminate the use of cement or lime in the production of calcium silicate hydrate (CSH) bricks, the sustainability of the brick industry can be further improved. The shift towards integrating sustainable bricks into large-scale industrial operations is a complex undertaking, requiring meticulous deliberation and cooperation among all parties involved. It functions as a vital endeavour that fosters an environmentally conscious and responsible construction sector.

**Keywords:** Brick manufacturing; Carbon footprint reduction; Environmental impact; Green construction; Sustainable bricks; Waste materials

# BIOFERTILIZER USAGE FOR SUSTAINABLE AGRICULTURE – REVIEW OF CHALLENGES AND STRATEGIES

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**Abstract:** Ever increasing demand for food essentially increases the volume of fertilizer application globally in the agricultural sector. At present, the annual global consumption of chemical fertilizer in agriculture amounts to 200 million metric tons. Toxic compounds present in chemical fertilizer leads to contamination of food, feed, and water bodies, and land deterioration, including soil infertility and ecosystem disruptions affecting food security, human health, and well-being. Additionally, chemical fertilizer production depletes finite natural resources. Therefore, there is a growing interest in replacing them with biofertilizers composed of living microorganisms as an efficient, environmentally friendly alternative. Biofertilizers improve plant growth and development by increasing nutrient availability through nitrogen fixation and solubilizing phosphorus, potassium, sulfur, and other micronutrients. Furthermore, they reduce the water contaminations in tank cascade systems and improve soil health and quality of yield while protecting plants from both biotic and abiotic stresses with using the secretions of microorganisms. Since tropical climates are more conducive for microorganisms, the use of biofertilizers become more attractive in tropical countries including Sri Lanka. However, despite the numerous advantages of biofertilizers, their low nutrient content, limited shelf life, lack of timely availability of microbial cultures and carrier materials, inadequate awareness, and poor technical know-how for application are the identified challenges. Overcoming these challenges involves enriching microbial growth by adding green manure, wood ash, and plant residues to provide essential nutrients. Additionally, extending the survival and effectiveness of microorganisms can be achieved through the use of vacuum packaging and frozen storage. Furthermore, it is crucial to adopt site-specific applications that incorporate a mixture of microbial strains, taking into account the knowledge of soil ecology to attain synergistic effects with biofertilizers. The implementation of governmental policies as well as the improvement of research and infrastructure facilities are critical for promoting biofertilizers as a sustainable tool for achieving food security.

**Keywords:** Food security; Human health; Microorganisms

# DESIGN AND IMPLEMENTATION OF AN OPEN ACCESS ECO-INFORMATICS PLATFORM FOR BIODIVERSITY CONSERVATION AND ECOSYSTEM MANAGEMENT

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**Abstract:** Eco-informatics plays a vital role in ecological research, biodiversity conservation, and sustainable ecosystem management. It is a combination of information technology and environmental science. This framework enables to generation of new knowledge through innovative tools and by the collection, integration, and dissemination of ecological data from various sources. The objective of this research was to design and implement an eco-informatics web-based system by collecting biodiversity, environmental, remote sensing, historical, population, and community dynamics data. The methodology includes several key steps as platform development, data governance model, data integration, data visualization, collaboration features, and community engagement. The flexibility of this platform allows researchers, ecologists, and conservation practitioners to upload, store, and manage their ecological data from different ecosystems. To establish a robust data governance model that effectively addresses data privacy, intellectual property, and ethical considerations while fostering open access and responsible data sharing, the platform will combine datasets from various sources to create comprehensive ecosystem assessments. The implementation will include data visualization tools, empowering users to generate customizable and easily shared maps, graphs, and other visual representations of ecological data. Additionally, collaboration features like discussion forums, project management tools, and user profiles will be integrated into the platform. Through this approach, the platform aimed to indicate several important outcomes. Those are enhanced collaboration, data-driven and informed decision-making, community empowerment, and improved data sharing. This platform is capable of providing data on its usage and can be implemented in field research.

**Keywords:** Collaboration; Eco-informatics; Ecological data; Ecosystem; Platform

# ISOLATION AND IDENTIFICATION OF ROCK PHOSPHATE SOLUBILIZING BACTERIA FROM A PINE FOREST SOIL CULTURE

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**Abstract:** Phosphorus (P) is one of the essential plant nutrients which is required to be abundant for plant growth and production. Plant-available P depends highly on the soil pH level. Under alkaline conditions, it becomes unavailable and forms insoluble complexes. Phosphorus Solubilizing Microorganisms (PSM) can effectively mineralize Eppawala Rock Phosphate (ERP) and convert it into plant-available forms.

