PROCEEDINGS

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WATER QUALITY AND HUMAN HEALTH: CHALLENGES AHEAD
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UNIVERSITY OF PERADENIYA, SRI LANKA

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I am delighted to extend a warm welcome to all participants of the 9th International Symposium on "Water Quality and Human Health: Challenges Ahead." This annual event, organized by the Board of Study in Environmental Science, is committed to addressing critical water-related issues.

I commend Professor Sudharma Yatigammana and the organizing committee for their dedication in bringing together experts to discuss the complex interplay between water quality and human health.

The symposium's key messages emphasize the human right to safe drinking water and the imperative of transforming water from a potential threat to a catalyst for health, well-being, and nutritional security. Additionally, the symposium aims to identify key challenges in water research. I am confident that the rich technical program will foster insightful discussions and collaborations.

I believe this symposium will contribute to a broader message aimed at securing sustainable development across the social, economic, and environmental dimensions. I encourage all participants to actively engage in the symposium and contribute to our collective efforts in safeguarding water resources.

Thank you.

Prof. H.M.T.G.A. Pitawala
Director, PGIS

Message from the Symposium Chairperson

It is with great pleasure that I chair the 9th International Symposium on Water Quality and Human Health: Challenges Ahead, organized by the Board of Study in Environmental Science, Postgraduate Institute of Science, University of Peradeniya. Past studies have demonstrated that the freshwater systems of Sri Lanka are under threat from pollution, especially due to anthropogenic activities. In addition, global water usage has increased at more than twice the rate of population increase during the last century. Consequently, one third of the world population and approximately one half of the people, especially in the developing world, are known to suffer from diseases associated with poor quality of drinking water. In this context, the Postgraduate Institute of Science, University of Peradeniya, initiated this symposium to provide a forum for analytical and solution-based discussions, to disseminate knowledge and information on current research. This forum also provides an opportunity for young researchers to interact with nationally and internationally eminent researchers who are currently involved in water research.

As the Chairperson of the Symposium, I am privileged and honored to work with a group of highly energetic and dedicated personnel in organizing this event. Thus, I take this opportunity to thank all who contributed in numerous ways and for their untiring efforts to make the symposium a great success. I hope that the International Symposium on Water Quality and Human Health: Challenges Ahead 2024, will be a fruitful occasion for knowledge sharing among students, researchers and professionals striving to address the world's current water challenges.

Thank you.

Prof. Sudharma Yatigammana
Department of Zoology
University of Peradeniya

Message from the Editors-in-Chief

As we gather for the 9th International Symposium on Water Quality and Human Health, it is essential to recognize the critical role that water plays in our well-being. Water is not merely a resource; it is a lifeline that sustains life, health, and the environment.

This year, we received an overwhelming 67 abstracts, each representing valuable research and insights. After meticulous review by experts in relevant fields, we have selected 58 of these abstracts for presentation. These contributions fall under four crucial themes:

(1) Water Quality: Ensuring that our water sources remain pure and uncontaminated is vital. Clean water directly impacts human health, from hydration to disease prevention.
(2) Water Pollution: Addressing pollution is a collective responsibility. Contaminants in water affect not only human health but also ecosystems and biodiversity.
(3) Pollution Remediation: Innovative solutions for cleaning polluted water are essential. Our symposium aims to explore effective methods for restoring water quality.
(4) Water Treatment and Human Health: Access to safe drinking water is a fundamental right. Effective treatment processes safeguard public health.

We are fortunate to have a distinguished team of experienced academics serving on the Editorial Board this year. Their expertise ensures the quality and rigor of our proceedings.

To all contributors, reviewers, and participants, we extend our heartfelt gratitude. Your dedication and insights elevate the symposium, fostering knowledge exchange and collaboration. We look forward to two enlightening days at Peradeniya, where we will collectively advance our understanding of water's impact on human health and the environment.

Thank you, and let us make this symposium a memorable and enriching experience.

Prof. Namal Priyantha and Dr. Chaminda Wijesundara
Editors-in-Chief

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Keynote Address

WATER QUALITY AND REMEDIATION OF INDUSTRIAL WASTEWATER

Water

Water, an essential nutrient, is fundamental for life and plays a vital role in our health by regulating many physiological functions in the human body. It is multifunctional due to its unique properties, such as polarity, ability of forming hydrogen bonds, high heat capacity, and cohesive and adhesive properties. These properties are important for many aspects, including the transportation of nutrients to cells, removal of waste from the body, protection of joints and organs, maintaining body temperature, and regulation of blood circulation. It also facilitates the exchange between ions, capillaries, and blood vessels. The high heat capacity of water aids in thermoregulation by reducing fluctuations in body temperature in warm or cold environments. If a sufficient volume of water is not taken, dehydration occurs; dehydration can lead to serious health issues, such as heatstroke, kidney stones, metabolic diseases, and urinary tract infections. Dehydration-related body mass loss is linked to increased tiredness and decreased attention.

Water Quality

Water quality refers to chemical, physical, and biological characteristics of water based on the standards of its usage. It is most frequently used with reference to a set of standards for conformity, which can be achieved through treatment of the water being used. The standards used to monitor/assess water quality lead to control the health of ecosystems, safety of human contact, extent of water pollution, condition of drinking water, etc. The recognition of the importance of drinking water quality on public health underscores the necessity for protection and management of water quality. The link between water quality and health continues to receive attention, with many health crises highlighting its significance. Issues such as kidney diseases, chronic impacts of infectious diseases on child development, transmission of diseases such as cholera, diarrhea, hepatitis A and typhoid, and neurotoxicity due to heavy metal contaminated water are some of them. Moreover, there are many emerging water quality issues, such as atmospheric deposition of mercury, microplastics, nonregulated contaminants and perfluorinated compounds.

Environmental water quality, also referred to as ambient water quality, relates to the well-being of flora and fauna in water bodies: oceans, rivers, lakes, swamps, and wetlands. Water quality standards for surface water vary significantly depending on environmental conditions, ecosystem characteristics, and intended human uses. Water contaminated with toxic substances and high concentrations of certain microorganisms lead to hazardous conditions even for non-drinking purposes, such as irrigation, agriculture, and industrial applications. In some locations, water quality conditions include high dissolved oxygen levels, low chlorophyll-a levels, and low turbidity.

Industrial water

Water quality has a significant impact on water supply toward industrial use as well. Many industries require water in different aspects during their production, such as for boilers, processing, product treatment and cleaning, and cooling. For these uses, certain characteristics of water, namely solubility, transportation potential and heat exchange potential, are useful although the required water quality is different for each purpose: For example, boilers are used to produce hot water, steam, or hyper-thermal water; Processing water is used as a raw material or additive in beverages, brewery, food processing, synthetic fiber processing, etc.; Water for product treatment and cleaning is used for physical processes such as cleaning, swelling, or dissolving raw material, intermediate products and final products. The quality and quantity of water for product treatment and cleaning depend on the manufacturing process and the final product. The quality of water required for

chemical, food, paper, and textile industry is high. Further, semiconductor processing water requires the highest quality of water, 'ultra-pure water', because silicon wafers or computer chips require extremely high precision and contaminant free water. Although the semiconductor manufacturing industries used organic solvents to clean the products in the past, it caused serious soil and groundwater contamination, and hence, is not recommended anymore. Ultra-pure water, which is water that has been purified to high levels of specification, is the optimal cleaning agent with no contamination or hazard to humans or the environment.

Industrial Wastewater (IWW) Treatment

Industrial water consumption affects the production cost as well as the conservation of limited water resources. Characteristics of wastewater from industrial sources vary with the type and the capacity of the facility, and on-site treatment methods. IWW results from any process or activity of industry which uses water as a reactant (industrial effluent), or transportation of heat or material. As the characteristics of the process specific waste vary, there is no standard or general design to treat all IWW. Nevertheless, the treatment of IWW usually adopts the following logical order:

- Removal of suspended solids and insoluble liquids.
- Removal of inorganic, non-biodegradable, or poorly degradable soluble content.
- Removal of biodegradable soluble content.

Various methods, such as adsorption, biological methods, electrochemical methods, filtration, and oxidation, can be used for treatment of IWW. However, these methods have their advantages and disadvantages: nanofiltration, reverse osmosis and ultrafiltration are effective in removing colored compounds, but dyes can clog the pores of the membrane thereby reducing the life-time and the efficiency of the membrane; electrochemical methods have high electricity cost; oxidation technologies are effective in degrading dyes, but produces undesirable by-products which should be treated subsequently; biological methods can be performed under aerobic or anaerobic or combination of both, but the process is time-consuming, less flexible in operation and ineffective in some instances.

Adsorption for IWW Treatment

Adsorption is one of the most effective physical methods due to its simplicity, technical feasibility, lower treatment cost and operational flexibility. Activated carbon, ion-exchange materials, clay types, polycarbonates, and different types of natural and processed biomasses including biochar have been used in IWW treatment. However, due to the low adsorption capacity, some adsorbents are not preferred in large-scale IWW treatment facilities. Performance characteristics of adsorbent material can be improved through various means: Polymer nanocomposites have demonstrated enhanced dye removal ability; temperature-optimized clay types have effectively removed heavy metals with decreasing turbidity; surface-treated biosorbents have shown increased adsorption capacities toward inorganic and organic contaminants. Nevertheless, many adsorbent modification methodologies are still at research level. Hence, optimization of solution and process parameters, and understanding the mechanism of contaminant removal at molecular level will be needed for extension of research findings toward commercialization. Another aspect in the use of adsorbents is regeneration, which is an important factor for wider acceptance of industrial applications. The degree of regeneration and the cost involved depend on the type of the adsorbent and adsorbate, and the strength of their attraction. For example, UV treatment leads to the degradation of dyes, while acid treatment could be used to regenerate metal ions.

Namal Priyantha, BSc (Perad), PhD (Hawaii), FNASSL, FIChemC, CChem
Senior Professor in Chemistry
University of Peradeniya

Invited Speech

ENGINEERED BIOCHAR MATERIALS FOR SUSTAINABLE WATER TREATMENT

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Biochar (BC) is a carbonous adsorbent that can be produced by thermal treatment under anaerobic or oxygen deficient conditions with any lignocellulose rich biomass. By manipulating its chemistry, BC can be successfully utilized in wastewater treatment and as an agricultural soil amendment. BC-adsorbate interactions are determined by the physicochemical properties of the BC surface. Analyzing the surface characteristics of BC has proven valuable in gaining a deeper understanding of the interactions between BC and adsorbates. The feedstock type, pyrolysis conditions, and physical and chemical value additions govern the surface characteristics of BC. Value additions can either increase the versatility of the BC surface by either enhancing the porosity by pore wall destruction or introducing new surface functionalities on the BC surface. Additionally, innovative approaches have successfully utilized biochar-clay composites and biochar derived from novel biomass sources for water remediation purposes. A fast and simple open vessel digestion method, as well as a microwave digestion method, can be optimized for several types of BC to overcome the limitations of the existing knowledge. Novel methods for modelling an amorphous biochar structure using molecular dynamics simulations have also been investigated.

The application of bare nano zero valent iron (nZVI) for remediation purposes is limited due to its tendency to aggregate, leading to quick passivation and reduced reactivity. To address this issue, biochar (BC) has been widely employed as a support material for nZVI. By inhibiting aggregation, BC enables better dispersion of nZVI on its surface, thereby enhancing the reactivity of nZVI. The loading of iron during the preparation of nZVI can be achieved either on the biochar itself or on the biomass before biochar production. Furthermore, interfacial deposited and engraved nZVI based biochar composites (BC-nZVI) have been compared for its performance. The stability of BC-nZVI prepared using carbothermal and liquid phase reduction methods has been compared. BC-nZVI holds great promise for addressing water contamination issues, providing an efficient, versatile, and environmentally friendly solution for remediation efforts. Ongoing research and development continue to explore new methods and applications to optimize its performance and broaden its scope in water treatment.

Invited Speech

THE UNSEEN THREAT: MICROPLASTICS AND THE BATTLE FOR WATER QUALITY

M.P. Deeyamulla

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Microplastics, those tiny fragments of plastic less than 5 mm in size, have emerged as a significant threat to global water quality. Despite their small size, microplastics pose significant threats to aquatic ecosystems, human health, and the overall well-being of our planet's water resources.

In recent years, research has revealed the pervasive presence of microplastics in freshwater bodies, oceans, and even in the air we breathe. These particles come from a variety of sources, including plastic debris breakdown, microbeads in personal care products, and synthetic fibers from textiles. Their durability and resistance to degradation mean that once released into the environment, microplastics persist for years, accumulating in water bodies and threatening marine life.

The impact of microplastics on water quality is multifaceted. They act as carriers of pollutants, adsorbing harmful chemicals such as pesticides and heavy metals. When ingested by marine organisms, microplastics can disrupt biological processes, leading to reproductive and developmental abnormalities. Furthermore, their small size allows them to enter the food chain, potentially exposing humans to microplastics through seafood consumption.

Addressing the challenge of microplastic pollution requires a comprehensive approach. Efforts to reduce plastic waste, improve waste management systems, and promote sustainable alternatives to plastic are crucial steps. Detection of microplastics in water is challenging but vital, requiring specialized methods like Raman spectroscopy and infrared spectroscopy. Additionally, advancements in monitoring and detection technologies are essential for accurately assessing microplastic levels in water bodies and understanding their ecological and health impacts.

The battle for water quality is intricately linked to our ability to combat microplastic pollution. By raising awareness, conducting research, implementing effective policies, and fostering global cooperation, we can work towards mitigating the unseen threat of microplastics and safeguarding the health and integrity of our water resources for future generations.

Invited Speech

EFFECT OF GEOGENIC FACTORS ON WATER QUALITY AND ITS RELATION TO HUMAN HEALTH

G.W.A. Rohan Fernando

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The chemical characteristics of groundwater are influenced by the solubility of minerals and chemical processes that regulate the release of trace elements from aquifer materials. As a result of the interaction between groundwater and aquifer materials, natural (geogenic) hazardous materials have the potential to contaminate groundwater and cause serious health issues for people. Only a very small number of the 98 naturally occurring elements have the potential to be geogenic contaminants. There are three critical factors: (1) their concentrations in rocks and sediments; (2) their solubility under at least some environmental conditions and (3) their presence in soluble form in concentrations that are toxic to humans. This article provides a state-of-the-art review of the complexity and dynamics of groundwater quality, as well as the impacts of various groundwater substances on human health in relation to its geogenic factors, and some important examples from Sri Lanka and elsewhere.

Most of the Sri Lankan Precambrian crust consists of high-grade metamorphic rocks with very few sporadic occurrences of igneous rocks, where Earth's mantle has been exposed. Water originating from altered igneous rocks that is mainly used for drinking purposes has low pH, high conductivity, and elevated trace element levels. Studies conducted at Eppawala, which is believed to be formed from carbonatitic magma with high fluoride contents in apatite, have clearly indicated that several regions of the dry zone of Sri Lanka are affected by excessive quantities of fluoride in the groundwater. Apart from the well-known dental fluorosis, skeletal fluorosis was also reported up to a certain extent in the high-fluoride regions. The recent increase in the incidence of Chronic Kidney Disease of unknown etiology (CKDu) has also highlighted the importance of the geochemistry of fluoride in groundwater of the dry zone. Fluoride concentrations from groundwater of Udawalawe region are also high ranging from 0.1 to 9.2 mg L^{-1}, probably because of mantle materials contaminated with water aquifers through the tectonic boundary between Highland and Vijayan Complexes that are running across Udawalawe region.

The excess amount of arsenic in drinking water exceeds the guideline from WHO (10 μg L^{-1}) has been reported from various parts of the world, In Bangladesh and India, groundwater arsenic contamination initially emerged as a major health issue, and later came to be known as the worst arsenic-affected countries in the world in terms of population exposure to arsenic-contaminated water. This sedimentary basin has been formed in Bangladesh located on the Bengal Basin formed by the Ganga-Brahmaputra-Meghna (GBM) river system by deposition of large volumes of arsenic-containing sediments that originated mainly from the Himalayas and was carried down by the mighty GBM rivers during the Pleistocene and Holocene periods. Arsenical pyrites in rocks from the Himalayas have accumulated in the alluvial sediments are oxidized, and as a result, arsenic is released into the groundwater. Cancer due to long-term low-dose arsenic exposure through consumption of contaminated water is now an important concern in Bangladesh as it is being increasingly reported from arsenic-exposed individuals.

Excess ingestion of Ca and Mg from calcareous rocks to the groundwater can cause coronary and vascular cerebral diseases and contribute to calculi that have plagued human health for centuries. In the "global stone belt," the prevalence of urolithiasis shows a remarkable association with high Ca and Mg concentrations in the spring water. Moreover, a loss in the balance of groundwater Ca and Mg (e.g., high Ca and low Mg) significantly increases the risk of acute myocardial infarction and urolithiasis.

It is proposed that safeguarding groundwater-dependent public health needs concerted efforts in geogenic source control, cross-scale rehabilitation, and social hydrology-based groundwater governance.