This research focused on increasing availability of plant available P from the ERP mineral. Phosphorus Solubilizing Microorganisms was isolated from the biofertilizer developed from a pine forest soil culture and identified using Pikovskaya Agar under serial dilutions in the pour plate method. Isolated PSM taxonomy was determined using 16S rDNA sequencing. Quantification of P availability by solubilizing ERP minerals was determined using the phosphomolybdate method. From the P solubilizing bacteria identified in pine forest soil culture, *Bacillus* sp. and *Acetobacter* sp. showed the most significant ( $P < 0.05$ ) performance in solubilizing ERP. The enhancement of available P in soil by incorporating microorganisms has a direct impact on increasing crop establishment, plant growth, and yield production.

**Keywords:** 16S rDNA; Eppawala rock phosphate (ERP); Phosphorus (P); Phosphorus solubilizing microorganisms (PSM)

# QUANTIFYING SOIL MOISTURE LEVELS THROUGH SATELLITE AND DRONE-BASED REMOTE SENSING FOR ENHANCED CROP WATER USE EFFICIENCY

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**Abstract:** Precision agriculture is a technology-driven approach, integrating advanced methods such as Variable-Rate Irrigation (VRI) systems and remote sensing technologies, to optimize farming practices. This study explores the impact of precision agriculture on water use efficiency (WUE) and crop productivity. Our objective was to investigate VRI enhance WUE and crop yields. Sensors were deployed across various fields to monitor soil moisture and crop health, enabling tailored irrigation. The VRI systems adjusted the water distribution in order to minimize water wastage, using this data. Crop health was monitored using remote sensing technology, which involved the use of satellites and drones. This allowed for the identification of specific locations that had different water requirements. The data was analyzed using Artificial Intelligence (AI) to create accurate watering schedules. The results of our study demonstrate a significant improvement in WUE, with VRI systems increasing WUE by up to 30% and remote sensing technology lowering water use by 20%. In addition, these technologies significantly enhanced agricultural productivity, with VRI resulting in a 10% rise and remote sensing leading to a 5% rise. The results validate that precision agriculture is a successful approach for enhancing WUE and enhancing crop output, emphasizing its potential as a sustainable agricultural solution.

**Keywords:** Artificial intelligence; Crop productivity; Precision agriculture; Variable-rate irrigation; Water use efficiency

# VEGETATION SURVEY OF RESTORED WETLANDS IN CALIFORNIA CENTRAL VALLEY, USING UNMANNED AERIAL VEHICLES (UAV) IMAGERY

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**Abstract:** Recent advances in unmanned aerial vehicles (UAV) have led to monitoring vegetation changes in restored wetlands using object-based image analysis (OBIA) and spectral indices in remote sensing. The objective of the study was to map vegetation on selected restored wetlands in California Central valley (CCV), quantify seasonal vegetation coverage, and assess vegetative health using visual and multi-spectral UAV image analysis. UAV imagery at eight privately managed restored wetlands in three regions of the CCV (Sacramento, Delta, and San Joaquin), once in the summer and fall, from 2020 to 2022 using a DJI Phantom 4 PRO flying at an average height of 120 m above ground height with side and front overlaps of 80% were acquired. The product UAV image collection was processed to create orthomosaic images with a 5 cm/px spatial resolution using the ortho mapping workspace within the Agisoft Photoscan and ArcGIS Pro 3.0.2 (Esri, Redlands, California, USA) software. Interannual phenological changes in wetland vegetation were calculated for 3-band (RGB data) UAV imagery collected, applying the Visible Atmospherically Resistant Index (VARI). Results of the VARI assessment showed an increase in vegetation at two sites in Colusa (1% Dobson and 5.3% Paulo) between the summer and Fall 2021 that may be attributed to the fact that they were undergoing irrigation. Substantial declines in vegetation at two other sites in Colusa (67.1% Bressler and 37.6% Myres) may indicate mechanical removal such as mowing or disking. Sites in the Delta region experienced marked increases in vegetation between the two sampling periods. The information gained from UAV survey could help wetland resource managers and landowners in determining site-specific courses of action to protect and enhance wetland functions.