WATER QUALITY

WQ01

ASSESSMENT OF WATER QUALITY PARAMETERS OF VALAICHCHENAI LAGOON, SRI LANKA

N. Tharminath[1*] and A.J.M. Harris [2]

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The present study was conducted at Valaichchenai Lagoon in Batticaloa District to identify the physiochemical characteristics of the water. The specific aim of the study was to assess the spatial variation of physiochemical water quality parameters of the lagoon and to find out the root causes of the variation. Water samples were collected on a replicate basis at 10 predefined sites labeled L1-L10. Sampling was conducted every fortnight at each location during daylight hours from April to August 2023. Temperature, pH, electrical conductivity, dissolved oxygen, total dissolved solids, salinity, turbidity, and density were determined *in-situ* and *ex-situ* by standard methods. Results revealed that salinity (0.28±0.18 to 12.57±0.84 ppt), electrical conductivity (222±28 to 28361±2026 µS cm^{-1}), total dissolved solids (123.1±12.8 to 13760.9±950.6 mg L^{-1}) and density (1.008±0.000 to 1.008±0.000 g mL^{-1}) showed significant spatial variation ($p < 0.05$) along sampling locations. However, temperature, pH, dissolved oxygen, and turbidity changed within a narrow range and lacked spatial variation ($p > 0.05$) along sampling locations. According to this study, Valaichchenai Lagoon had different ranges of salinity levels at various locations. High salinity levels above 10 ppt were observed in the lagoon water near Barmouth. Locations farthest from Barmouth showed the lowest salinity levels in the range of 0-1 ppt. Freshwater inflow and distance from the sea play a major role in the variation of salinity of the Valaichchenai Lagoon.

Keywords: Lagoon, Salinity, Water quality parameters

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WQ02

COMPARISON OF PHYSICOCHEMICAL PARAMETERS IN TWO PONDS LOCATED IN JAFFNA, SRI LANKA

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Water quality is characterized by various physicochemical parameters which may change widely due to many factors, such as source of water, type of pollution and seasonal fluctuations. The present investigation focused on the physicochemical characteristics of pond water of Ariyakulam (09°40'06" N; 80°01'09" E) and Pullukkulam (09°39'51" N; 80°00'43" E) urban ponds located in Jaffna District, Sri Lanka, during a period of six months from September 2021 to February 2022. Surface water samples were collected from four sites in triplicate once a month from each pond. Temperature, total dissolved solids (TDS), pH, and electrical conductivity (EC) of the samples were measured on-site, and chloride, sulfate and nitrate concentrations, dissolved oxygen (DO) and biochemical oxygen demand (BOD) were determined using standard procedures. The data were analyzed statistically using One-way ANOVA followed by Tukey's pairwise comparisons for each pond. The pooled data between the two ponds were compared with Student's *t*-test in Minitab 19 software. The results revealed that the average water temperature, TDS, pH, EC, chloride, sulfate and nitrate concentrations, DO and BOD values were 26.54±0.71 ^{o}C, 350.58±7.40 mg L^{-1}, 7.54±0.03, 585.44±15.95 µS cm^{-1}, 65.9±8.9 mg L^{-1}, 42.8±1.1 mg L^{-1}, 5.2±0.1 mg L^{-1}, 2.30±0.07 mg L^{-1} and 1.45±0.05 mg L^{-1}, respectively, in Ariyakulam pond, and the same parameters were 27.20±0.58 ^{o}C, 566.31±14.49 mg L^{-1}, 7.96±0.46, 882.91±17.37 µS cm^{-1}, 177.4±2.1 mg L^{-1}, 68.3±1.8 mg L^{-1}, 21.9±2.6 mg L^{-1}, 3.77±0.07 mg L^{-1} and 2.61±0.08 mg L^{-1}, respectively, in Pullukkulam pond. Physicochemical parameters of both ponds differed significantly from each other ($p < 0.05$), with the highest values observed in the Pullukkulam pond. This could be attributed to the unsafe disposal of household waste and surface runoff. Implementing pollution preventive measures through community-based engagements is recommended to create a pleasant urban environment in Jaffna City.

Keywords: Jaffna, Physicochemical parameters, Urban ponds, Water quality

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WQ03

MICROBIAL CONTAMINATION IN GROUNDWATER SOURCES IN SELECTED DISTRICT SECRETARIAT DIVISIONS OF NORTH-CENTRAL PROVINCE, SRI LANKA

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Groundwater, which is easily accessible and dependable, has been a vital part of the global water supply for agriculture, industry and residential use, and is the major source of drinking water in the dry zone of Sri Lanka. However, the microbial quality of water is one of the major public health concerns in the region. The present study assessed the microbial quality of groundwater sources in the North-Central Province by comparing the total coliform (TC) and the fecal coliform, *Escherichia coli* (*E. coli*) counts to the maximum permissible levels of Sri Lanka Standards (SLS-614) of drinking water quality. The study was carried out on 52 groundwater samples of shallow dug wells from selected District Secretariat (DS) divisions in Polonnaruwa District, namely Welikanda, Dimbulagala, Lankapura, Medirigiriya, Elahera, Hingurakgoda and Thamankaduwa. Except for two dug wells, all the other wells were protected. The samples were checked for total coliforms including *E. coli*, *Citrobacter freundii*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Klebsiella pneumoniae* and the fecal coliform *E. coli*. The water samples were cultured on m-Endo broth for total coliforms and m-FC broth for fecal coliforms and identified based on colony morphology. The results revealed that 54% of the water samples collected were contaminated with total coliforms and 34% of the samples were contaminated with fecal coliform *E. coli*. All samples collected from Dimbulagala and Lankapura DS divisions were negative for fecal coliform *E. coli*. However, 50% of the samples from Dimbulagala DS division and 33% of the samples from Lankapura DS division were positive for TC counts. Sixty percent (60%) of the samples from Walikanda DS division, 33% of samples from Madirigiriya, 40% of the samples from Elahera, 55% of the samples from Hingurakgoda and 50% of samples from Thamankaduwa DS divisions were positive for fecal coliform *E. coli*. According to the results, total coliforms ranged from 0 to 600/100 mL and the fecal coliform *E. coli* ranged from 0 to 400/100 mL. The SLS standards for total coliforms and fecal coliforms are 10 CFU/100 mL and 0 CFU/100 mL, respectively. This study suggests that the majority of shallow groundwater sources are at high risk of fecal contamination although they are protected. Therefore, strict precautions and actions are needed to minimize the fecal contamination of drinking water of shallow dug wells, as it is the major source of water for human consumption in the dry zone of Sri Lanka.

Keywords: Dug well, Fecal coliform, Fecal contamination, Groundwater, North-Central, Total coliforms

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WQ04

VALORIZATION OF GLUCOSE-DERIVED HUMIN AS A LOW-COST, GREEN, REUSABLE ADSORBENT FOR DYE REMOVAL

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The isomerization of D-glucose into D-fructose is a crucial industrial process for various food applications, such as the production of high fructose corn syrup. It also serves as a pivotal intermediate step in generating platform chemicals, such as 5-hydroxymethylfurfural, furandicarboxylic acid and levulinic acid. However, this conversion process results in the formation of undesirable black substances known as humin, which exhibits a polymeric furanic-type structure. This study focused on obtaining glucose-derived humin (GDH) by reacting D-glucose with an allylamine catalyst in a deep eutectic solvent, followed by carbonization at 500 °C for 2.0 h and then GDH, thus obtained, was explored as a cost-effective, eco-friendly, and reusable adsorbent for the removal of cationic methylene blue (MB) dye from water. This study marks the first application of GDH for toxic dye removal in wastewater. The morphology of pristine GDH was changed after the post-carbonization, leading to increased surface area, pore volume, and the formation of activated carbon. The removal efficiencies for MB dye were found to be 52.46% for pristine GDH, and 97.06% for carbonized GDH. Several factors, including the mass of adsorbent, initial MB concentration, reaction temperature, reaction time and medium pH, were identified as influencing dye removal efficiency. Notably, GDH exhibited superior efficiency in removing MB dye compared to the anionic methyl orange dye. Temperature measurements indicated an exothermic process following pseudo-first-order kinetics, with adsorption behavior fitting the Langmuir absorption isotherm. Utilizing response surface methodology, optimum reaction parameters were predicted, with 600 min reaction time, 50.00 mg L^{-1} initial dye concentration, and 0.11 g GDH, yielding a desirability of 98.70%. The optimized MB dye removal rate from this model was 96.85%, aligning well with the experimental value of 92.49%. ANOVA techniques confirmed the significance of the model, with F values indicating significance ($p < 0.05$) and suggesting the significance of model terms. Impressively, after 10 cycles, the MB removal rate remained above 80% by carbonized GDH, extending its potential as a green adsorbent for cationic dye removal from wastewater. This underlines the economic and environmental feasibility of utilizing the entire biomass conversion process.

Financial assistance from the National Science and Technology Council, Taiwan (Grant Nos. NSTC 110-2221-E-110-024 and 111-2221-E-008-111-MY3) is acknowledged.

Keywords: Carbonization, MB dye removal, Regeneration of adsorbent, Response surface methodology

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WQ05

DETERMINATION OF PHYSIOCHEMICAL PARAMETERS OF KORAIKULAM, A WATER BODY IN MANNAR ISLAND, SRI LANKA

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This study investigated the physiochemical parameters of Mannar's inland freshwater body, Koraikulam, shedding light on the ramifications of water pollution, and the consequential ecological and social challenges. Samples were collected from September to December 2023 covering before and after the start of the northeast monsoon of Sri Lanka. Monthly data were randomly collected at three different locations at the tank. Various physiochemical parameters, namely surface water temperature, salinity, pH, dissolved oxygen content, turbidity and electrical conductivity, were determined. Results indicated that the mean values during the study period were 31.7 °C, 0 psu, 6.54, 6.5 mg L^{-1}, 664.7 mg L^{-1} and 1254.4 µS cm^{-1}, respectively. Using MATLAB, association between monthly physiochemical parameters and mean monthly rainfall was examined through linear regression, yielding a coefficient of correlation (r) of 0.67. Among the parameters, pH showed a significant difference before and after rainfall [p = 0.04* (14 df)] when tested with chi-square analysis. These factors significantly influence the water quality, and flora and fauna inhabiting these ecosystems. Understanding these characteristics is crucial for sustainable water management and conservation efforts. Since Mannar falls under the arid zone, the quality and the quantity of precipitation received by the Koraikulam tank are vital. These water bodies serve as vital habitats for various migrant avifaunal species such as Greater Flamingo (*Phoenicopterus roseus*), Northern Pintail (*Anas acuta*), Brown-headed Gull (*Chroicocephalus brunnicephalus*), Gray Plover (*Pluvialis squatarola*), which migrate in larger numbers. Additionally, Koraikulam water resources play a pivotal role in agriculture. On average, during the Maha season, 24,280 m^2 of paddy fields had been cultivated for the last four years with an average of 30.107 megatons km^{-2} of paddy. Despite benefits, Koraikulam faces numerous anthropogenic threats, including land encroachment, poor tank management, and waste dumping. These activities degrade water quality, impact groundwater recharge and pose risks to public health through waterborne diseases. This study helps to understand the changes in physiochemical parameters which could aid in holistic water management and promote the conservation of this tank. Furthermore, there is an urgent need to highlight this issue to promote sustainable practices and safeguard ecosystems for future generations.

Keywords: Mannar, Monsoon, Water pollution, Water quality

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WQ06

VULNERABILITY ASSESSMENT OF GROUNDWATER RESOURCES IN THE JAFFNA PENINSULA, SRI LANKA: A MODEL STUDY FOR NITRATE DISTRIBUTION

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The assessment of groundwater vulnerability has become indispensable in the realm of hydrogeological science. It plays a crucial role in assessing, monitoring, conserving, and managing groundwater resources, especially in the Jaffna peninsula, where the water demand is mainly fulfilled by groundwater which exists in a hydrogeologically sensitive setup. In this study, a modified DRASTIC model, one of the most accurate overlay and index methods, was employed for the assessment of groundwater vulnerability. This modification considered the land use data from the WaPor open access web portal consisting of remote sensing satellite data, thereby providing a more relevant, updated, and accurate representation of vulnerability. The primary objective of this study was to delineate susceptible zones for groundwater pollution within the peninsula by integrating assessed hydrogeological layers or formations within the GIS. During the process, eight parameters (depth to water, net recharge, aquifer media, soil media, topography, impact of vadose zone, hydraulic conductivity and land use) utilized from temporal groundwater level fluctuation over ten years, borehole information of 102 tubewell constructions and test pumping and land use were manually evaluated according to a rating criterion and developed raster layers within a GIS database. The raster layers were overlaid according to the weight allocation and the groundwater vulnerability map was prepared. The resulting index map revealed a wide range of index values (100 to 250), which were categorized into five distinct classes, namely very low, low, moderate, high, and very high. The vulnerability assessment of a region covering 1025 km^2 classified 26% of the area as moderate, 35% as high and 39% as very high vulnerability zones. Groundwater recharge is notably heightened in shallow karstic aquifers, particularly in Jaffna, Nallur, Karaveddi, and Kopay, rendering these areas more susceptible to contamination. Soil textures, ranging from sandy loam to Solodized Solonetz and Solon Chaks, play a crucial role in groundwater permeability, in areas like Vadamarachchi and Pachchilapallai being more vulnerable to contamination due to easy percolation. The aquifer media, primarily limestone formations, exhibit high permeability and karst features, increasing vulnerability to contamination. Variations in hydraulic conductivity, flat topography and diverse land uses further contribute to the region's groundwater vulnerability. Urbanized areas, such as Jaffna and Nallur, exhibit higher aquifer vulnerability. The model validation provides how accurately the simulated conditions match the actual condition of the model area and the ultimate step for assessing the model accuracy. It demonstrated a strong correlation between nitrate levels which were measured before and after the monsoons over 10 years and the resulting DRASTIC-LU index. This validation not only enhances the credibility of the model but also underscores the practical utility of the assessment. The results of this vulnerability assessment on groundwater contamination can be used as a decision-making tool for policymakers and local authorities in land use management and planning.

Keywords: Aquifers, DRASTIC index, Groundwater, Nitrate, Vulnerability

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WQ07

THE GEOCHEMICAL ORIGIN OF WATER SALINITY IN THE DRY ZONE OF SRI LANKA

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This study focuses on Netiyagama village in Mihintale, Anuradhapura District, where water scarcity is exacerbated by elevated salinity levels (Average = 1759.24 mg L^{-1}), exceeding World Health Organization (WHO) standards. Salinity is influenced by ions, such as Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3-, Na^+ and Cl^-, primarily originating from the weathering of silicate rocks in the Wanni complex. This area comprises metamorphic rocks, such as charnockitic gneiss, hornblende biotite gneiss and granitic gneiss, as well as vein quartz and pegmatites, which are metamorphosed at upper amphibolite to granulite facies metamorphism. Petrographic analysis reveals moderate weathering of minerals, accelerated by hot temperatures in the dry zone, releasing the above ions into the environment. Temperature fluctuations between 28 °C to 32 °C characterize the region, with the northeast monsoon from December to January and the southwest monsoon from May to July influencing rainfall patterns. The study area, characterized by flat terrain, is recharged by two nearby reservoirs. While the main fracture patterns lie in north-south and north-west directions, minor fractures can be observed along the north-east direction. Water movement is slow due to the flat terrain and syncline fold structure, leading to high retention times that allow for the mixing and concentration of ions in groundwater. The predominant water type, Ca-HCO_3, constitutes over 85% of shallow and deep groundwater, with some occurrences of non-dominated cation-HCO_3, Mg-HCO_3, Na-K-HCO_3, and Ca-Mg-Cl types. Groundwater isotopes deviated from the local meteoric water line indicate moderation in precipitation due to geochemical processes or anthropogenic activities such as agriculture. This study underscores the importance of protecting recharge areas, particularly the nearby reservoirs, for sustainable groundwater management.

Keywords: Dry zone, Granulite-facies, Metamorphic terrain, Silicate minerals, Syncline fold structure

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WQ08

IMPORTANCE OF MAPPING WATER QUALITY PARAMETERS IN A SELECTED AREA IN GAMPAHA DISTRICT, SRI LANKA

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The quality of surface water and groundwater is of primary importance in maintaining the balance of natural ecosystems. Therefore, regular investigation of the water quality should be a priority to maintain the safety of humans. As water and soil are in contact, soil quality parameters would be complementary to water quality parameters. Therefore, mapping water and soil quality parameters is a successful approach as relevant maps constructed for each parameter can be used as a reference for predictions and future studies, and to address environmental issues raised by natural phenomena and anthropogenic activities. The determination of quality parameters together with mapping is followed by developed countries, mainly in the Scandinavian region. However, such approaches are not widely implemented in Sri Lanka, despite their necessity. The only nationwide mapping of groundwater quality parameters had been published as "Hydrogeochemical Atlas of Sri Lanka" in 1993, and hence, the data available in this publication are outdated. Further, the number of samples used in this investigation was inadequate to represent the entire country, especially the Northern Province due to issues of inaccessibility during the time of sampling. Therefore, this research focused on the extension of applying the concept of mapping in Sri Lanka as a pilot study selecting a single Grama Niladhari Division, Ihalagama-East, located in the Gampaha District, using a large number of sampling sites. Though the smallest administration unit was selected as the study area, a total of 59 groundwater and surface water samples as well as 59 soil samples were collected covering the entire area using random sampling. Conductivity, pH, nitrate content, phosphate content, Ca hardness and total hardness of water samples were determined while pH, nitrate content, phosphate content, soil organic matter content, and water-soluble and soil extractable Na^+, K^+ and Ca^{2+} of soil samples were determined using standard procedures to generate contour maps using Surfer software. The pH, conductivity, phosphate content and the nitrate content of water samples were found to lie within the ranges of 4.41-7.11, 52.0-277 µS cm^{-1}, 1.37-3.99 mg $L^{-1,}$ and 1.24-279.00 mg L^{-1}, respectively. The soil pH in all the samples falls within the acidic range, varying from 2.99-6.73, while most of the soil samples contain high nitrate contents, indicating significant contamination. The percentage soil organic matter content varied between 0.60% and 13.27%, and further, the distribution of water-soluble and extractable cations did not exhibit a wide range. The distribution of the nitrate content in the previous study ranged from 1-40 mg L^{-1}, showing a considerable deviation from the values obtained from the current study. This highlights that the variation of parameters in the study area is of considerable magnitude and has significant differences with the maps of the previous study. This highlights the need for routine analysis and mapping of the entire country.

Keywords: Mapping, Parameters, Soil, Water

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WQ09

COMPREHENSIVE STUDY OF FACTORS INFLUENCING THE ACCESSIBILITY AND WATER CONSUMPTION PATTERNS IN PUNGUDUTIVU ISLAND OF JAFFNA PENINSULA, SRI LANKA

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Water plays a vital role in sustaining life and supporting various human activities, particularly in health, agriculture, and industry. The arid regions of Sri Lanka's dry zone, especially rural areas, face a significant challenge of ensuring access to safe water. High salinity and year-round drought in Pungudutivu Island contribute to an ongoing struggle with water scarcity. Despite previous efforts of rational water distribution through local government tankers funded by the central government, the economic crisis has resulted in the discontinuation of funding, transforming water distribution into a paid service. This shift highlights challenges in maintaining access to safe water in the face of economic hardships, significantly impacting the communities of Pungudutivu. This study aimed to identify factors that influence water consumption patterns, water accessibility, and to identify contributors to household water use. The study utilized both primary and secondary data, gathered through a field survey conducted in the study area from August to September 2023. Primary data were collected through a questionnaire distributed among 145 households via simple random sampling, ensuring equal household representation. Secondary data were obtained from governmental bodies and community organizations in the region. In this study, the socio-economic status, water use economics, and per capita water consumption in households in Pungudutivu were analyzed and modeled using the *R* statistical software package. The findings revealed crucial insights, such as the average family income in Pungudutivu, which is 38,552 LKR, with a significant majority falling into low (63.45%) and middle (28.27%) income categories. All the people depend on water brought by trucks for their drinking purposes. For cooking purposes, 42.8% of households exclusively use water from trucks, while 57.2% of households receive water from trucks and from their own wells, and from other sources (public and private wells). For washing and bathing, only 9.7% of households exclusively rely on water from trucks, while 90.3% use water from wells. The findings reveal that households with lower education levels (primary and secondary education) spend more (1500 LKR) on water compared to the group who have received higher education (tertiary education) (1169 LKR). The low-income group spends 4494 LKR less, while the middle-income group spends 3609 LKR less when compared to the high-income group. The size of the household influences water spending as well, with an increase of 171 LKR for each additional person in the family. Those who use water from trucks for cooking spend more, and seasonal users spend more than daily users. The outcome of this study emphasizes the necessity of formulating strategies for water supply in Pungudutivu and potentially reinstating the free water supply scheme, which is crucial for poverty alleviation.

Keywords: Economic crisis, Groundwater, Safe water, Salinity, Water scarcity

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WQ10

ASSESSMENT OF SURFACE WATER QUALITY IN THE UPPER AND LOWER REGIONS OF WALAWE RIVER BASIN, SRI LANKA

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The Walawe River basin is the fourth largest river basin in Sri Lanka, and one of the most economically and geologically important river systems, running across 4% of the country's total area. This study was conducted with the primary objective of comparing the water quality between the upper and lower regions of the Walawe River basin. The river basin was considered upper and lower regions depending on the topography of the whole basin. The lower region was mostly flat and extended to an elevation of about 80 m and the upper region consisted of locations started around 300 m elevation. For this study, 12 locations from each region were selected and sampling was carried out in September 2023. Surface water samples were analyzed using standard methods. The investigation included analysis of key water quality parameters, such as pH, total dissolved solids (TDS), total suspended solids (TSS), electrical conductivity (EC), and concentrations of chloride, fluoride, nitrate, phosphate and sulfate. The data were statistically analyzed using independent samples *t*-test to find any significant differences in water quality between the two regions. The Water Quality Index (WQI), a comprehensive metric used to assess overall water quality, was calculated using the weighted arithmetic WQI method. The WQI was calculated by established Sri Lankan standards pertinent to drinking water, irrigation, and aquatic life. The results revealed significant differences ($p < 0.05$) in several key water quality parameters between the upper and lower regions. Notably, TDS, EC, and concentrations of chloride, fluoride, nitrate, phosphate and sulfate exhibited statistically significant differences ($p < 0.05$) between the two regions. The WQI calculations showed that 42% of the samples collected from the lower region and 92% of the samples from the upper region fell within the "excellent" range in terms of drinking water quality. WQI calculated in the context of irrigation suitability indicated that 58% of the samples in the lower region and 100% of the samples in the upper region were within the "excellent" category. In terms of aquatic life suitability, 17% of the lower region samples and 75% of the upper region samples were categorized as "excellent." Additionally, 33% of the lower region samples and 25% of the upper region samples fell into the "good" range. Notably, 50% of the lower region samples exhibited "poor" suitability for sustaining aquatic life. Based on the results of this study, it is concluded that the upper and lower regions of the Walawe River basin have significant differences in water quality. The upper Walawe region consistently shows better water quality, with a higher percentage of samples falling within the "excellent" range of the WQI. Conversely, the lower region has a diverse profile that requires targeted interventions to address challenges and ensure the overall health and sustainability of the Walawe River basin.

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Keywords: Surface water, Walawe River basin, Water quality index (WQI)

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WQ11

SYNTHESIS OF A CHEMO-SELECTIVE RECEPTOR ARM FOR THE DETECTION OF MICROCYSTIN-LR WITH THE AID OF SURFACE-ENHANCED RAMAN SPECTROSCOPY

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Water pollution poses significant risks to human health and ecosystems, emphasizing the need for real-time detection and treatment strategies. One such hazardous contaminant is Microcystin-LR (MC-LR), a toxin produced by cyanobacteria, which is a blue-green algae found in water bodies. According to the World Health Organization, MC-LR concentrations exceeding 1 μg L^{-1} would result in severe liver damage and even fatalities. Therefore, the detection of MC-LR is of utmost importance. However, current detection methods, including chemical and biochemical methods, and self-assembly technology, suffer from challenges, such as poor selectivity, lack of robust protocols, limited detection range, slow detection, matrix interference and high cost. In this context, this study aimed to develop a highly selective and efficient method for detecting MC-LR, offering potential applications in water quality monitoring and environmental protection. Here, silver nanoparticles (AgNPs) were synthesized and modified with a maleimide terminal-bearing functional arm which has the potential to selectively bind with the diene fragment of the MC-LR structure under the Diels-Alder reaction conditions. Then, the selective detection of MC-LR was achieved using functionalized AgNPs bearing maleimide terminals with the aid of surface-enhanced Raman spectroscopy (SERS). The synthesis of AgNPs in this study employed the hydroxylamine hydrochloride method. The chemo-selective maleimide functional arm was separately synthesized by reacting mercaptoethylamine with maleic anhydride. To prevent reactions between maleic anhydride and the thiol group, the thiol group of the mercapto-ethylamine was capped before the synthesis of the desired maleimide functional arm. The surface of the AgNPs was modified by allowing the thiol-capped maleimide functional arm to bind with the AgNP surface which is governed by the affinity of the thiol groups to silver. Finally, the Diels-Alder reaction between the diene motif of the MC-LR and the dienophile fragment of the maleimide terminal enabled the SERS-based detection of MC-LR. The peak at 409 nm of the UV-visible spectra, and the average particle size of 61 nm from the dynamic light scattering and transmission electron microscopy results confirmed the formation of nanosized monodispersed AgNPs. Furthermore, the formation of the desired maleimide from the maleic anhydride was confirmed by the stretching peak at 1145 cm^{-1} by the C-N-C bond. The surface modification of the AgNPs and optimization of the AgNP maleimide ratio was also supported by the indication of a peak at 236 cm^{-1} for the Ag-S bond in the SERS findings. This innovative approach is expected to establish an affordable and specific method for detecting and quantifying MC-LR in environmental water samples upon completion of both modeling and detection stages. This study lays the groundwork for further optimization and implementation, addressing the urgent need for reliable monitoring and mitigation strategies in the field of cyanotoxin detection to safeguard human and environmental health.

Keywords: Microcystin LR, Silver nanoparticles, Surface enhanced Raman spectroscopy, Water pollution

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WQ12

δ^2H AND $\delta^{18}O$ COMPOSITION OF RIVER WATER ALONG AN ALTITUDINAL GRADIENT IN A SMALL MOUNTAIN SUB-CATCHMENT OF MAHAWELI RIVER, SRI LANKA

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Water dynamics in mountain catchments in tropical regions is an important issue in watershed management. When studying water dynamics in watersheds, water isotope composition (δ^2H and $\delta^{18}O$) provides important information. Atabage Oya is one of the major mountain tributaries in the upper Mahaweli basin, with a total catchment area of 44 km^2. Drastic variations in the sub-basin from 600 to 1350 m from mean sea level are one of the key features of the selected tributary basin. To examine the isotope composition, river water samples were collected in September and November 2022 and in January and March 2023. Twenty sites were considered as a catchment representing different elevation regions. The results showed that the $\delta^{18}O$ composition of the mainstream and its tributaries ranged from -6.77 to -5.15‰, while the δ^2H content varied from -40.2 to -28.6‰. In some months, the isotopic composition was enriched compared to the local meteoric waterline ($\delta^2H = 8.0\delta^{18}O+10.5$), indicating a dominance of evaporation, while higher enrichment was found in March sampling. Overall, the river water isotope values plotted on the regression line are denoted by $\delta2H = 6.39\delta18O+3.49$ ($r = 0.929$). The d-excess value varies between 12 and 15‰, and on average it is 13.5‰. In contrast, the $\delta^{18}O$ and d-excess values suggest an enhanced terrestrial recycling moisture source in precipitation, possibly originating from the southeast monsoon. Isotopic composition is negatively correlated ($r = -0.586$ $p = 0.006$) with sampling site elevation, indicating possible fractionation and excessive evaporation during runoff to the deeper elevated regions in the sub-catchment. Isotopic composition results will provide insights into water resources in the watershed and other geochemical parameters. The results also demonstrated the need for detailed and site-specific collection of rainwater samples over an extended period to effectively detect climate-induced changes in water resources in the Mahaweli River basin.

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Keywords: Evaporation, Land use, LMWL, Recharge, Water isotopes

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WQ13

HYDROGEOLOGICAL ASSESSMENT OF GROUNDWATER IN THE METAMORPHIC TERRAIN OF DRY ZONE, SRI LANKA: INTEGRATION OF PIPER CLASSIFICATION, MULTIVARIATE ANALYSIS, AND GEOLOGICAL MAPPING

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Interactions between rocks and water in a metamorphic terrain play a crucial role in shaping the chemical evolution of groundwater geochemistry. Precise determination of the geochemical signatures of groundwater can offer a rapid method for geological mapping programs, leading to significant cost savings by avoiding the need for expensive drilling. The Piper trilinear diagram is commonly employed for hydrogeochemical facies determination. However, the Piper method relies only on the geochemistry of main ions, and categorizes water types into limited groups, restricting the identification of fine structures within groundwater signatures. In this investigation, the Piper method was employed to ascertain the hydrochemical composition of groundwater, predicated on the mineralogical characteristics imparted by the lithological formations within the aquifer systems in Netiyagama located in Anuradhapura District. The variation of major ions concerning rock types was used to identify different patterns based on lithology. The resulting sub-groups were further classified using a multivariate statistical method. Total alkalinity (30.38-601.72 mg L^{-1} $CaCO_3$), pH (6.49-8.57 mg L^{-1}), TDS (75-1035 mg L^{-1}) and EC (155-1850 mg L^{-1}) were determined for each unfiltered sample within 24 h of collection. Anions and cations in samples were determined through ion chromatography and inductively coupled plasma optical emission spectroscopy, respectively. Results show that the major ions and their variations are as, Ca^{2+} (6.67-195.38 mg L^{-1}), Na^{+} (14.09-317.22 mg L^{-1}), K^{+} (0.64-26.14 mg L^{-1}), Mg^{2+} (2.89-96.02 mg L^{-1}), SO_4^{2-} (4.98-193.58 mg L^{-1}), Cl^{-} (10.85-668.23 mg L^{-1}), HCO_3^{-} (37.06-734.09 mg L^{-1}) and CO_3^{2-} (75.26-1490.80 mg L^{-1}). Water classification and hydrogeochemical mapping were done using Origin Pro software and ArcGIS mapping software, respectively. Piper analysis classified water facies as Ca-HCO_3, Ca-Cl, Na-K-HCO_3, Ca-Mg-Cl, and Na-Cl. The predominant water type, $CaHCO_3$, encompasses over 85% of shallow and deep well water, with a minority comprising Ca-Cl, Na-K-HCO_3, Ca-Mg-Cl, and Na-Cl. Surface water in discharge areas predominantly falls into the Na-K-HCO_3 type, with occasional occurrences of Na-Cl. The geology of the area comprises granitic gneiss, biotite gneiss, and hornblende biotite gneiss. Recharged areas exhibit heightened weathering of granites and amphiboles, supplying elevated levels of Ca^{2+}, Na^{+}, Cl^{-}, F^{-} and Sr to the water. Element depletion and enrichment are linked to leaching of primary mafic minerals of hornblende, biotite, plagioclase due to prolonged residence time. Hydrogeochemical components and clusters identified through HCA analysis unveil subsets within the data that exhibit notable enrichments of bicarbonate (HCO_3^{-}), sodium (Na^{+}), and fluoride (F^{-}) ions, especially within deep groundwater sources.

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Keywords: Dry zone, Hydrogeochemistry, Geochemistry, Groundwater, Sri Lanka

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WQ14

SPATIAL AND TEMPORAL VARIATION OF WATER QUALITY IN GROUNDWATER SOURCES AND FINAL BOTTLED WATER PRODUCTS IN SRI LANKA

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Groundwater is the primary source used for bottled water manufacturing, and the source should be registered for bottling. Further, the source and the treated water should comply with Sri Lanka Standard (SLS) 614:2013. Consequently, understanding the spatial variation and processes affecting water quality has a timely demand to sustain water resources under changing climate and local environmental pressures. The present study was conducted to determine the spatial and temporal variation in water quality parameters of groundwater sources used in bottled or packaged drinking or natural mineral water manufacturing. For this purpose, water samples from selected bottled water sources (n = 16) in wet and intermediate zones of Sri Lanka, representing tube wells, dug wells and springs, were analyzed monthly for a period of one year. Respective final bottled water products were also analyzed to investigate the quality of the final treated product. The results show that pH varies within the range of 4.1-8.0 (SLS: 6.5-8.5) with an average of 6.3±0.8 where 75% of the source water samples do not comply with the standard. Total dissolved solids (TDS) (SLS: < 500 mg L^{-1}) and hardness (SLS: < 250 mg L^{-1}) vary within the range of 8.9-184.2 mg L^{-1} and 3.2-206.8 mg L^{-1} as $CaCO_3$, respectively, in source water (n = 15) complying with the standard except for one location in Matale District. Alkalinity (SLS: < 200 mg L^{-1}) and nitrate (SLS: < 50 mg L^{-1}) contents comply with the standards in all the sources having ranges of 3.9-189.3 mg L^{-1} as $CaCO_3$ and (< 0.2-21.6 mg L^{-1}), respectively. The pH decreases with the rainfall, while TDS and hardness increase in some water sources (n = 6). Moreover, respective water quality parameters in all final bottled water products after treatment lie within the SLS standard except for pH in six brands. TDS, alkalinity, hardness, and nitrate concentration had been reduced while pH had been increased in all final products as compared to those of the source water. It is concluded that the groundwater quality of bottled water sources varies depending on the geomorphology, rainfall, and groundwater flow paths of the respective areas. Effects of anthropogenic factors are minimal for water quality in bottled water sources. As pH is not adjusted in most bottled water products even after treatment, it is recommended that bottled water manufacturers consider this aspect in addition to taking measures to reduce the total ion content in water.

Keywords: Bottled water, Groundwater, Spatial variation, Temporal variation, Water quality

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WQ15

QUANTITATIVE DETERMINATION OF ANIONS IN ATMOSPHERIC DEPOSITION OF KANDY AND PERADENIYA, SRI LANKA, AS A MEASURE OF SURFACE WATER QUALITY

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The composition of atmospheric bulk deposition, which is the combined form of wet deposition and dry deposition, could be considered as a factor that influences the surface water quality. Dissolution of pollutants released to the atmosphere would alter the chemical composition of rainwater, which ultimately contributes to chemical characteristics of surface water, leading to health issues of the biota and the surroundings. In this regard, this study aimed at quantitative determination of chemical characteristics of precipitation in Kandy and Peradeniya over a period of five months from May to October 2023. Bulk precipitation in two sampling sites was analyzed weekly for water quality parameters: pH, conductivity, and anions; Cl^-, NO_3^- and SO_4^{2-}, standard analytical methods revealed that the Kandy city and the University of Peradeniya sites had 40% and 25% dry-only precipitation, respectively. The volume-weighted mean (VWM) values of pH in Kandy city and University of Peradeniya were 6.52 and 6.70, respectively. Moreover, only 15% of acidic precipitation events below pH 5.6 were recorded in Kandy, and no acidic precipitation was recorded at the site of the University of Peradeniya. The VWM pH values of both sites were observed to be within the standard pH of water quality. The concentration of anions at the Kandy city sampling site was in the range of 0.376-11.063 mg L^{-1}, and that at the University of Peradeniya site was in the range of 0.343-10.220 mg L^{-1}. The VWM concentrations of major anionic species were in the order $Cl^- > SO_4^{2-} > NO_3^-$, and Cl^- was identified to be dominant at both sites. All three major anions were observed to be within the respective standard permissible levels for drinking water. Very strong or strong positive Pearson correlations were observed between Cl^- and SO_4^{2-}, Cl^- and conductivity, and SO_4^{2-} and conductivity at both sites. Although this study reveals that rainwater quality depends on both natural and anthropogenic resources, continuous assessment is further needed to draw conclusions on surface water quality.