**Keywords:** Central valley; Restored wetlands; UAV; VARI; Vegetation

# REMOTE MEASUREMENT OF ABOVEGROUND BIOMASS, PLANT HEIGHT AND LEAF MOISTURE IN RICE (*ORYZA SATIVA* L.) USING SENTINEL-2 SATELLITE IMAGERY

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**Abstract:** Rice (*Oryza sativa* L.) is a staple crop in Asian countries. Plant parameters, such as above-ground biomass, leaf moisture and plant height are important indicators in rice crop monitoring. The objective of this study was to test the correlation between ground truth data and remotely sensed satellite data. The experiment was done at rice farmer-field at Gampaha, Sri Lanka cultivated with Bg 374 variety. Crop measurements were collected from five quadrant samples per single satellite pixel across the field. This was repeated in two growth stages, panicle initiation and booting stage. The satellite images with 10 m x 10 m resolution were downloaded using Google Earth Engine platform. The sample quadrant locations were labelled by an RTK-enabled drone flown over the field before data collection. The zonal statistics tool of QGIS software was used to extract waveband data from corresponding satellite pixels and used to compute vegetative indices (VIs). Regression analysis results showed best relationship with AGB Soil Adjusted Vegetation Index (SAVI:  $R^2=0.48$ ) in panicle initiation stage and Green Vegetation Index (GVI:  $R^2=0.46$ ) in booting stage. The Greenness Index (GI:  $R^2=0.20$ ) exhibited the best relationship with leaf moisture in panicle initiation stage and Normalized Difference Vegetation Index (NDVI:  $R^2=0.93$ ) in booting stage. For plant height (Float disc method), Ratio Vegetation Index (RVI) exhibited the best relationship both in panicle initiation ( $R^2=0.19$ ) and in booting stage ( $R^2=0.26$ ). The findings could be of future use for advanced remote sensing techniques in monitoring rice crops for smart agriculture.

**Keywords:** Booting stage; Ground truth data; Panicle initiation stage; Satellite imagery; Vegetation indices

**DNA BARCODING: PREPARATION OF RBCL AND MATK  
GENOME REGIONS OF *JEFFREYCIA ZEYLANICA* (L.) H. ROB.,  
S.C. KEELEY & SKVARLA (ASTERACEAE)**

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**Abstract:** *Jeffreyia zeylanica* (L.) H. Rob., S. C. Keeley & Skvarla, is an endemic Sri Lankan medicinal plant which is commonly observed within the tank cascade systems of Sri Lanka. Recent studies have shown that it contains Vernolactone, a novel compound that mediates significant cytotoxic effects in breast cancer cells and promotes apoptosis and autophagy in human teratocarcinoma cancer stem-like cells. For this study, 200 mg of plant material was collected from a single plant for each of the two DNA markers. The plant was identified with the assistance of medicinal plant experts at Gampaha Wickramarachchi Ayurveda Teaching Hospital (GWATH), Yakkala and Samples were obtained from the herbal garden at GWATH. MatK and rbcL genes are chosen for their variability among species and their relative conservation within a species. The standard CTAB method with few modifications was used for the extraction and purification of DNA. MatK and rbcL genes in the chloroplast genome were amplified using universal primers by PCR (polymerase chain reaction). Two optimized PCR cycle parameters were used. PCR products were purified. Purified PCR products were sequenced and raw sequencing data was edited using Bio Edit software. Galaxy, the web-based platform was used to assemble the forward and reverse reads into contigs. Moreover, BLAST search against the GenBank nucleotide database was conducted to confirm the identity of the obtained MatK and rbcL sequences. It showed a maximum similarity of 100% for matk and 99.3% for rbcL. The PCR-based amplification of conserved regions (*matk* and *rbcl*) or their combination is commonly employed to establish DNA barcodes for species identification. This case demonstrates the use of DNA barcoding for the identification of medicinal plant materials.