Keywords: Atmospheric bulk deposition, Chemical characteristics, Pearson correlation, Surface water quality, Volume weighted mean

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WATER POLLUTION

WP01

GEOCHEMICAL TRACER TO IDENTIFY NITRATE POLLUTION IN GROUNDWATER IN THE DRY ZONE OF SRI LANKA

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Groundwater serves as a vital water source in the dry zone of Sri Lanka. Typically, deep aquifers remain isolated from anthropogenic activities. However, the infiltration of nitrates into groundwater has emerged as a serious environmental concern in areas with intensive agricultural practices. Owing to its inherent stability, high solubility and ease of migration, nitrate has emerged as a primary pollutant in groundwater. Elevated levels of nitrates not only contribute to the occurrence of methemoglobinemia but also pose mutagenic risks. To ensure a safe water supply and effectively combat nitrate pollution, it is very important to identify the sources of nitrate contamination. This study aims to investigate the variation of nitrate levels in deep aquifers in Netiyagama, Mihintale. The primary objectives were to identify areas of nitrate pollution in groundwater, and to determine the potential sources of organic nitrogen oxidation. To achieve this goal, dual isotope analysis (^{15}N and ^{18}O) method was used and is in progress. A total of 83 water samples were collected from various locations, including surface, shallow and deep-water sources. These samples were analyzed using inductively coupled plasma spectroscopy to quantify major ions. Additionally, nitrogenous species, such as NO_3^-, N_2H_4 and NH_3, were examined to determine the total nitrogen content. Several nitrate hotspots were identified closer to agricultural lands in the spatial map compiled with Inverse Distance-Weighted Interpolation method. The nitrate levels of the groundwater samples ranged from 0.00 mg L^{-1} to 179.78 mg L^{-1}, and the maximum was reported in a tube well located in a preschool. The level was three times higher than the permissible level of SLS standards for drinking water and showed a significant increase with time without direct anthropogenic activity. The water in the area is predominately composed of sodium or potassium types, bicarbonate types, and mixed types due to the interaction between rocks and water. This has been identified through the Piper trilinear method. The pH of the samples ranged from 7.03 to 9.54, indicating that groundwater in this region is alkaline. Based on the geology of the region, the groundwater also exhibits high salinity due to intensive weathering. Furthermore, the water shows a permanent hardness, which results from the weathering of feldspar-rich minerals present in the rocks. This study illustrates the various pathways through which nitrates from anthropogenic sources can migrate into hard rock aquifers, relying on the microbial nitrogen cycle and depending on the soil profile of the area. The cross sections of rock fractures showed a direct connectivity of surface water bodies to deep aquifers in certain locations indicating the possibility of infiltration of nitrogen sources. The findings highlight the significant impact of anthropogenic nitrogen input mainly due to agricultural runoff and fertilizer use, as evidenced by the variations observed in NO_3^-, Cl^- and total dissolved solids contents along the direction of the steepest water flow in the study area.

Keywords: Anthropogenic, Aquifers, Groundwater, Nitrate, Pollution

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WP02

SCREENING THE PRESENCE OF CYANOTOXIN IN SELECTED RESERVOIRS IN SRI LANKA AND UTILIZING MOLECULAR MARKERS FOR AN ENHANCED EARLY WARNING SYSTEM

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The occurrence of toxic and non-toxic cyanobacteria in irrigation and drinking water resources is a significant health and ecological concern worldwide. Therefore, establishing reliable and cost-effective tools to identify the occurrence of toxin-producing cyanobacteria could lead to an early warning system to prevent toxin-contaminated water consumption and use in recreational activities. The present study employed two methods; an enzyme-linked immunosorbent assay (ELISA) to quantify cyanotoxins and polymerase chain reaction (PCR) to evaluate the presence of the genes responsible for producing cyanotoxins microcystin (MC), cylindrospermopsin (CYN), nodularin (NOD), anatoxin-a (ANA-a) and saxitoxin (SAX). Forty-three (43) water samples from selected water bodies in Sri Lanka, including categories for drinking, recreational and irrigation, were collected between November 2019 and July 2020. Three water samples were collected from each reservoir for the analysis. The results of the study showed that 24 water bodies contained at least one of the toxin-producing genes. In Beira Lake, 3.31 µg L^{-1} of MC was detected by ELISA. Among the tested cyanotoxins, MC was found to be the most dominant (37%) in the water samples collected following CYN (10%), SAX (10%), NOD (10%) and ANA-a (10%), respectively. The results of the study showed that two thirds of the water bodies tested were contaminated with at least one cyanotoxin-producing gene. The study could provide information for drinking water supply, irrigation and recreational water companies to adhere to suitable risk assessment strategies.

Keywords: Anatoxin-a, Cylindrospermopsin, Drinking water safety, Microcystin, Nodularin, Saxitoxin

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WP03

AMOXICILLIN AND CIPROFLOXACIN RESISTANCE OF *Salmonella* spp. AND *Shigella* spp. ISOLATED FROM COASTAL WATER FROM NEGOMBO TO MIRISSA, SRI LANKA

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Salmonella spp. and *Shigella* spp. are two major water-borne pathogens that cause salmonellosis and shigellosis, respectively. Amoxicillin (AMX) and ciprofloxacin (CPX) are two common antibiotics used to treat these diseases. The coastal belt between Negombo to Mirissa is a major coastal tourism hotspot in Sri Lanka. Hence, the objective of the present study was to detect *Salmonella* spp. and *Shigella* spp. from the coastal belt from Negombo to Mirissa and evaluate their antibiotic resistance against AMX and CPX. Fourteen sample localities were selected along Negombo to Mirissa coastal belt and three samples were collected from each locality into 2.5 L sterilized glass bottles. The samples were transported to the laboratory at 4 °C and immediately subjected to microbiological analysis. *Salmonella* spp. and *Shigella* spp. were isolated following standard procedure using enriched cultures in buffered peptone water and xylose lysine deoxycholate agar selective media. The positive isolates were confirmed using biochemical tests, and they were subjected to antibiotic resistance plate assays according to the Clinical and Laboratory Standards Institute (CLSI) guidelines using varying concentrations of AMX and CPX between 60 µg mL^{-1} and 360 µg mL^{-1}. Twenty-four (24) isolates were identified of which 13 were *Salmonella* spp. and 11 were *Shigella* spp. Furthermore, 83% of the isolates were resistant to AMX at 60 µg m L^{-1}, while all isolates were sensitive to CPX at the same concentration. Additionally, 29% of the isolates showed resistance against AMX even at a maximum concentration of 360 µg m L^{-1}. The results of the study indicate the presence of AMX-resistant environmental bacteria. Further studies are needed to evaluate the mechanisms of resistance to these two antibiotics and the resistance of environmental bacteria against other commonly used antibiotics in medical and veterinary fields.

Keywords: Amoxicillin, Ciprofloxacin, Resistance, *Salmonella* spp., *Shigella* spp.

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WP04

VIRULENCE POTENTIAL AND ANTIBIOTIC RESISTANCE OF *Escherichia coli* ISOLATES FROM CONTROLLED OPEN DUMP SITES IN SRI LANKA

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Urbanization and rapid industrialization have accumulated massive amounts of municipal solid waste in open dump sites which could lead to contamination of groundwater. *Escherichia coli* (*E. coli*) is a facultative anaerobic bacterium, and *E. coli* O157 is a pathogenic strain that causes severe human illnesses including bloody diarrhea. The present study focuses on the virulence potential and antibiotic resistance profiles in *E. coli* isolates from well water around the Karadiyana, Meethotamulla and Kerawalapitiya controlled open dump sites in Sri Lanka. The Most Probable Number (MPN) method was followed to isolate *E. coli* and the virulent genes, eae, stx1 and stx2 were selected for the screening of *E. coli* O157. The antibiotics amoxicillin (AMX), ampicillin (AMP), sulfamethoxazole/trimethoprim (SUF/TRI), sulphadimidine (SDI), cloxacillin (CLOX), tetracycline (TET), erythromycin (ERM), gentamicin (GEN), azithromycin (AZY) and ciprofloxacin (CIP) were used to determine antibiotic resistance of isolated *E. coli* following the standard well diffusion method. According to the results, *E. coli* count of water ranged from 0-120 MPN mL^{-1} around the Kardiyana dump site, whereas it ranged from 0-75 MPN mL^{-1} and 3-115 MPN mL^{-1} in groundwater samples collected from the Methotamulla and the Kerawalapitiya dump sites, respectively. Overall, the resistance in isolated *E. coli* against antibiotics; AMX, AMP, SUF/TRI, SDI, CLOX, TET and ERM was high (> 70%) compared to the other tested antibiotics, namely CIP, GEN and AZY (<40%). In this study, enteropathogenic *E. coli* pathotype was identified in 17 samples, whereas the enterohaemorrhagic *E. coli* pathotype was found in only three samples. However, further research needs to be carried out to confirm if solid waste dump leachate is the source of groundwater contamination in these areas.

Keywords: Antibiotic resistance, *E. coli* O157, Leachate, Municipal solid waste

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WP05

THE CONTRIBUTION OF ORNITHOLOGICAL EUTROPHICATION TO THE DETERIORATING WATER QUALITY IN THE KANDY LAKE ECOSYSTEM, SRI LANKA

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Eutrophication is a leading cause of the decline of aquatic ecosystems and has been predominantly attributed to anthropogenic activities. However, minimal attention has been directed towards exploring alternative sources. This study investigated the correlation between water quality and nutrient enrichment arising from waterbird activities, most notably through the addition of their nutrient-rich excrements to water, which is termed guanotrophication. This study was conducted at Kandy Lake, situated in the Central Province of Sri Lanka, to assess the potential contribution of the aquatic and roosting waterbirds, residing in communal nesting sites on trees bordering the lake, to eutrophication. A comprehensive examination was conducted at six sampling sites, distributed evenly across areas with varying bird densities, from February to July 2022. On-site measurements, such as pH, temperature, total dissolved solids, conductivity and dissolved oxygen (DO), were collected using portable meters. Laboratory analyses of samples from each site were performed using analytical techniques, such as ion chromatography, to determine the impact of nutrients, such as phosphate and nitrate. Additionally, plankton samples were collected using a 20 µm pore size plankton net. A concurrent bird survey was conducted to determine the diversity and abundance of avian species within the lake premises. Statistical analyses using Minitab v.18 and Canoco v.5 software aimed to establish correlations between nutrient loading by birds and water quality. The study revealed a notable tendency for waterbirds to aggregate at communal nesting sites, forming heronries, resulting in higher bird density on one side of the lake. Correlations between measured environmental variables and biota indicated a moderately negative correlation between DO and bird densities. Further surveys revealed a statistically significant ($p < 0.05$) positive correlation of 0.042 between bird abundance and phosphate levels, indicating potential contribution from avian excrements. Phytoplankton also exhibited a positive correlation with bird densities. The prevalence of bloom-forming phytoplankton, including *Aulacoseira* sp., *Pediastrum* sp., and *Microcystis* sp., known indicators of eutrophication, was notably high at sites with elevated bird densities. Canonical correspondence analysis identified nitrate and nitrite as crucial environmental variables explaining phytoplankton variation, while DO, pH, nitrate and nitrite influenced zooplankton variation. Thus, this study indicates ornithological eutrophication manifesting in Kandy Lake. The findings underscore the importance of considering waterbird activities as potential contributors to nutrient enrichment in aquatic ecosystems, shedding light on a previously overlooked aspect of eutrophication dynamics. Further research in this direction is warranted to comprehensively understand and mitigate the impact of ornithological eutrophication on freshwater bodies.

Keywords: Guanotrophication, Nutrient loading, Ornithological eutrophication, Plankton, Waterbirds

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WP06

PIPE-BORNE DRINKING WATER CHALLENGES DUE TO INTERMITTENT WATER SUPPLY

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Access to clean drinking water is a fundamental necessity for communities across the globe. However, in many regions, the presence of intermittent water supply (IWS) systems poses distinct challenges in maintaining water quality and ensuring its safety in distribution systems. This issue is particularly prevalent in less developed countries, such as Sri Lanka, where the implementation of IWS is a common strategy employed in drinking water distribution networks to address water demand. This research aims to examine the water quality issues in IWS with a specific focus on selected regions in the Kandy District where water is received only once a week. The water samples were collected directly from tap lines and categorized into two distinct sampling groups: IWS with resumption and IWS after resumption within two to three hours. Physicochemical parameters, including pH, electrical conductivity, turbidity, total dissolved solids, color, residual chlorine, free ammonium ion, nitrite, nitrate, microbiological parameters, total coliforms (TC), fecal coliforms (FC), heterotrophic plate count (HPC) and colony morphology, were determined. Moreover, the research involved conducting a questionnaire survey among the community served by the selected water supply scheme to gain perceptions and experiences related to IWS. The results revealed a variation in water quality parameters across the two sampling categories. All physicochemical parameters were found to be in accordance with Sri Lankan drinking water quality standards (SLS-614:2013). Low levels of free ammonium ions and elevated levels of nitrite and nitrate levels were observed in two types of samples which were within the SLS standards. In terms of microbial quality, it is notable that TC or FC was not detected in any of the water samples. However, the HPC was found to be very high in samples from IWS with resumption (Mean = 1560 CFU mL^{-1}) and IWS after resumption (Mean = 150 CFU mL^{-1}). The survey results highlighted the significance of both the public and expert ideas in understanding the concerns surrounding water quality in IWS. These findings provide valuable perspectives on the state of the water quality in the IWS in the area investigated. Even though physicochemical parameters were in adherence to SLS standards, no risk of fecal contamination, significantly high HPC levels, and diverse colony morphology are of concern. Therefore, further investigation is needed to ensure the microbial quality issues identified in the IWS.

Keywords: Heterotrophic plate count, Indicator bacteria, Intermittent water supply, Resumption

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WP07

USE OF STABLE ISOTOPES FOR IDENTIFICATION OF GROUNDWATER RECHARGE CAPACITY WITH SPECIAL REFERENCE TO GAMPOLAWATTHA WATER SUPPLY SCHEME

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As the population grows, the need for drinking water and agriculture increases exponentially. Water stored underground is the most essential resource among freshwater sources; however, it is rapidly decreasing due to over-exploitation and pollution. Globally, artificial recharge of aquifers is considered a potential solution to overcome the problem of groundwater level depletion. However, identifying and quantifying the natural groundwater recharge process is crucial for artificial groundwater recharge. In many areas of Sri Lanka, groundwater resources have declined drastically, negatively impacting drinking water supplies. During the dry season, the Gampolawatta water supply scheme in Naranwita was severely affected by water shortage. Therefore, a detailed study was conducted to identify a suitable location for an artificial recharging project. The identification of natural recharging processes is essential for this. This study aimed at analyzing water samples from available groundwater wells and surface water sources, including rainwater, for their major element and isotope composition (δ^2H and $\delta^{18}O$). The δ^2H values of water samples from tube wells ranged from -34.57 to -30.01‰ with a mean of -31.97‰, while water samples from dug wells ranged from -34.55 to -32.26‰ with an average of -33.27 ‰. The $\delta^{18}O$ of water samples from tube wells and dug wells were -5.88 to -5.06‰ and -5.74 to -5.32‰, respectively. The isotopic composition of most groundwater samples was plotted near the local meteoric waterline, suggesting direct recharge from local precipitation. Mass balance calculations showed that 72% of water from tube wells and 91% of water from dug wells were directly recharged by rainfall, while the remainder came from surface water sources. Based on isotope data, it is recommended to collect rainwater in artificial ponds and then discharge it into the aquifer via deep wells to improve the groundwater level in the region.

Keywords: Artificial recharge, Drinking water, Mass balance, Naranwita, Water isotopes

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WP08

DEVELOPMENT OF A BIPOLAR ELECTROCHEMICALLY GENERATED CHEMILUMINESCENCE DETECTOR FOR As(III) PRESENT IN WATER

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Water is a most precious and vital natural resource that is crucial to life. Even though about 71% of the earth's surface is covered with water, only 1% is potable, and this minute amount is at risk mostly owing to the pollution from anthropogenic activities. Among them, significant attention has been devoted to arsenic due to its high toxicity. Even very low levels of arsenic can cause serious health issues particularly to infants, and hence, the quantification of trace arsenic metal in water is important. Spectroscopic techniques are the most popular methods of detection of arsenic in drinking water. However, certain drawbacks such as very high capital cost and the requirement of conventional laboratories have sparked the interest in electrochemical methods which are low-cost and field-portable. Therefore, the aim of this work was to develop a simple, versatile, field portable and low-cost detector to trace As(III) ions in water using bipolar electrochemically generated chemiluminescence (Bipolar ECL). Bipolar electrochemistry (BPE) is an unconventional technique where a conducting object is addressed electrochemically in an electrolyte without direct ohmic contact. In this study, electrogenerated chemiluminescence (ECL) was chosen as the optical detection method to couple with the electrochemical detection using the bipolar electrode. Based on these principles, a smartphone-based monitoring platform coupled with the ImageJ software was developed to detect ECL. The smartphone application named "OSnap" was used in this study to capture luminescence with timelapse and to stop motion projects. First, the ability of this platform was successfully evaluated using a luminol-hydrogen peroxide chemiluminescence system in which a calibration curve with R^2 of 0.9982 was produced by varying the luminol concentration. Next, experiments were carried out to evaluate the effectiveness of the system for the detection of As(III) in water. The optimum amount of H_2O_2 for electrogenerated chemiluminescence was 1 µL of 0.30 mmol L^{-1}. The capability of measuring electrogenerated chemiluminescence was evaluated under a nitrogen purging environment using a series of arsenic standards . A calibration curve with R^2 of 0.9978 was produced by varying the concentration of arsenic. Future work will encompass the integration of the detector developed with a paper-based separation device to detect heavy metal pollutants in water.

Keywords: Bipolar electrochemistry, Bipolar electrode, Chemiluminescence, Electrogenerated chemiluminescence, Smartphone

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WP09

CHEMICAL MODIFICATION OF SILVER NANOPARTICLES TO MODEL THE SELECTIVE DETECTION OF MICROCYSTIN-LR WITH THE AID OF SURFACE-ENHANCED RAMAN SPECTROSCOPY

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Microcystin is a secondary metabolite produced by certain cyanobacterial species, such as the genera *Microcystis*, *Nostoc*, *Aphanizomenon*, *Anabaena*, *Planktothrix* and *Cylindrospermopsis*. Microcystin-LR (MC-LR) is the most toxic congener found in aquatic environments, such as slow-moving streams, lakes, ponds and reservoirs. These metabolites are harmful to both the environment and human health. Various methods, including biological (Mouse bioassay), biochemical (protein phosphatase inhibition assay, enzyme-linked immunosorbent assay), chemical (high-performance liquid chromatography) and biosensor approaches, are currently used to detect MC-LR in aquatic environments. However, these methods are costly and require tedious sample preparation procedures and specialized expertise. Hence, novel and rapid protocols to detect MC-LR are urgently needed. This research aimed to develop an innovative, reliable, and robust chemoselective protocol for detecting MC-LR using surface-enhanced Raman spectroscopy (SERS). More specifically, amidine-carboxylate interactions are used as the chemoselective strategy in this study. This involved synthesizing silver nanoparticles (AgNPs) using the Leopold-Lendl method, which was then characterized using UV-Vis spectrophotometry and particle size analysis. The surfaces of the AgNPs were modified using thioglycolic acid solutions of different concentrations to obtain thioglycolic acid-modified AgNPs, which were characterized using UV–Vis spectrophotometry. Solutions of $MgSO_4$ and NaCl of different concentrations were used to obtain enhanced Raman peaks for adsorbed thioglycolic acid on AgNPs. Amidine-carboxylate salt bridge formation was used as a key chemoselective strategy to keep MC-LR and AgNPs in close proximity to enhance the peak signal attributed to MC-LR. Arginine was selected as the model compound to optimize conditions for amidine-carboxylate salt bridge formation owing to its amidine fragment akin to the amidine fragment in the MC-LR structure. A concentration of 50 mg L^{-1} arginine solution was allowed to form an amidine-carboxylate salt bridge with thioglycolic acid modified AgNPs at pH 8.00 and 9.00 under vigorous mixing for 10 h. The salt bridge formation was then characterized using SERS. Based on spectroscopic analysis, the wavelength at the highest absorption was determined at 408 nm. The average size of AgNPs was determined to be 40 nm. Surface saturation of thioglycolic acid was obtained by mixing 1000 µL of 2.56×10^{-11} mol L^{-1} of AgNP solution with 100 µL of 100 mg L^{-1} thioglycolic acid solution. SERS was employed to characterize the adsorption of thioglycolic acid, and it revealed a notable increase in Raman intensity when $MgSO_4$ was used instead of NaCl, especially with the best enhancement observed by adding 50 µL of 1.00 mol L^{-1} $MgSO_4$ solution. Despite modeling amidine-carboxylate interaction with thioglycolic acid-modified AgNPs and arginine indicated a peak shift of arginine, no apparent peak shift occurred under the given conditions. Therefore, these parameters require further optimization before using them as a basis for the development of a selective method to detect MC-LR with the aid of modified AgNPs and SERS.

Keywords: AgNPs, Microcystin, Raman spectroscopy, Selective detection

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WP10

DEVELOPMENT OF AN ELECTROANALYTICAL METHOD BASED ON MODIFIED ELECTRODE TO DETERMINE TRACE AMOUNTS OF ARSENIC PRESENT IN WATER

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Arsenic (As) is a toxic heavy metal that is detrimental to human health even in trace amounts. It may be added to water and soil via natural sources such as arsenopyrite and volcanic eruption, and through anthropogenic activities such as coal burning, use of agrochemicals and pharmaceuticals, timber treatment, waste disposal, and mining. Real-time and onsite detection of As in water is essential to minimize arsenic contamination in drinking water. Many analytical tools, such as atomic absorption spectroscopy, inductively coupled plasma mass spectrometry, inductively coupled plasma atomic emission mass spectrometry and neutron activation analysis, are available to determine the concentration of As in water; however, these methods require conventional laboratories and are very expensive. Electrochemical methods have potential to yield a cheap and field-portable alternative. The electrochemical response of As on a bare glassy carbon electrode (GCE) is minimal, and therefore, electrode modifications are essential. Different types of electrode modifications were attempted, and it was found that the electrochemical deposition of gold nanoparticles (AuNP) on GCE produced the highest electrochemical response in cyclic voltammetry. A 1.000 mmol L^{-1} solution $HAuCl_4$ in 0.500 mol L^{-1} H_2SO_4 was cathodically scanned between +1.0 V to -0.6 V with 0.05 V s^{-1} scan rate for the potential deposition of AuNP on GCE. The cathodic peak appeared at +0.74 V corresponding to the reduction of Au(III) into Au(0). The number of deposition cycles was optimized as twenty to obtain the highest anodic current for As(III). A calibration curve for As(III) was constructed by recording the anodic peak current of the cyclic voltammogram from -0.705 V to +0.600 V with 0.05 V s^{-1}. A detection limit of 2.344 ppm was obtained with an R^2 value of 0.5118. In summary, the electro-deposition of Au on GCE yields higher oxidation peak currents compared to deposition by drop casting. This method holds promise for enhancing the trace analysis of As in portable water.

Keywords: Arsenic, Cyclic voltammetry, Electrodeposition, Gold nanoparticles, Modified glassy carbon electrode

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WP11

EVALUATION OF HEAVY METAL POLLUTION AND SUSTAINABLE REMEDIATION PRACTICES IN THE LOWER CATCHMENT OF THE KELANI RIVER BASIN: A SYSTEMATIC REVIEW

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The heavy metal contamination of surface and groundwater levels has a significant impact on the water quality of inland water resources. The Central Environmental Authority, Sri Lanka, claims that the Kelani River is the most contaminated river in Sri Lanka. It is heavily polluted by liquid waste from expanding industries, agricultural runoff, and household and municipal waste, especially in the lower catchment. In light of this, this review was conducted to assess whether certain heavy metals remain in compliance with Sri Lanka water quality standard limits (SLS:614; 2013), and to understand the possible remedies for the reduction of heavy metal accumulation to ensure the sustainable management and pollution control of lower catchment of the Kelani River basin. This review exclusively focused on peer-reviewed research studies (30 research articles) that were conducted during the past decade (2013-2023), and published in the English language. The study locations of published literature were selected and grouped based on industrial discharge, anthropogenic activities, catchment characteristics, and land use practices. Heavy metals, including cadmium (Cd), aluminum (Al), zinc (Zn), lead (Pb), chromium (Cr) and copper (Cu), were selected for the study as they were the most studied parameters. SLS:614; 2013 standard was used to observe the suitability of selected heavy metal concentrations across land uses with the permissible limits for water consumption. According to the results, the mean value of Al (1.98±1.15 mg L^{-1}) was detected in exceeded amounts from 2018 to 2023, in the lower catchment across industrial sites. Furthermore, the mean values of other heavy metals such as Cd (0.05±0.12 mg L^{-1}), Zn (0.06±0.04 mg L^{-1}), Cu (0.02±0.01 mg L^{-1}), Cr (0.01±0.00 mg L^{-1}), and Pb (0.01±0.00 mg L^{-1}) remained within the drinking water standards (SLS:614; 2013). The study discovered that metal concentrations other than Al were within acceptable limits during the research period. However, there was a noticeable trend that indicated a rapid increase in their levels. Given the significance of the Kelani River, prompt action and the development of long-term strategic measures are required. The study emphasizes the importance of protecting the lower Kelani River basin from industrial, domestic and agricultural pollution. To address this issue, the review suggests that best management practices be implemented at the industrial level, along with effective stormwater management and water treatment methods such as coagulation, adsorption, precipitation and ion exchange. Additionally, constructed wetlands are recommended for pollution reduction. Furthermore, the study advocates for stronger stakeholder collaborations such as university-industry partnerships, and community engagement activities such as awareness campaigns. This collaborative effort aims to address mainly the exceeded levels of Al, and other emerging heavy metal concentrations in the lower catchment of the Kelani River basin, ensuring the long-term sustainability of the river basin.

Keywords: Heavy metals pollution, Lower catchment-Kelani River basin-Sri Lanka, Surface and groundwater quality, Water treatment and remediation

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WP12

NAVIGATING THE WATER REVOLUTION: A SYSTEMATIC REVIEW OF DIGITAL TOOLS FOR SUSTAINABLE WATER MANAGEMENT

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The implementation of digital technology in water management is crucial for the achievement of efficient, robust, and equitable procedures. It offers experts with up-to-the-minute information, maximizes the efficient use of resources, and improves overall sustainability. This technological revolution is crucial for addressing complex water concerns and ensuring future water sustainability. Therefore, a comprehensive systematic literature survey was conducted (1) to identify and classify digital tools in sustainable water management to evaluate their contributions to sustainability; and (2) to assess the benefits and constraints of these tools. The search entailed utilizing the Google Scholar search engine to screen peer-reviewed scholarly research communications published in English between the years 2013 and 2023. The use of inclusive terms such as "digital tools", "sustainable water management", and "urban water governance" was implemented. A total of 35 papers were obtained through this procedure for thorough data analysis. The papers provided significant insights into the changing environment of digital technologies and their influence on sustainable water management practices. The literature survey suggested vast arrays of digital tools revolutionizing sustainable water management which ranged from smart meters and remote sensing that gather real-time water quality and quantity data, to artificial intelligence (AI) and digital twins that analyze information for informed decision-making. Software like WEAP and AQUEDUCT which enhance water stewardship initiatives, and network optimization and flood alert systems which improve system resilience were also recovered as digital tools used in sustainable water management. Public platforms and augmented reality applications which raise public awareness and facilitate communication also appeared in the searches. The results showed that WEAP, AQUEDUCT, and Green-Gray Assessment Guide even assist with water resource planning for future scenarios. However, despite their immense potential, limitations were also recovered in using digital water management tools as well. These include high cost, lack of resources in developing regions, and complexities in data handling. Data security, privacy, and quality also raise concerns, necessitating clear regulations. Additionally, our results suggested that user awareness, digital divides, and resistance to behavior change limit the adoption of such tools. Furthermore, institutional barriers such as missing digital strategies and integration challenges add complexity. Finally, these tools may not be universally applicable, and require reliable data sources to function effectively. To overcome these constraints, the studies identify investments in infrastructure, user training, and data security helpful. Digital tools hold substantial promise for urban water management, but addressing gaps and challenges is crucial. Future research must prioritize societal acceptance through ongoing stakeholder engagement. Overhauling water utilities with a focus on data-driven culture, security, and collaboration is essential. Leveraging AI technologies for infrastructure optimization and anomaly detection is critical. Comprehensive methods are needed to tackle urban challenges and resource complexity for holistic water management.

Keywords: Artificial intelligence and machine learning, Digital tools, GIS and RS, Integrated holistic approach, Resource optimization, Water governance

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WP13

GROUNDWATER SALINIZATION IN THE CASCADE AQUIFER SYSTEM AT MADDERAMBAWA IN NORTHWESTERN SRI LANKA

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The salinization of groundwater is a complex environmental problem in the dry zone of Sri Lanka. The Madderambawa cascade in Puttalam District is facing severe salinization of groundwater, affecting drinking water supplies and agriculture. A detailed hydrogeochemical study was carried out to identify the sources and processes of salinization. Thirty-one samples, including groundwater (n = 25) and surface water (n = 6) covering the entire cascade, were collected and analyzed for major cations, anions, trace elements, and stable water isotopes. Anions were quantified using ion chromatography, while cations and trace elements were quantified using inductively coupled plasma mass spectrometry. The $\delta^{18}O$ and $\delta^{2}H$ compositions were determined using a cavity ring-down infrared spectrophotometer. The major cation concentrations in the cascade vary in the order $Na^+ > Ca^{2+} > Mg^{2+}$, while the anion concentrations vary in the order $Cl^- > HCO_3^- > SO_4^{2-}$. Among the main water types, Na^+-Cl^-, the non-dominant cation-Cl^- and the non-dominant cation-HCO_3^- were dominant in the cascade. The electrical conductivity of water sources varied between 351 µS cm^{-1} and 9400 µS cm^{-1} (mean = 3045 µS cm^{-1}). It was positively correlated with Cl^- (r = +0.97), which ranged from 48 to 4635 mg L^{-1} (mean = 1017 mg L^{-1}), and Na^+ (r = +0.90), which ranged from 29.4 to 1900 mg L^{-1} (mean = 481.4 mg L^{-1}). Forty-eight percent of the wells exceeded the maximum allowable F^- level of 1.0 mg L^{-1}. The values of $\delta^{18}O$ and $\delta^{2}H$ of groundwater in the cascade varied from −6.23‰ to −0.36‰ and from −39.77‰ to −7.43‰, respectively, while $\delta^{18}O$ and $\delta^{2}H$ values of surface water ranged from 0.34‰ to 6.47‰ and from −3.28‰ to 29.72‰. The $\delta^{18}O$ and $\delta^{2}H$ isotope signatures of surface water in the cascade deviated from the local meteoric water line ($\delta^{2}H=8.95\delta^{18}O + 15.13$, r = 0.95), suggesting intense evaporation. Most near-surface groundwater is highly enriched in $\delta^{18}O$ and $\delta^{2}H$, while the majority of saline groundwater lies along and close to the local meteoric line, suggesting that groundwater has not been modified before recharging. Stable water isotope signatures of groundwater indicated that groundwater was recharged primarily from the northeast monsoon. Hydrogeochemical and stable isotope evidence suggests that groundwater salinity in the area be caused by the dissolution of materials in the geologic matrix and subsequent evaporation. High fluoride levels in groundwater could lead to fluoride-related health problems in the cascade. The results of this study suggest the need for a comprehensive groundwater management plan for the cascade that prioritizes salinity control measures.

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Keywords: Dry zone, Groundwater salinization, Shallow aquifers, Water quality

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WP14

PLANKTON AS ENVIRONMENTAL INDICATORS TO ASSESS THE CHANGES OF WATER QUALITY IN KANDY LAKE, SRI LANKA

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Eutrophication is a phenomenon seen in freshwater and marine systems throughout the world. Both anthropogenic activities and natural phenomena could increase the nutrient levels in aquatic ecosystems. Since plankton acts as an environmental indicator, the relationship between plankton and environmental parameters helps to understand the changes in the water quality of a water body over time. Thus, the variation of plankton in Kandy Lake in the Central Province of Sri Lanka was investigated to gain insights into the environmental changes within the system. Eight sampling sites were selected based on different environmental parameters, including depth of water, level of light penetration and the rate of sedimentation. Sampling was conducted for six months from January to June 2023, both during the morning (0600-0800 h) and afternoon (1200-1400 h). On-site measurements of several important physicochemical parameters, including pH, temperature, total dissolved solids (TDS), conductivity and dissolved oxygen (DO), were measured using portable meters. Laboratory analysis was conducted using samples obtained with a 20 µm pore size plankton net. The relationship between plankton and the measured environmental variables was analyzed statistically using Canoco 5 for Windows and Microsoft Excel 2010. Bloom-forming phytoplankton including *Aulacoseira* sp., *Pediastrum* sp., *Coleastrum* sp., and *Microcystis* sp., were abundant throughout the study period in all study sites. However, according to statistical analysis, *Euglena* sp., *Micrasterias* sp., *Crucigenia* sp. and *Chroococcus* sp. respond to variations in pH, TDS, temperature and conductivity, and they are the best environmental indicators. Furthermore, the said parameters indicate that the system is eutrophic. Low water quality related zooplankton, such as *Cladocera* sp., Nauplius larva, *Keretella* sp. and *Rotifera* sp., were abundant throughout the study period in all study sites. However, *Chydorus* sp., that respond to variations of pH, TDS, temperature, and conductivity are the best environmental indicators, and further, these parameters indicate that the system is eutrophic. The water temperature ranged from 26 °C to 31 °C while pH was consistently higher than 7.00. Furthermore, while conductivity (188-272 µS cm^{-1}) and TDS (90-128 ppm) were relatively high, DO was low. Statistical analysis reveals that while conductivity and TDS have an inverse relationship, pH and DO do not have a significant effect on the distribution of plankton. The present study shows the relationship between changes in water quality and the distribution of plankton species. Plankton, therefore, are environmental indicators that respond to shifts in water quality.