**Keywords:** BLAST; DNA barcoding; *Jeffreyia zeylanica* (= *Vernonia zeylanica*); MatK; rbcL; Medicinal plant identification

# EFFICACY OF DIFFERENT PRETREATMENTS ON *PARTHENIUM HYSTEROPHORUS* L. TO ENHANCE CELLULOSE RECOVERY FROM THE LIGNOCELLULOSIC BIOMASS

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**Abstract:** This study was aimed to select a cost-effective pretreatment for aggressive colonizer *Parthenium hysterophorus* in order to utilize the lignocellulosic biomass for the production of cellulosic bioethanol. Deploying diverse pretreatment methods will enable to choose the efficient and economical path to cellulose recovery from the biomass. Pretreatment is necessary to expose the carbohydrate polymers buried in the interior of the cell wall and make them accessible to the hydrolytic enzymes during saccharification to yield appreciable levels of fermentable sugars subsequently producing ethanol. Dried ground powder of *Parthenium hysterophorus* biomass was subjected to fifteen different chemical (NaOH, H<sub>2</sub>SO<sub>4</sub>, Chlorocholine- oxalic acid, Performic acid, H<sub>2</sub>O<sub>2</sub>) and physical (autoclaving, microwave, dry heat in furnace, boiling) treatments of different combinations. The dry weight of cellulose and lignin was calculated for all the treated samples using gravimetric methods. This was further confirmed by subjecting the pretreated samples to Fourier Transform InfraRed Spectroscopy (FTIR) to examine the functional groups of the polysaccharide. Acid treatment (0.1-1.0% H<sub>2</sub>SO<sub>4</sub>) at 200°C provided comparatively higher cellulose yield, but it removed lignin less effectively than NaOH treatment. Microwave assisted NaOH and boiling with NaOH were found more effective than NaOH at room temperature. Based on the gravimetric estimation and FTIR analysis, boiling at 2% NaOH treated sample for 20 minutes, autoclaving at 2% NaOH treated sample for 20 minutes with sudden pressure release and microwave assisted 2% NaOH treatment at 280 W for three minutes were among the effective pretreatment methods of biomass investigated.

**Keywords:** Aggressive colonizer; Bioethanol; Cellulose; Lignocellulose; Lignin; Pretreatment

# EVALUATION OF EFFECTIVE MICROORGANISMS AND VERMITEA TECHNOLOGY TO REDUCE CHEMICAL FERTILIZER USE ON FODDER CULTIVATION

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**Abstract:** The study aimed to evaluate the growth and yield performance of premier fodder varieties grown with reduced inorganic fertilizer with effective microorganisms (EM) and Vermi products (VP). The experiment was carried out in a farmer's field at Rambewa, Sri Lanka (8.440° N 80.505° E). The study was a 4 x 4 factorial layout in a Randomized Complete Block Design with three replicates. Selected commercially available EM and farm-made VP were assigned into four levels of combinations; F<sub>1</sub>: Vermitea + 50 % Recommended Level of Inorganic Fertilizer (RLIF), F<sub>2</sub>: EM + 50% RLIF, F<sub>3</sub>: EM + Vermitea + 50% RLIF and F<sub>4</sub>: RLIF. Four fodder varieties; Napier (*Pennisetum purpureum* x *Pennisetum glaucum*) cv Pakchong-1, Red Napier, Fodder Sorghum (*Sorghum bicolor*) var. Sugargraze and Fodder Maize (*Zea mays*) var. Weera were grown under recommended management practices. Growth and yield parameters were recorded at the time of harvesting. There was no significant (P>0.05) interaction between fodder and fertilizer for plant height, leaf numbers, width and length, fresh and dry matter (DM) yields, DM percentage and brix value. Recorded DM yields for Pakchong-1, Red Napier, Maize and Sorghum grown with F<sub>4</sub> were 2923 ± 309, 2167 ± 1046, 10311 ± 1515 and 19122 ± 5286 kg ha<sup>-1</sup>, respectively. The 50 % reduction of inorganic fertilizer resulted in 1714±324 – 2852±722, 1872±421 – 3826±1184, 8648±1215 – 11962±1774 and 8796±1066 – 13460±1147 kg ha<sup>-1</sup> of DM yields from Pakchong-1, Red Napier, Maize and Sorghum, respectively. The study concludes that the reduction of inorganic fertilizer up to 50% does not affect the yield and growth parameters compared with RLIF application in studied fodder varieties. Thus, the usage of EM and VP technology can be recommended to improve ecosystem health in tank cascade systems in dry and intermediate zones of the country.