Keywords: Changes in water quality, Environmental indicators, Eutrophication, Kandy Lake, Nutrient loading, Plankton

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POLLUTION REMEDIATION AND WATER TREATMENT

PR01

ASSESSMENT OF REVERSE OSMOSIS TREATED DRINKING WATER IN ADDRESSING WATER QUALITY CHALLENGES IN CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY PREVALENT AREAS

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Reverse osmosis (RO) technology is widely used in small-scale water treatment facilities; thus, understanding of the quality of treated water can be incorporated to address drinking water issues in the dry zone of Sri Lanka where Chronic Kidney Disease of unknown etiology (CKDu) is prevalent. Therefore, this study was conducted with the objectives of: (1) to assess the efficacy of RO-treated drinking water implemented by the National Water Supply and Drainage Board and the Sri Lanka Navy in Anuradhapura District, Sri Lanka; and (2) to understand the challenges of implementation of RO for water treatment in the study area, and thereby to propose remedial measures to improve water treatment facilities. Sixteen RO plants were selected using purposive sampling technique in the area, and triplicated water samples were obtained in raw water and permeate of drinking water. One-way ANOVA was followed to quantify the significant difference between raw water and permeated water across different parameters in the 16 selected RO plants. According to the results, significant differences were observed in the parameters of electrical conductivity, total organic carbon and fluoride, between the raw and permeate stages. However, no significant differences were noted in pH, total dissolved solids, hardness, nitrate and sodium, between the raw and permeate stages. Despite these variations, it is noteworthy to state that all parameters were lower in the permeate stage compared to those at the raw stage. A recovery rate of less than 50% was found in the 16 RO plants, with a concentration factor of 2. Concerning drinking water standards outlined by the Sri Lanka Standards (SLS 614: 2013), all measured parameters, except pH, meet the specified requirements. Notably, the pH levels in the permeate, ranging from 5.8 to 6.5, deviate below the recommended SLS range of 6.5-8.5, signaling a propensity towards acidity. The pH of the antiscalant added or the amount of alkalinity present could be the reason for this acidity. It is required to do pH adjustment before distributing the permeate to people. Considering the low recovery rate, steps needed to be taken to suggest efficient methods of increasing the recovery by changing the setup of the plant or in the RO module system. At present, problems exist with backwashing in RO plants, operational difficulties, and the requirement for a uniform maintenance method even with some standards being followed. The introduction of an ion exchange treatment or water softener for improved hardness removal, and routine water quality testing are among the recommended actions.

Keywords: CKDu, Dry zone-Sri Lanka, Reverse osmosis, Water quality, Water treatment

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PR02

EFFICACY OF ELECTRO DIALYSIS REVERSAL TECHNOLOGY FOR GROUNDWATER REMEDIATION IN CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY AFFECTED REGIONS

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Chronic Kidney Disease of unknown etiology (CKDu) has emerged as a critical health concern, mainly in the dry zone of Sri Lanka, and is suspected to be linked to groundwater contaminants, necessitating immediate intervention. Electrodialysis reversal (EDR) technology serves as a promising water treatment technology to tackle this health concern. In addition, EDR requires less pretreatment than reverse osmosis, while often providing a more robust and reliable operation. Thus, this study examined the efficacy of EDR technology in treatment of groundwater in CKDu-affected areas in the dry zone of Sri Lanka. An EDR plant situated in Kahatagasdigiliya, Anuradhapura District, was selected via purposive sampling to examine critical parameters pertinent to CKDu-affected regions, *viz.* pH, electrical conductivity (EC), hardness, fluoride, and nitrate levels. Water quality sampling was conducted using three replicates to test each testing parameter to ensure the accuracy of data. Initial raw water quality of the source of water collected was above the Sri Lanka Standards (SLS 614:2013) which indicated the unsuitability for drinking. Findings underscore the consistent maintenance of pH levels within the safe range specified by SLS 614:2013; (6.5-8.5), fluctuating between 6.59 and 6.97 across various stages of treatment. Notably, EC levels consistently remained well below the permissible limit of 750 µS cm^{-1} throughout the treatment process. However, in terms of hardness, the feed flow exhibited levels surpassing safe thresholds (420 mg L^{-1}), highlighting persistent challenges in CKDu-affected regions, although with a moderate reduction observed post-treatment. Remarkably, while fluoride levels approached the maximum allowable limit in the feed flow (0.73 mg L^{-1}), the EDR process consistently ensured fluoride levels in the permeate remained within safe limits. Nitrate concentration, which was 5.34 mg L^{-1} in the feed and 4.14 mg L^{-1} in the permeate, posed no significant risk based on permissible limits. Comparison with data from the National Water Supply and Drainage Board showcased a close alignment between research findings and established standards (SLS 614:2013). This study demonstrates the timely need of employing the EDR technology of water treatment in the CKDu-affected areas in the dry zone, emphasizing the considerable potential of EDR technology as a feasible and effective solution.

Keywords: Anuradhapura-dry zone-Sri Lanka, CKDu, Electrodialysis reversal, Groundwater treatment, Water quality and water treatment

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PR03

REMOVAL OF Cr(III), A TOXIC INDUSTRIAL POLLUTANT, FROM SYNTHETIC EFFLUENTS BY ARECA NUT FIBERS

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Chromium compounds are used in many industrial processes, such as tanning of leather and electroplating, and consequently, effluents of such industries may contain chromium species at levels higher than the tolerance limit, making it a necessity for treatment, as such species could lead to various health effects. Hence, the development of environmentally friendly, efficient and economical treatment methods for heavy metals and their compounds from industrial effluents is needed. The purpose of this research was therefore to investigate biosorption characteristics of Cr(III), on dried fibers of mature areca nut (*Areca* sp.), a common palm tree grown in Sri Lanka. The optimum parameters determined under static conditions using 50.0 mL of 10 mg L^{-1} Cr(III) solutions with fibers of 0.5-1.0 cm length were 0.50 g dosage, 15 min shaking time, 60 min settling time, and 4.5 solution pH, at which an efficient removal of >90% was achieved. Adsorption of Cr(III) on these fibers is a monolayer process due to the fibrous nature of the biosorbent, as supported by the validity of the Langmuir adsorption model. Moreover, Cr(III) adsorption on the biosorbent does not obey the Freundlich adsorption model which accounts for surface heterogeneity caused by multilayer adsorption and assumes exponential decay in the energy distribution of adsorbed sites. X-ray fluorescence spectroscopic studies confirm the biosorption of Cr(III) on the fibers, while Fourier transform infrared spectroscopic investigation indicates the presence of hydroxyl groups in the biosorbent, which could be deprotonated during base treatment leading to stronger affinity toward positively charged Cr(III) species, as evidenced by removal experiments. Results of the above static experiments could be extended toward dynamic experiments and prototype studies to employ fibers of the areca nut for industrial applications.

Keywords: Adsorption isotherm, Areca nut fibers, Chromium, Monolayer

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PR04

X-RAY PHOTOELECTRON SPECTROSCOPIC ANALYSIS OF GRAPHITE OXIDE-COATED SAND FOR FLUORIDE REMOVAL

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Excess fluoride in drinking water can risk human dental and skeletal health. Several methods exist to remove the excess fluoride; however, the development of a sand filter unit is a more cost-effective and valuable option. This research used an improved synthesis of graphite oxide (GO) to enhance the reactivity of natural sand. The GO dispersion was coated on the sand surface using mild heat treatment of the sand composite labeled as GOS1. The GO coating procedure on sand was repeated up to three times (GOS3) and five times (GOS5). X-ray photoelectron spectroscopic (XPS) measurements were recorded with AlK_{α} X-ray source (1486.7 eV, 180° hemispherical energy analyzer with a radius of 150 mm). The XPS measurements elucidated the surface functional groups of GO, sand, and GO/sand composites. The C 1s spectrum of GO can be deconvoluted into peaks at the binding energies (BE) of 288.5 eV, 287.9 eV, 286.9 eV, 286.7 eV, 284.9 eV and 283.4 eV, attributed to carboxylic (COOH), carbonyl (C=O), epoxy (C-O-C), hydroxyl (C-OH), C sp^2 (C=C) and C sp^3 (C-C), respectively, using the Gaussian function. Compared to GO, three different peaks were observed in the BE range of 283.8-283.9 eV, 285.3-285.4 eV and 289.4-289.8 eV, corresponding to the C-Si, C-O-Si and π-π* transition, respectively, of GO coated sand composite. The presence of the peaks for C-Si and C-O-Si confirmed the interaction between sand and GO. During each coating, the peak position of C-OH shifted negatively, but the peak area decreased for GOS1 as compared to that of GO. In contrast, the peak area for C-OH increased for both GOS3 and GOS5. This may be due to the increase in the number of GO layers on sand particles during each coating. In GOS1, GO comes into direct contact with sand, leading to its involvement in the sand-GO interaction during heat treatment. The peak position of C-O-C shifted positively during each coating. The peak area and the peak width at half maximum of C-O-C decreased, possibly due to H-bonding with sand and GO. These three sand composites, GOS1, GOS3 and GOS5, removed fluoride at 46%, 54% and 68%, respectively. Fluoride removal occurs through the exchange of fluoride and hydroxyl groups of GO. The peak area of the C-OH decreases after the removal of fluoride, confirming that hydroxyl ions are involved in the removal process. Additional coating layers of GO (GOS3 and GOS5) are employed to remove fluoride from water. Due to its stability, S-OH groups do not participate in ion-exchange reactions as readily as C-OH groups. After fluoride removal, the samples show an additional peak at 288.5 eV, corresponding to the C-F bond.

Keywords: Fluoride removal, graphite oxide, sand, XPS

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PR05

TEMPERATURE EFFECTS ON METHYLENE BLUE TEXTILE DYE ADSORPTION ON ACTIVATED CHARCOAL

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Removal of methylene blue (MB), a common textile dye, from contaminated water is necessary to safeguard the quality of ecosystems. Among many techniques available for dye removal, adsorption has become attractive although many such systems are still at the research level. An important aspect that has not been well attended in adsorption studies is the effect of temperature of the treatment system on the extent of removal although industrial effluents are usually released under warm conditions. In this context, the present study is based on the adsorption of MB dye on coconut shell based activated charcoal (AC) under different temperature conditions, and in the presence of selected industrial chemicals. The adsorbent, AC, is superior to many others owing to the advantages of being cost-effective, eco-friendly, and efficient. The optimum conditions for this adsorption system determined at ambient temperature in batch studies are 40 min shaking time, 15 min settling time, pH 7, and 0.25 g AC, at which an excellent extent of removal of 95% is achieved. The standard free energy change of adsorption (ΔG^{Θ}) of MB on AC under the optimized conditions is negative within the solution temperature range of 298-328 K, indicating the spontaneity of the adsorption process. Moreover, the average standard values of the enthalpy change and the entropy change are determined to be 34.9 kJ mol^{-1} and 136.7 J mol^{-1} K^{-1}, respectively, indicating that the adsorption of MB on AC is endothermic, absorbing heat from the surrounding with increasing randomness. The presence of NaCl, which was used to represent an ionic environment, leads to a decrease in the spontaneity of MB adsorption at ambient temperature. Nevertheless, the endothermic behavior is enhanced in the presence of NaCl yet maintaining a satisfactory extent of adsorption at warmer temperatures, but lower values at ambient temperature. Moreover, the chemical oxygen demand is decreased after treatment of MB solutions with AC even in the presence of NaCl. The results of this study would be useful in designing large-scale treatment systems with AC, especially in warmer conditions, as adsorption characteristics strongly depend on the temperature of the treatment system.

Keywords: Activated charcoal, Adsorption, Methylene blue, NaCl, Temperature effects

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PR06

EXPERIMENTAL PARAMETERS ON SUPERHYDROPHOBIC PROPERTIES OF CARBON NANOTUBES FOR OIL REMOVAL

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Consuming water contaminated with oil can be hazardous to human health. Removing oil from water sources ensures the safety of drinking water supplies and protects communities from potential health hazards. Efficient oil removal techniques have become increasingly critical in mitigating negative impacts of oil spills on both natural ecosystems and human societies. Vertically aligned carbon nanotubes (VA-CNTs) have exhibited promise as efficient materials for oil separation owing to their distinctive structural and chemical attributes. VA-CNTs were successfully synthesized through a novel single-zone floating catalyst chemical vapor deposition (SS-FCCVD) method using camphor/ferrocene precursor systems at 850 ºC. The contact angle (CA) measurements were also made to investigate the surface wetting property of CNTs grown on *p*-type Si(100) at different camphor loadings (17.0 g, 12.8 g and 8.5 g), while keeping the camphor/ferrocene ratio fixed at 20:1. Use of high mass of camphor (17.0 g) results in more rapidly generated and randomly entangled CNTs on the silicon substrate. The CNT surface is hydrophobic with its CA of 83º. As judged by the CA values with decreasing the mass of camphor, as-prepared CNTs are super-hydrophobic exhibiting a CA of 148-154º. Super-hydrophobic characteristics of surfaces can be obtained due to the quality of characters that may increase when the carbon source is reduced. The surface of VA-CNTs shows lotus-leaf-like super-hydrophobic topography. The micro-patterns in CNT bundles create a micro-scale roughness while the individual nanotubes contribute to the nano-scale roughness. Due to the dual roughness like a lotus leaf, nanotubes have stopped water seeping into air pockets between the micro-pattern, leading to less water sticking. The high hydrophobicity of CNTs results in high oleophilic properties, leading to greater extent of oil removal. On the contrary, the CA of randomly entangled CNTs/silicon plates is very low due to the loss of micropattern roughness on the surface. These findings demonstrate that the CAs on various CNTs' top surfaces are significantly affected by the orientation of carbon nanotubes. Furthermore, CNTs with different surface morphologies can be synthesized by changing experimental parameters. This method followed a single step to synthesize the dual-scale surface roughness of VA-CNTs on Si plates. Thus, the study of different nanostructures supports the optimization of superhydrophobicity, leading to improved water repellence and oil absorption, expanding the range of applications from self-cleaning to anti-fouling and more. However, further research and development is needed to overcome the challenges and refine the technology for widespread use.

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Keywords: Contact angle, Single-zone floating catalyst chemical vapor deposition, Superhydrophobic property, Vertically aligned carbon nanotubes

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PR07

DESIGNING CLOUD-CONTROLLED LABORATORY-SCALE WATER DESALINATION PLANT FOR RURAL COMMUNITY EDUCATION AND SKILLS DEVELOPMENT

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Tailored water membrane topology in response to variable water quality parameters is of paramount importance. The ability to customize and control membrane topology allows technologists to address water salinity fluctuations. Currently, a demonstrative laboratory-scale water desalination plant comprising reverse osmosis, nanofiltration, and ultra membranes has been developed. It includes a customizing facility designed to serve as an instructive tool for plant operators and technologists to assess the most suitable membrane topology. The plant automation was achieved on an ESP 32 platform. Low-powered microcontrollers (5 V) with embedded modules were used to control the water treatment plant. This module offers Node-RED nodes for building a live data dashboard. Also, it offers a text editor that runs in the browser to facilitate data to flow with a variety of configurations in the palette which can be instantaneously pushed to the runtime mode. The MQTT protocol was used to transfer data between the controller and the user interface (UI)-cloud. Five cycles of the water treatment plant, *viz*., purification, water filling, water flushing, low water level detection and rainwater flushing cycles were remotely controlled. In the dashboards (physical and virtual) an LED display panel appears with the Wi-Fi connectivity status. When the main switch is on and Wi-Fi connects the water treatment plant, the user can remotely control various segments, *i.e*., solenoids, pumps, TDS, pH sensors, etc. of the plant via the controller. The user can also manipulate the system in virtual mode to attain required training under treatment plant run time. A trained technologist by this method can provide services to the community in plant operation, daily cleaning, and user maintenance remotely. The ESP 32 platform demonstrates significant potential for the broader application of such systems in community-scale water treatment and lays the groundwork for future advancements. The conversion of the controller to a dedicated printed circuit board (PCB) module for use in community-scale water treatment plants is currently in progress.

Financial assistance from the National Research Council of Sri Lanka (Grant No. NRC TO 16-015) is acknowledged.

Keywords: ESP 32, Membrane topology, Microcontroller, MQTT protocol, Nanofiltration, Node-RED, Real-time monitoring, Reverse osmosis

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PR08

PALMYRAH NUTSHELL CHARCOAL, AN EFFECTIVE ADSORBENT FOR REMOVAL OF Fe^{3+} FROM WATER

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Iron is commonly found in groundwater and poses a significant adverse effect on human health. Reverse osmosis (RO) water filtering system is commonly used in Sri Lanka to purify groundwater for drinking purposes. Iron, along with other unwanted species, can be removed from ground water using the RO water filtering system. However, high-level of iron content in ground water has been reported to reduce the performance of RO water filtering systems as the deposition of iron on RO membrane leads to fouling. Therefore, pretreatment of fed water to remove iron is an essential step to increase the lifetime of RO membranes. Although there are many conventional methods, there is a continuous impetus to develop cost-effective and environmentally benign methods. The present study focuses on the use of charcoal obtained from palmyrah nutshell, an abundant and easily accessible resource in the northern parts of Sri Lanka, to minimize Fe^{3+} in aqueous solution. The charcoal was prepared from palmyrah nutshells at 300 ºC using muffle furnace and characterized for its moisture content, ash content, volatile matter content and fixed carbon content, using standard analytical methods. Charcoal obtained at 300 °C was found to have moisture content of 5.1-5.9%, ash content of 0.9-1.5%, volatile matter content of 5.9 - 6.8% and fixed carbon content of 85.8-88.1%. The batch absorption experiments, in triplicate, were carried out to find the adsorption capacity of charcoal on $Fe^{3+}$from aqueous solution. Stock solutions of Fe^{3+} were prepared using ferric ammonium sulfate. The concentration of Fe^{3+} used in this study ranges from 50 mg L^{-1} to 150 mg L^{-1}. The concentration of Fe^{3+} (before and after contact with charcoal) was determined using JASCO UV/VIS/NIR spectrophotometer by making colored complex with NH_4SCN. The experimental conditions, such as contact time and adsorbent dosage, were optimized for maximum removal of Fe^{3+} ions. Results showed that 82-99% Fe^{3+} removal was observed for 50-150 mg L^{-1} Fe^{3+} solution with 1.00 g charcoal during 1.0 h shaking at 200 rpm. Based on the results obtained, palmyrah nutshell charcoal is an effective adsorbent for the treatment of Fe^{3+}-contaminated water.