**Keywords:** Dry matter yield; Fodder sorghum; Fodder maize; Fresh yield; Napier



## 8. Poster Presentations



# SYNERGISTIC NEXUS OF GEOTHERMAL ENERGY AND CLIMATE CHANGE MITIGATION; A SYSTEMATIC LITERATURE REVIEW

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**Abstract:** The growing concern over climate change has prompted an intensified examination of sustainable energy sources, and geothermal energy is a promising candidate in this regard. This sustainable energy source, derived from the Earth's internal heat, offers many advantages that position it as a viable solution for reducing greenhouse gas emissions and transitioning towards a low-carbon future. Therefore, the objectives of this systematic review were to (1) comprehensive synthesis of the existing body of research on the relationship between geothermal energy utilization and its role in climate change mitigation, (2) explore the opportunities, challenges, and potential outcomes associated with geothermal energy adoption and provide valuable guidance for policymakers, researchers, and stakeholders invested in achieving a sustainable and resilient energy future. We reviewed 50 scientific papers published from 2000 to 2022 using the Scopus search engine, and "climate change", "geothermal energy", "renewable energy and power" were the main keywords. We focused our search on scientific articles written in English. The relationship between geothermal energy utilization and its role in climate change mitigation was reviewed. Further, the opportunities, challenges, and potential outcomes linked with adopting geothermal energy and practices to achieve a sustainable and resilient energy future were explored. As a stable and renewable power source, geothermal energy reduces greenhouse gas emissions (97%), helps decrease reliance on fossil fuels, and supports climate-resilient infrastructure. Compared to the fossil fuels, primary shared obstacles to geothermal resources include high initial expenses, intricate and costly technologies, extended production periods, and significant financial risk without rewards. Nevertheless, geothermal energy offers multiple advantages: it remains unaffected by weather, exaggerated widespread accessibility, lacks geographical constraints, eco-friendly, and cost-efficient. Geothermal energy has become a robust partner in the global struggle against climate change.

**Keywords:** Climate change mitigation; Energy utilization; Geothermal energy; Renewable power; Sustainable energy

# EFFECT OF GLYCERINE TREATMENT ON THE MECHANICAL STRENGTH OF BANANA LEAVES TO BE USED IN FOOD PACKAGING

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**Abstract:** The pollution is a major drawback in the conservation of natural ecosystems, especially the aquatic habitats. One of the main causes behind this is the plastic items that are used as single-used food packing. The utilization of banana leaves as food wrapping and serving material is an age-old practice that evidences that there are possibilities to develop sustainable packaging materials from banana leaves, which will help in the present context for tackling plastic pollution. The current study aims to analyze the effect of a chemical named Glycerine on the mechanical strength of banana leaves in the path of developing a bio-degradable food packaging material. For this purpose, the fresh banana leaves harvested from Jaffna peninsula were collected, reduced in size, and subjected to treatment with glycerine solutions at two concentrations (25% and 33.3%) for seven days. Each day, the samples of banana leaves were retrieved from the dip, dried for 24 hours at room temperature, and then assessed for mechanical properties such as Load-bearing capacity, Tear resistance, and Hardness. The results revealed that the banana leaves reached optimal mechanical strength through the treatment with 33.3% glycerine for one day, where there was a significant increase ( $P < 0.05$ ) in the load-bearing capacity ( $1.88 \pm 0.08 \text{ N}$ ,  $2.18 \pm 0.08 \text{ N}$ ), tear resistance ( $1.90 \pm 0.09 \text{ N}$ ,  $3.33 \pm 0.26 \text{ N}$ ), and hardness ( $16 \pm 2 \text{ N}$ ,  $22 \pm 2 \text{ N}$ ) of the banana leaves before and after the optimum treatment. The results suggest that Glycerine solution (33%) can enhance the banana leaves' mechanical strength, which may be used as a source for developing bio-degradable packaging materials. Furthermore, these biodegradable packaging materials will support in the conservation of aquatic ecosystems including the cascade system, by mitigating pollution and in the restoration of water quality.

**Keywords:** Bio-degradable; Food-wrapping; Load-bearing; Packaging material; Tear resistance.

# SUSTAINABLE SEEDLING BLOCK PRODUCTION THROUGH THE INTEGRATION OF TEA PROCESSING WASTE AND ORGANIC MATERIALS

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**Abstract:** The purpose of this study is to utilize waste tea from tea processing industries to prepare seedling blocks incorporating other organic materials. Refused tea waste was obtained from a leading commercial tea factory in the Sabaragamuwa province of Sri Lanka. Various media materials, such as tea waste only (T1), tea waste: biochar (2:1) (T2), tea waste: goat manure (2:1) (T3), tea waste: vermicompost (2:1) (T4), and tea waste: poultry manure (2:1) (T5), were used to prepare these biodegradable seedling blocks. The materials were naturally air-dried, crushed, and sieved by a 2 mm mesh. To prepare one seedling block, 15 g of ingredients were hand-mixed, including 12 mL of starch solution (5%) and 12 mL of water with 1.5% CuSO<sub>4</sub> solution. Seedling blocks were prepared by compression with a load of 200 N using a compression cylinder. The average dry mass of the seedling block was 22 g, which served as a reference. A depression was created in the centre to place the cabbage seeds, and the experiment was replicated four times. Seedling blocks were oven-dried at 60°C for 24 hours, and the blocks were 5 cm in diameter and with a height of 3 cm. The parameters, such as relaxation density, porosity, volume change ratio, and seedling emergence, were evaluated at 5% significance level. Based on the analyzed data, relaxation density, which reflects the stability of the seedling blocks after 48 hours of relaxation, was not significantly influenced among all the tested treatments. It was noted that T2 treatment resulted in higher porosity (0.99%) and a volume change ratio of 2.12 compared to all other treatments. Additionally, 80% of seedling emergence was observed in the T2 treatment, indicating good performance compared to all other treatments. Hence, integration of the tea processing waste and other organic materials can be used as potential raw materials to produce sustainable seedling blocks.

**Keywords:** Biochar; Manure; Seedling emergence; Tea waste; Vermicompost

# UTILIZATION OF BROILER SLAUGHTERHOUSE WASTEWATER SLUDGE TO FORMULATE LOW-COST POST- LARVAL SHRIMP FEED FOR *PENAEUS MONODON*

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**Abstract:** The shrimp industry in Sri Lanka is a vital contributor to export earnings, but faces challenges due to the rising cost of shrimp feed ingredients. A sustainable solution is being explored, which involves repurposing waste from broiler slaughterhouses to create cost-effective shrimp post larval (PL) feed. This research focused on developing such a feed using dried broiler wastewater sludge as a key ingredient. Three experimental feeds were formulated, each incorporating varying levels of sludge (10%, 15%, and 20%) by replacing fishmeal, with a commercial PL feed used as the control with four replicates for each. The study analyzed the nutritional composition, stability, and presence of *Escherichia coli* and *Salmonella* bacteria. Crude protein (CP) content in all experimental feeds was significantly higher ( $P < 0.05$ ) than in the control feed (47.2%) and there was no significant difference in CP values in sludge included feeds ( $P > 0.05$ ). Nevertheless, all the formulated feed met the CP requirements for post-larvae of *Peneaus monodon* within the range of 45-55%. Crude fat content of the tested feeds was significantly affected ( $P < 0.05$ ) with the sludge inclusion where the highest fat content was observed in the 20% sludge inclusion (11.05%). The stability of the pellets and the effect of the aeration were significantly affected ( $P < 0.05$ ) with the sludge inclusion while the highest stability (6.53%) and the lowest effect of aeration (7.59%) were observed in the 15% sludge included feed. All feed samples tested negative for the presence of *E. coli* and *Salmonella* bacteria. The cost analysis revealed that incorporating broiler wastewater sludge as a partial substitute for fishmeal could effectively reduce feed cost. Therefore, broiler wastewater sludge can be a valuable and sustainable ingredient in shrimp PL feed production and 15% sludge inclusion results best nutrition and physical attributes offering economic benefits.