Keywords: Adsorption capacity, Charcoal, Contact time, Muffle furnace

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PR09

SYNTHESIS OF REDUCED GRAPHENE OXIDE-METAL OXIDE COMPOSITE USING SRI LANKAN VEIN GRAPHITE FOR REMOVAL OF CADMIUM(II) IONS FROM WATER

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Cadmium (Cd) is widely known as a heavy metal with many adverse effects on living organisms and the environment. Cadmium poisoning due to the release of heavy metal pollutants into water bodies is considered to be a major threat to living organisms. The cheapest remediation technique for the removal of contaminated heavy metals, such as cadmium, from water bodies would be batch adsorption. Reduced graphene oxide (rGO)-incorporated nanocomposites play an important role in heavy metal adsorption from water due to the wide range of carbon and oxygen-bearing functional groups that can act as excellent adsorption sites to capture metal cations. In this research, a Sri Lankan vein graphite sample was oxidized to graphene oxide (GO) by the modified Hummers method. Then, rGO ternary composite was synthesized by the combination of Fe_2O_3 and TiO_2 using the wet impregnation method followed by calcination at 300 °C. A diversity of rGO to metal oxide ratios has been synthesized, and characterization was performed using scanning electron microscopy (SEM), X-ray diffraction and Fourier transform infrared spectroscopy, to determine the conformity of the presence of the given materials. The varied ratios were tested for Cd adsorption at different pH values from 2.00 to 6.00, and the contact time of the composite material varying as 1, 2, 5, 15, 30, 60, 120, up to 180 min. The batch adsorption technique depicted an optimum Cd adsorption capacity of 604 µg g^{-1} of adsorbent for GO-incorporated ternary composite at a pH of 6.00 with an optimal shaking time of 1.0 h. It was also observed that the larger the content of rGO incorporated into the composite, better Cd adsorption results could be obtained due to the large amount of oxygenated functional groups present between layers of graphene sheets that can act as an excellent adsorption site for positively charged metal ions. A low adsorption efficiency was obtained with the oxide composite only in comparison to the pure reduced graphene oxide due to the failure to obtain composites at the nanoscale, as depicted by SEM images. This is due to decreased pore volume and effective surface area as the composites have been synthesized in the micrometer range. Improved adsorption properties can be obtained with increasing rGO ratios, and this will be expanded to incorporation of rGO obtained from different Sri Lankan graphite samples with a wide array of particle sizes of nanocomposite preparation using different ratios of metal oxides as adsorbent materials incorporating photocatalysis.

Keywords: Cadmium poisoning, Pollution remediation, rGO, Ternary composites

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PR10

NANOELECTROCHEMISTRY FOR DETECTION OF CHROMIUM(VI) IN AQUEOUS ENVIRONMENT

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Chromium has several forms in the environment, with Cr(III) and Cr(VI) being the most persistent. Because of higher carcinogenic, mutagenic and oxidative properties, Cr(VI) is more dangerous than Cr(III). Therefore, accurate analysis of Cr(VI) in the environment is crucial. Electrochemical methods are among the most promising techniques for rapid and highly sensitive determination of Cr(VI) in water. Exploring materials with excellent electrocatalytic properties to construct sensitive interfaces is the key to improving the performance of electrochemical sensors. The Au/mpg-C_3N_4 and Au/UiO-66 nanocomposites were synthesized via a combination of the solvothermal method and the chemical reduction method, and the nanocomposites were used as the modification material for constructing the Cr(VI) electrochemical sensor. The experimental results showed that gold nanoparticles with an average diameter of about 25 nm were successfully reduced on the surface of UiO-66. The Au/UiO-66 nanocomposites-modified glassy carbon electrode (GCE) was used to detect Cr(VI) in aqueous environment through linear sweep voltammetry (LSV). Under the optimal conditions, the sensitivity of the sensor was 5.04×10^{-3} μA ppb^{-1}, and the minimum detection limit was 11.73 ppb over a wide linear dynamic range of 100-1200 ppb. The Cr(VI) concentration in the electroplating waste solution was determined to be 10.64 ppm by the procedure developed. The recovery was 92.4%, indicating that the Au/UiO-66/GCE sensor may be used to quantify Cr(VI) in electroplating wastewater. The Au/mpg-C_3N_4 nanocomposites, prepared via a photocatalytic reduction method, were also used for GCE modification. LSV and chronoamperometry were adopted to detect Cr(VI) in the water environment. Under the optimized conditions, the sensitivity of the sensor towards Cr(VI) is 2.20×10^{-3} μA ppb^{-1} with a wide linear dynamic range of 100-1000 ppb, and the minimum detection limit of 14.7 ppb. The sensor has good repeatability, reproducibility, and anti-interference performance. The content of Cr(VI) in the tannery wastewater calculated, using this sensor, was 376 ppb, which was similar to the ICP-OES result (386 ppb) with a recovery rate of 97.4%. Additionally, the Au/mpg-C_3N_4 nanocomposite modified the commercial screen-printed electrode (SPE) with industrial mass production was used to evaluate the practical applications of Au/mpg-C_3N_4 nanocomposite for on-site monitoring of Cr(VI) in the industrial waste liquid. The results show that the Au/mpg-C_3N_4/SPE sensor has a high sensitivity towards Cr(VI) (3.07×10^{-2} μA ppb^{-1}), and the Cr(VI) in real leather wastewater and plating wastewater can also be accurately detected.

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Keywords: Chronoamperometry, Glassy carbon electrode, Nanocomposite, Sensor, Voltammetry

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PR11

PERFORMANCE OPTIMIZATION OF THIN FILM NANOCOMPOSITE MEMBRANE FOR WATER PURIFICATION USING A SPIN-ASSISTED METHOD

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Water purification has become a global challenge due to environmental pollution associated with urbanization and industrial activities. Advanced technologies along with sustainable practices should be developed to address this challenge to ensure the access of clean water to all human beings. Nanofiltration (NF) is a promising membrane technology used in the water purification industry. Its energy requirement leads to less high fluxes and salt rejections compared to reverse osmosis. Yet, the majority of commercial NF membranes face numerous challenges, such as high energy consumption, poor antifouling, and limitations of permeability and selectivity. By optimizing the thickness, the required energy and the pressure needed to drive the membrane would be reduced simultaneously. In this study, a spin-assisted interfacial polymerization technique was used to vary the thickness, and the aim was to find out the effect of spin acceleration on the membrane thickness. For this purpose, a thin film nanocomposite membrane (TFN) was developed by fabricating a graphene oxide (GO) incorporated polyamide (PA) layer on top of a porous substrate of polyether sulfone (PES). The spin coating method would ensure the even distribution of GO within the PA layer and its uniformity. Monomers for the PA are piperazine (PIP) and trimesoyl chloride (TMC). The membranes were fabricated using different angular accelerations and a fixed angular velocity of 3600 rpm for 30 s. A homemade crossflow filtration cell was used to check the membrane performance. The pure water permeability (PWP) was evaluated at ambient temperature and pressure of 4 bar. Scanning electron microscopy was used to measure the thickness of the PA layer. The different angular velocities used to fabricate the membranes are 20, 40, 60, 80 and 100 rpm s^{-1}. Membrane fabricated at 80 rpm s^{-1} angular acceleration exhibited the highest permeability of 31.0 L m^{-2} h^{-1} bar^{-1} and 90% of Ca^{2+} and Mg^{2+} salt rejection along with an optimum lower thickness value of 114.0 nm of the PA layer. According to the results, when increasing the angular acceleration, the thickness of the fabricated PA has reduced, and lower thickness values have shown higher permeability values. The lower thickness values of the PA layer have provided less transportation barrier for water molecules and increased the flow of the water through the membrane, thereby reducing the energy requirement for filtration and achieving cost efficiency. This work concludes a novel spin-assisted method to fabricate TFN-NF membranes with high performance.

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Keywords: Nanofiltration, Permeability, Salt rejection, Spin, Thickness

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PR12

BACTERIAL DEGRADATION OF POLY-AROMATIC HYDROCARBON, PHENANTHRENE

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Phenanthrene (PHE) is a compound belonging to a group of polycyclic aromatic hydrocarbons (PAHs). These compounds are widely distributed and have a long half-life in an environment of high hydrophobicity and high lipophilicity. Anthropogenic activities have aggravated the release of these contaminants and have caused a significant issue due to their mutagenic and carcinogenic aspects which adversely affect ecosystems and their organisms. Bioremediation is an environmentally friendly approach which could be applied in solving this problem. The present study focuses on bacterial degradation of PHE and identifies the bacteria which could efficiently degrade PHE. In this study, marine water samples were collected from selected locations along the western coastal belt. After the enrichment study, 30 morphologically different colonies of bacteria were isolated. An enzyme-linked immunosorbent assay plate method was used to examine the PHE degradation potential of the 30 isolates from which two potential PHE-degrading bacteria were selected and tentatively identified using gram staining and biochemical tests such as urease, lactose, and Klingler Iron Agar (KIA) tests. The degradation kinetics were studied using high-performance liquid chromatography (HPLC). Considering the half-life and the PHE degradation rate of the tested bacteria strains, the most potential PHE degrader "bacteria A" was selected for further studies. Bacteria A showed 2.17 days of half-life to degrade a 5 mg L^{-1} PHE solution whereas 4.42 days were taken to degrade a 10 mg L^{-1} solution. The study is in progress to optimize the physical and chemical environmental factors which enhance the degradation kinetics of the PHE in the natural environment.

Keywords: Bioremediation, Carcinogenic, High-performance liquid chromatography, Phenanthrene, Polycyclic aromatic hydrocarbons

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PR13

DEVELOPMENT OF BIOCHAR-BASED AEROGEL FOR EFFICIENT TREATMENT OF OIL CONTAMINATED WATER

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Water pollution due to industrial oily wastewater, accidental oil spills and oil leakages have become serious disasters that threaten the aquatic environment. Therefore, oil/water separation using efficient and environmentally friendly methods has become significant. The present study focused on synthesizing an environmentally friendly and hydrophobic aerogel using biochar (BC) derived from *Eichhornia crassipes* (Water Hyacinth) as the raw material and polyvinylalcohol (PVA) as the crosslinking agent through a simple and low-cost method. Initially, a BC-based aerogel (BC-0-unmodified) was facilely prepared via alkaline/H_2O_2 pretreatment, freeze-drying and silanization with methyltrimethoxysilane (MTMS). Subsequently, biochar-based modified aerogels were prepared using zeolite at different concentrations (0.2 g zeolite: BC-1, 0.5 g zeolite: BC-2 and 1.0 g zeolite: BC-3 aerogels) to further enhance the oil absorption capacity. BC-2 modified aerogel showed the lowest density, highest porosity, highest oil absorption capacity, and highest oil absorption rate. Moreover, these modified aerogels were magnetized with $FeSO_4$ for easy collection of aerogel during its various applications. Hence, their physicochemical properties including chemical structure and surface morphology were characterized by Fourier transform infrared spectroscopy and scanning electron microscopy. According to the results of absorption capacity, BC-2 aerogel presented excellent adsorption performance for a wide range of oil products (crude oil 37.81±1.13 $g.g^{-1}$, diesel oil 32.27±0.85 $g.g^{-1}$, gasoline 32.91±0.84 $g.g^{-1}$). Furthermore, the corresponding cyclic tests showed that the absorption capacity remained at 80.98% after 10 consecutive cycles, indicating a high reusability. Henceforth, the production of aerogel using *Eichhornia crassipes* is an eco-friendly green approach to control the growth of these aquatic invasive plants.

Keywords: Aerogel, Aquatic invasive plants, Biochar, Oil absorption capacity, Oily wastewater

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PR14

APPLICATION OF SRI LANKAN RED EARTH TO REMOVE CIPROFLOXACIN IN AQUEOUS MEDIA

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Ciprofloxacin (CIP) is the most widely prescribed fluoroquinolone class antibiotic in the world. The widespread use causes extensive release of CIP into the environment at higher concentrations. This led to creating antibiotic resistance among microorganisms and is a major global health issue. This study aims to investigate the potential of Sri Lankan red earth (RE), a natural Fe-Al oxide and oxy-hydroxides rich soil, in removing CIP from aqueous medium. Batch experiments were carried out to study the optimum conditions including initial adsorbate concentration (68, 104 and 129 mg L^{-1}), contact time (5, 10, 30, 60 and 120 min), adsorbent dosage (5, 10 and 20 g L^{-1}) and pH (2, 7 and 10). The CIP concentration was determined using UV spectrophotometry (at 273 nm). The maximum removal of 98.5% was obtained for 68 mg L^{-1} CIP solution with the RE dose of 10 g L^{-1} at a 30-min contact time under natural pH condition of ~4. The maximum CIP removal is observed at pH between 4-7, due to the electrostatic attraction between the zwitterionic form of CIP and positively charged surface sites of RE at pHs below the point zero charge of RE at 8.5. The removal efficiency drastically decreased at pH < 8.5 due to the electrostatic repulsion between the anionic form of CIP and the negatively charged surface sites of RE. The experimental data best fitted with the Freundlich adsorption model (R^2 = 0.9872) indicating multilayer adsorption with the maximum adsorption capacity of 19.92 mg g^{-1}. This study confirms that RE can be used as an efficient adsorbent for the removal of CIP in aqueous medium.

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Keywords: Adsorption, Ciprofloxacin, Red earth

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PR15

REMOVAL OF OIL SPILLS USING BIOCHAR FROM THE FRUIT OF *Cerbera manghas* (WEL KADURU)

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The pollution of aquatic ecosystems is of grave concern as such ecosystems are vital to the sustenance of biodiversity and human wellbeing. Oil spills have been identified as a major threat to such ecosystems owing to the difficulty of cleaning and the adverse impact of aquatic flora and fauna. Currently, the removal of oil is accomplished via physical, chemical, and biological methods. Physical methods involve the use of booms, skimmers, and adsorbents. Among these methods, the use of natural sorbents has become an emerging topic, mainly due to their low-cost, availability, biodegradability, ease of use, and buoyancy. In this research, the use of the fruit of *Cerbera manghas* (Sinhalese: Wel Kaduru), a widely available resource in the coastal and inland areas of Sri Lanka, was assessed as a potential natural sorbent for the removal of oil. The efficiency of charcoal produced by this sorbent to remove oil was studied by varying several parameters: dosage, pore structure, particle size, contact time, oil type, oil volume, salinity, and the effect of weathering. It was found that the maximum absorption capacity depends on the type of oil according to the extent of adsorption determined by varying different volumes of oil. However, the maximum adsorption capacity of the three oil types was within the range of 4.96-11.16 g oil g^{-1} charcoal. With the variation of the charcoal dosage, the maximum adsorption capacity values ranged from 7.48 to 10.56 g oil g^{-1} of charcoal for each oil type, indicating that the extent of oil adsorption increases with the charcoal dosage. Variation of the contact time of interaction of oil types with the charcoal led to maximum adsorption capacities within 30-45 min. Moreover, the amount of oil adsorbed decreases with time due to the weathering of oil as it naturally changes its characteristics due to oxidation and evaporation. For instance, the maximum and minimum adsorption capacities of 6.71 g oil g^{-1} and 5.30 g oil g^{-1} charcoal were determined when oil and water were in contact with each other for 1 day and 9 days, respectively. Further, as expected, the extent of removal of oil was strongly affected by the particle size of the sorbent, indicating that small particle sizes are more effective in the oil cleanup process. This adsorption process was fitted by neither the Langmuir isotherm model nor the Freundlich model, indicating that the adsorption is a multilayer process and that the adsorbent is hydrophobic. The use of this natural sorbent will be a beneficial and effective approach to the cleanup oil spills in a practically applicable manner. Furthermore, the oil-adsorbed charcoal could be subsequently used for energy production, and further, the ash remaining after the burning of oil-adsorbed charcoal has the potential to be used for dye removal.