**Keywords:** Broiler; Pellet stability; Shrimp; Wastewater sludge

# **YOUTHS' PERSPECTIVES ON USING A SMART FOOD WASTE ACCELERATOR FOR A HEALTHY LIFESTYLE IN COLOMBO, SRI LANKA**

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**Abstract:** As a part of the initiative called Youth Leadership for Climate Action (YLCA), which is carried out by Biodiversity Sri Lanka (BSL) and funded by the British Council to develop young people into community leaders in climate action. This community intervention for the fellowship is to address the burden issue of food waste management. A prototype which is AI-led smart food waste accelerator model was built. A baseline study in Dehiwala municipal council region was conducted by a qualitative sampling approach based on key informant interviews from youths by using structured questionnaires to identify their perspectives on food solid waste management. A total of 567 responses from youths aged between 18 to 29 were gathered. As a result, 91% of the study population is concerned about food waste management in their households. However, 89.45% of the study population stated that there is no specific proper way of disposal of food waste and more than 93% of them depended on local government authority's vehicles. This study showed that average of 0.67 kg of food waste accumulated in each household per day and most of them were the remaining meals. Furthermore, 89% of the study population was interested in buying AI-led innovative smart food accelerator for their households and 96% of them were interested to learn its functions and features if it is available in the market. There is a demand for implementing the AI-led smart food waste accelerator model among the youth in Colombo.

**Keywords:** Food waste management; Innovations; Smart food waste accelerator; Youth leadership for climate action

## DEVELOPMENT OF AN EASY-TO-USE DOSAGE FORM FROM FRESH GINGER RHIZOME (*ZINGIBER OFFICINALE*)

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**Abstract:** Ginger (*Zingiber officinale*) has been widely used in Ayurveda and Chinese medicine and has been commonly used as a spice from ancient times. In Sri Lanka, ginger is cultivated as a commercial crop hence there is an abundant harvest. The water-soluble powder form of Ginger rhizome (Ardraka Satva in Ayurveda) is an effective preparation for many disease conditions. In this study an approach was made to produce a water-soluble powder form of fresh ginger rhizome as an easy-to-use dosage form, considering the availability. Local ginger variety was selected as a research drug and three samples were prepared per standard procedures. Cleaned fresh ginger rhizomes were cut into pieces and crushed. Then, crushed rhizomes were kept for one night to obtain the sediment by adding four parts of water. Next day white color powder extract was obtained after removing the supernatant water and drying the powder in shade. This preparation in an easy-to-use dosage form was evaluated for organoleptic, physicochemical, phytochemical, and chromatographic parameters and also detected the shelf life of the finished product for six months at room temperature. Results revealed that the moisture content of the ginger extract was 9.01% and the ash value was 0.43%. The water-soluble ash value was 0.37%. Phytochemical analysis of hot water extract of ginger extract revealed the presence of starch and alkaloids only. TLC studies were done by using the solvent system of toluene: ethyl acetate: formic acid-9:1:2 ratio. In the chromatographic study, it showed a prominent area with a 0.4 R<sub>f</sub> value. After six months the shelf life study showed similar organoleptic features of the dried powder. Results of these physicochemical, phytochemical, pharmacognostic and TLC analysis can be used as standards of Ginger extract and this research also seek to enhance the value of ginger crops in Sri Lanka by transforming excess harvests into innovative and easy-to-use dosage forms. The project not only has the potential to bolster the agricultural sector but also provides consumers with user-friendly, ginger-infused products, thereby fostering a positive impact on public health and the economy while promoting sustainable resource utilization.

**Keywords:** Dosage form; Easy-to-use; Ginger; *Zingiber officinale*

# LEVERAGING AI AND MACHINE LEARNING FOR SUSTAINABLE URBAN WETLAND RESOURCE MANAGEMENT: INSIGHT FROM A WETLAND CONSERVATION LENS

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**Abstract:** The critical advancements in sustainable water resource management and associated challenges utilize diverse methodologies, including machine learning and innovative approaches, to address the complex dynamics of water resources. The previous studies of sustainable urban wetland resource management examine various regions and water systems, underlining the significance of informed decision-making, sustainable practices, and advanced mathematical paradigms. Hence, a systematic review of primary research was conducted to provide insight from a wetland conservation lens through leveraging AI and machine learning for sustainable urban wetland resource management. The process of article screening was executed by adopting search keywords such as "Machine Learning", "Responsible Governance", "Sustainability", "Sustainable Technology", "Water Resource Management" and "Wetland Conservation" using the Web of Science database. The peer-reviewed articles published in English from 2018 to 2023 were included in content analysis and thematic analysis. The study's findings revealed the potential of machine learning and data-driven insights in enhancing water resource management. A hybrid model accurately predicts daily flow rates, demonstrating the transformative power of technological innovation. Societal involvement in decision-making reinforces the role of responsible governance in sustainable water management. Innovative "soft sensor" approaches for real-time phosphorus removal monitoring promise significant cost savings in wastewater treatment. It explores the crucial connection between technology and sustainability, highlighting societal actors and innovative governance frameworks. In conclusion, informed decision-making, interdisciplinary collaboration, and responsible governance are vital for addressing water management challenges, paving the way for a more sustainable and water-secure future.

**Keywords:** Machine learning; Sustainable technology; Water resource management; Wetland conservation

# CALLUS INDUCTION OF SELECTED TOMATO (*LYCOPERSICON ESCULENTUM* L.) VARIETIES USING ANTHR CULTURE TECHNOLOGY

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**Abstract:** The study aimed to expedite plant breeding programs in Solanaceae through double haploid plant production using anther culture in selected tomato varieties. The experiment involved callus induction in culture bottles using a Complete Randomized Design with three treatments and three replicates. Unopened flower buds were harvested five days after emergence, sterilized with alcohol and Clorox, and incubated in darkness for 14 days at 25°C to induce callus. Three Kinetin concentrations (1 mg L<sup>-1</sup>, 2 mgL<sup>-1</sup> and 3 mgL<sup>-1</sup>) were tested on different tomato varieties, and data was collected on the number of anthers planted and the number of calli produced. The results showed no significant difference between 1 mg L<sup>-1</sup> and 2 mg L<sup>-1</sup> Kinetin for callus induction. The highest callus induction (26.66%) was observed with 2 mgL<sup>-1</sup> Kinetin in the HT-5 variety. Callus induction efficiency varied among tomato varieties, with significant differences in Lanka Sour and Bhathiya for Kinetin concentrations 1 mg L<sup>-1</sup> and 2 mgL<sup>-1</sup>. Treatment three exhibited high callus contamination (30%), while Lanka Sour variety displayed the highest callus greening (24.44%) with 2 mgL<sup>-1</sup> Kinetin. Varietal differences were significant for Kinetin concentrations 1 mgL<sup>-1</sup> and 2 mgL<sup>-1</sup> in Lanka Sour and Bhathiya, but not in other varieties. Regarding the number of days for callus induction, 2.0 mgL<sup>-1</sup> Kinetin required a shorter period compared to other concentrations. In conclusion, the experiment's findings on callus initiation using MS medium supplemented with 2 mgL<sup>-1</sup> Kinetin, particularly with the distinct responses with displaying the highest callus greening observed in HT-5 and Lanka Sour varieties. This microcosmic study in plant biology aligns with the practices promoting plant health and biodiversity not only benefit agricultural productivity but also play a crucial role in maintaining the delicate balance of Cascade Ecology, ultimately influencing the well-being of human societies.

**Keywords:** Anther culture; Callus induction; Kinetin; Tomato

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## International Conference on EcoHealth Nexus: Bridging Cascade Ecology & Human Well-Being

The International Conference on Eco-Health Nexus (ICEN 2023) seeks to promote interdisciplinary dialogues and solutions surrounding cascade ecology and human well-being. Cascade ecology refers to the study of ecological interactions in connected networks of tanks, streams and wetlands that exchange water, nutrients, and organisms. This conference explores how protecting the tank cascade systems would improve eco-health and community resilience. With its theme "To Bridge Cascade Ecology and Human Well-Being for a Sustainable Future," the event brings together experts and practitioners across domains - from water management and climate science to agriculture, archaeology, governance and more. The conference envisioned to facilitate a collective synthesis of existing and new knowledge that integrate environmental and human health for future benefit.

Spanning three days, the conference program features several tracks on diverse sustainability topics, from biodiversity conservation and ecological interactions to indigenous wisdom and societal governance. Participants can explore water-centred solutions; innovations in monitoring, technology and management; and nexuses between factors like food, nutrition, disasters, development etc. Sessions also focus directly on Sri Lankan tank cascade systems and how applying such ancient knowledge can build future sustainability. By facilitating synergetic nexus between cascade ecology, sustainability and policy, the ICEN 2023 promises a vibrant exchange of ideas to chart an integrated path ahead - one where ecological and community wellness reinforce each other.

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