Keywords: Adsorption, Capacity, Charcoal, Oil

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PR16

LINEAR MODEL APPROACH TO ANALYZE RADIAL ACCELERATION EFFECTS OF MEMBRANE THICKNESS IN SPIN COATING

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Achieving the desired properties of the membrane fabrication using the spin coating method requires precise control of coating thickness. While a general equation exists for coating thickness based on angular velocity, the significant influence of radial velocity and radial acceleration of the rotor remains critical, especially considering the non-constant nature of radial velocity. The aim of this study was to develop a mathematical model that explains the relationship between film thickness and radial acceleration in spin coating, assuming constant angular velocity and other key parameters, such as temperature, pressure and solution concentration. Using MATLAB software, data on the acceleration, deceleration and spin time of the rotor measuring the coating thickness were entered as output. By plotting the radial velocity vs. rotation time, Equation (1) describing the relationship between the area under the curve and the radial acceleration (*f*) was obtained. Then, by integrating the area under the velocity-time curves for the radial velocity change, Equation (2) correlating the integrated area (*x*) to membrane thickness (*y*) was generated.

$$\text{area} = \left(\frac{6480000}{f}\right) + 113400 \qquad (1)$$

$$y = 4.3573\times10^{-4}\, x + 9.8653 \qquad (2)$$

Further analysis involves replacing the variable *x* (representing the integrated area) in Equation (2) with the expression derived from Equation (1), yielding the final linear equation (3) that correlates membrane coating thickness (*h*) directly to radial acceleration (*f*). This new approach bridges the gap between process parameters and membrane properties, providing valuable insights for optimizing membrane fabrication processes.

$$h = \frac{2823.5}{f} + 59.2771 \qquad (3)$$

Financial assistance from the National Research Council of Sri Lanka (Grant No. NRC TO 16-015) is acknowledged.

Keywords: MATLAB, membrane modeling, membrane technology, spin coating method, water desalination

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PR17

MICROCHIP ASSISTED MICROFLUFIC METHOD FOR IN SITU TOTAL NITROGEN DETECTION IN WATER

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The flourishing field of microfluidic technology offers unparalleled prospects for environmental monitoring by enabling rapid, multi-parameter analyses with minimal sample requirements. This expedites the detection process and aligns with UN sustainable development goals by reducing the pollution footprint of analytical practices. Several surface modification techniques are carried out to minimize non-specific adsorption and enhance the compatibility of microfluidic chips with different samples. However, system consistency and detection sensitivity remain key hurdles for the widespread adoption of these techniques. One of the key goals of the study was to explore the design of a special extended-path length optical system to achieve lower detection limits. This research explores the above critical issues, focusing on the impact of cutting fluid in the fabrication of polymethylmethacrylate (PMMA) microchips on the detection of total nitrogen. To address the outlined research questions, a comprehensive screening test was conducted to determine the known concentration of total nitrogen in a water sample using fabricated microchips comprised of four distinct pressure-sensitive films and a double-sided adhesive, aiming to assess the adherence properties. The microfluidic chip constructed utilizing pressure-sensitive film with double-sided adhesive demonstrated a higher level of efficiency. The effect of different commercially available pressure-sensitive films on the surface of the chips was also evaluated, specifically targeting their role in modulating the absorption characteristics at the wavelength of 220 nm associated with total nitrogen detection. The pre-cut pressure-sensitive films exhibited excellent performance when applied to the surfaces of the chips for the determination of the total nitrogen of the water sample. Additionally, multiple analytical techniques were deployed to assess the consistency and sensitivity of the microfluidic system under different conditions. The efficiency of cutting fluids in the detection of total nitrogen was investigated using certified samples with concentrations ranging from 1 mg L^{-1} to 5 mg L^{-1}. Initially, without the cutting fluid, the relative errors for the measurements continued to rise at 50%. However, after introducing the cutting fluid, a remarkable decrease in relative error to 0%, 0%, 5%, 7% and 1% were observed for concentrations of 1 mg L^{-1}, 2 mg L^{-1}, 3 mg L^{-1}, 4 mg L^{-1} and 5 mg L^{-1}, respectively. This result underlines the significant positive effect of cutting fluid in lubricating the microfluidic chip during fabrication, consequently enhancing the accuracy of the detection process. By unraveling the role of cutting fluid in the fabrication of PMMA detection chips, the understanding of system consistency and detection limit issues in microfluidic applications for environmental analysis has been advanced in this study.

Keywords: Cutting fluid, Lab-on-a-chip, Microfluidic technology, Micro-sensors, Nitrogen detection

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PR18

REMOVAL OF AN ANIONIC SURFACTANT, SODIUM DODECYL SULFATE, FROM AQUEOUS SOLUTION BY FIRED BRICK CLAY PARTICLES

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The group of surfactants, which are industrial chemicals, have multiple uses in various sectors where they perform vital roles enabling a large range of manufacturing or production processes. Although their primary application is the use as emulsifying, dispersing, or wetting agents, owing to inherent characteristics of surfactants, they are also used as lubricants, coolants, or carriers for other process materials. Among many types of surfactants, anionic surfactants have a negatively charged end of the molecule leading to hydrophilic properties. Sodium dodecyl sulfate (SDS) is an anionic surfactant used as a common component of many domestic cleaning, personal hygiene, and cosmetic and pharmaceutical products, as well as of industrial cleaning and product formulations. It is a flammable solid, which causes skin irritation, serious eye damage and respiratory irritation. As the use of SDS has been on the rise, both industrial and domestic wastewater would contain high levels of SDS together with other surfactants. It is therefore a timely need to develop strategies to remove SDS from contaminated water although methods have not been much employed for this task. The objective of this research was therefore to investigate the interaction of SDS with fired brick clay particles at ambient temperature for possible extension toward its efficient removal. Brick clay particles, when fired in the laboratory, lose their mass initially due to the evaporation of moisture at about 100 °C, and then the decomposition and/or volatilization of organic matter at higher temperatures. According to thermogravimetric experiments, brick clay is probably free from moisture and organic matter when it is fired at up to 400 °C, resulting in a porous structure to trap SDS molecules, as confirmed through scanning electron microscopic images. The concentration of SDS in the suspension after being adsorbed to brick clay particles fired at temperatures from 100 °C up to 800 °C determined through a surfactant-selective electrode indicates that the most efficient attraction between SDS and the adsorbent occurs at 400 °C, at which the turbidity of the brick clay suspension is minimum, demonstrating that this is the optimum temperature for the removal of SDS from aqueous solution. The other experimental parameters optimized varying one parameter at a time while keeping the others constant leads to the values of 1.5 h shaking time, 0.5 h settling time and 2.0 pH. Nevertheless, ambient pH condition is recommended as it shows more than 85% removal. It is proposed that this methodology be extended for treatment of effluents containing SDS and other anionic surfactants.

Keywords: Adsorption, Shaking time, Surfactant-selective electrode, Thermogravimetry

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PR19

GREEN SYNTHESIS OF IRON OXIDE NANOPARTICLES FROM MAGNETITE TO REMEDIATE FLUORIDE IN CONTAMINATED WATER

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This study delved into a novel, environmentally friendly and low-cost method for the synthesis of iron oxide nanoparticles (IONPs) to remove fluoride (F^-) in aqueous media. The process uses natural magnetite extracted from an ore deposit as the iron precursor and tea (*Camellia sinensis*) leaf extract as the reducing agent. Synthesized IONPs were characterized using scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD). SEM observations indicated the formation of spherical and sub-spherical IONPs aggregated with size ranged between 40 and 100 nm. The FTIR spectrum with bands at 3192 cm^{-1}, 403 cm^{-1}, 640 cm^{-1} and 547 cm^{-1} corresponding to stretching vibrations of α-Fe-O-OH, α-Fe_2O_3 and Fe-O, respectively, confirmed the formation of IONPs. The XRD analysis confirmed the formation of Fe and IONPs. The peaks observed at 2θ values of 14.67°, 27.96°, 31.62°, 45.42° and 73.33°, with the corresponding lattice parameters of (133), (290), (579), (507) and (717) further confirmed the formation of IONPs. Subsequent laboratory batch experiments demonstrated high F^- removal ability of the synthesized IONPs. The adsorbent dosage, contact time, initial F^- concentration, solution temperature and pH were examined as variables. With a contact time of 30 min at or near neutral pH, over 92% of F^- was removed from the solution with 5 g L^{-1} adsorbate. Kinetics data obtained from the adsorption experiments were best fitted with the pseudo-second order model (r = +0.9806) with a rate constant of 4.87 g mg^{-1} min^{-1}. Accordingly, the F^- adsorption by IONPs can be considered as a chemisorption process showing an initial fast adsorption rate followed by slow adsorption. Since the pH at the point of zero charge (pH_{PZC}) of IONPs was 8.15, the F^- adsorption was higher at acidic pH than at alkaline pH. The adsorption process was exothermic as the extent of defluoridation decreased when the temperature was increased from 293 K to 303 K. While the coexisting chloride showed a detrimental effect on F^- removal by IONPs, the presence of nitrate did not affect F^- removal. According to the results, IONPs can be effectively used to remove F^- in contaminated water.

Keywords: *Camellia sinensis*, Defluoridation, Magnetite, Nanosynthesis

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PR20

REMOVAL OF RHODAMINE B FROM DYE EFFLUENTS USING WASTE SLUDGE BIOCHAR

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Rhodamine B (Rh-B) is a harmful dye commonly utilized in the dyeing processes due to its unique characteristics. It can negatively affect the environment and human health when released into industrial effluents from washing and printing processes. Therefore, the removal of Rh-B from these effluents is crucial before they are discharged into the environment. To address this issue, this research aimed to develop a chemically modified new biochar (BC) with waste sludge (WS), which possesses a distinct chemical nature and a high adsorption capacity for removing Rh-B. Following the pyrolysis of WS and chemical treatment using dilute sulfuric acid, the modified BC sample was characterized using scanning electron microscopy, revealing an increased porous structure. The removal efficiencies of Rh-B were determined using UV-Vis spectrophotometry at its maximum absorption wavelength of 554 nm. Efficiency increased steadily with contact time between 5 and 25 min, reaching a maximum of 95%. Varying the BC concentration from 0.1 to 0.5 g/10 mL resulted in an efficiency of approximately 78%. At a pH of 12 in the Rh-B solution, a removal efficiency of 94% was achieved. These findings indicate that as time increases, along with higher doses of adsorbent and alkaline pH levels, the dye removal percentages improve. Therefore, it can be concluded that the novel modified BC be used to remove Rh-B released from industrial plants.

Keywords: Biochar, Dye removal, Pyrolysis, Rhodamine B, Waste sludge

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PR21

MATURE TEA LEAVES AS A LOW-COST ADSORBENT FOR REMOVAL OF LEAD FROM AQUEOUS SOLUTION

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Heavy metal pollution is a major global concern of water pollution. Among heavy metals, lead is considered one of the most hazardous, as it easily accumulates in human tissues and poses a significant threat to aquatic environments. Adsorption is preferred over other heavy metal removal processes due to its low capital cost, simple design, and no production of toxic pollutants. This study explored the possibility of using mature tea leaves, an abundant sustainable resource, as an adsorbent to remove Pb(II) from aqueous solutions without any chemical modifications. The adsorbent was prepared from mature tea leaves, which were cleaned and dried, ground into a powder, and subjected to a hot water wash. Finally, the samples were dried once more and sifted to achieve a particle size range of 300-500 μm. The effect of adsorbent dosage (0.2000-1.2000 g), shaking time (5-50 min), settling time (10-80 min), and pH levels (2.00-5.00) were examined using 100.00 mg L^{-1} solution of Pb(II) under static conditions. Then, all solutions were filtered, and the residual metal concentration was determined using atomic absorption spectrophotometry. When increasing the adsorbent dosage from 0.2000 g to 1.2000 g, the removal efficiency of Pb was increased from 64.1% to 99.8%. The adsorption of Pb(II) was evaluated at different shaking times. Initially, tea leaf adsorbent had many active sites for the adsorption of the Pb(II) and with time the extent of removal became almost constant (99%) due to saturation of active sites by the lead ions. According to the results, there was no significant difference in the percentage removal with settling time. The optimum adsorbent dosage obtained was 0.8000 g. The optimum shaking and settling times obtained were 40 min and 20 min, respectively. The removal percentage of Pb(II) was low when the pH was 2.00. At low pH, there were enormous amounts of H_3O^+ ions that effectively competed with the Pb(II) ions for the adsorption sites and reduced the metal uptake capacity. It was found that the optimum pH for removing Pb(II) was between 4.00 (99.7%) and 5.50 (99.5%). The equilibrium adsorption data well-fitted to the Langmuir adsorption isotherm model (R^2 = 0.9971) resulting in the maximum adsorption capacity of 5.36 mg g^{-1} for lead. When compared to other unmodified biosorbents, it can be concluded that mature tea leaves have a high potential to remove lead from aqueous solutions. The removal of Pb by mature tea leaves adsorbent follows pseudo-second-order kinetic model (R^2 = 0.9931). The XRF data indicated the absence of Pb and the presence of Ca and Mn in mature tea leaves. From FTIR experiments, it can be claimed that aliphatic C-H, C-O-H, and C-O stretching functional groups were involved in adsorption. The results of this study indicate that mature tea leaves adsorbent has a high potential to remove Pb(II) from wastewater.

Keywords: Adsorption, Heavy metals, Lead, Mature tea leaves

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PR22

THE CHARCOAL OF "YAKADA MARAN/YAKUL MARAN" AS A LOW-COST ADSORBENT FOR THE REMOVAL OF LEAD FROM AQUEOUS SOLUTION

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Water pollution due to heavy metals is a global concern with the limited availability of potable water. Lead is a heavy metal that may cause water pollution, and sources of lead are numerous, including ceramics, paints, electronic devices, lead acid batteries and old pipes. Lead poisoning may cause long-term harm in adults, high blood pressure, and kidney damage, and exposure of pregnant women to high levels of lead can cause miscarriage and low infant birth weight. Adsorption is preferred over other heavy metal removal processes due to its low capital cost, convenience, simple design, and absence of toxic pollutants. This study explored the possibility of using the charcoal of Yakada Maran/Yakul Maran (*Syzygium zeylanicum*) as an adsorbent to remove Pb(II) from aqueous solutions, which was collected from the Dunumadalawa Forest Reserve in Kandy District, Sri Lanka. The effect of the adsorbent dosage (0.100-0.500 g), contact time (15-300 min) and settling times (15-120 min), were examined using a 10.0 mg L^{-1} solution of Pb(II). This observation demonstrates that the biosorbent itself has an ability of removing Pb(II) by the aforementioned optimized parameters to some extent by the interactions of its functional groups. The optimum adsorption dosage for Pb(II) was 0.400 g, the optimum contact time was 1.0 h and the optimum pH level of the solution was 6.1. The effect of the experimental parameter of settling time did not have a significant impact on absorbance. The characterization experiments revealed that Pb was not present in the pure material before adsorption. Aliphatic C≡C–H, C–O–H, and aromatic C=C-H were the functional groups that may have been involved in the adsorption of Pb(II). Based on the results of this study, it can be concluded that the charcoal of the Yakada Maran/Yakul Maran adsorbent has a high potential to remove Pb(II) from aqueous solutions and has a commercial benefit due to its low preparation cost.

Keywords: Dosage, Functional groups, Optimized parameters, Settling time

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PR23

MEMBRANE-DRIVEN WATER DESALINATION AND REMOVAL OF TOTAL DISSOLVED SOLIDS FROM DRY ZONE WATERS IN SRI LANKA

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Over three million individuals, mainly residing in the North and North-Central Provinces of Sri Lanka, face water stress due to the lack of access to safe drinking water within their home areas. Unfortunately, most of the water sources in the dry zone have excess fluoride levels, high hardness, excess salinity and high levels of total dissolved solids (TDS) which render the water unfit for consumption. TDS is a secondary contaminant in drinking water with permissible limits of 300 mg L^{-1}. Water desalination is the first step in improving the palatability of such water, and various methods have been used to achieve the desired salinity levels in drinking water. In the current study, a reverse osmosis (RO) desalination system with an optimized membrane configuration was used to remove excess salinity without the use of external chemicals. This system employs ultrafiltration, and nanofiltration followed by reverse osmosis membranes in a special topology. This allows the selective removal of excess salinity and TDS while retaining essential nutrients, such as calcium, magnesium, potassium and other beneficial minerals. The nanofiltration step removes larger contaminants, such as organic matter, heavy metals and certain salts; but crucially preserves vital minerals with smaller ionic radii in the permeate stream. For experimental purposes, a seawater sample diluted with deionized water was used as the feed water. After being filtered using an ultrafiltration unit, TDS and electrical conductivity of the seawater decreased from 1360 mg L^{-1} and 2630 µS cm^{-1} to 1210 mg L^{-1} and 2430 µS cm^{-1}, respectively. The concentrate generated from the nanomembrane was used as the feed water for the RO membrane. The nano and RO membrane permeates were combined to achieve the desired water quality. To assess the performance, TDS, electrical conductivity and pH of both the feed and permeated water were measured, along with the flow rate of both the permeate and concentrated water using a multiparameter with a calibrated probe for over 30 days. The average concentration in the feed was 1190 mg L^{-1}, whereas the average concentration in the permeate was 40 mg L^{-1}. A 96% average rejection rate was observed for this period. The results of the study suggested that the filtration system was effective in removing a significant percentage of dissolved solids from the feed. Therefore, it could be concluded that the reverse osmosis system, at the laboratory level, exhibits high rejection rates for water desalination, and hence it could be a potential method for providing safe drinking water in the dry zone of Sri Lanka.

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Keywords: Membrane topology, Nanofiltration, Reverse osmosis, Water desalination

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PR24

NANO ZERO-VALENT IRON DECORATED ON PRE- AND POST-PYROLYZED LIGNIN: EFFECT OF ENCAPSULATION FOR HEAVY METAL REMEDIATION

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Heavy metals (HM), such as lead (Pb) and cadmium (Cd), are major hazards to human health and the environment. Nano zero-valent iron (nZVI) is gaining attention for HM remediation due to its high reactivity and non-toxicity. Biochar (BC) is an eco-friendly, low-cost support material which also facilitates nanoparticle encapsulation and contaminant adsorption. Synthesis of nZVI-BC composites via combined processes of pyrolysis and carbothermal reduction is a prevalent and environmentally benign method, yielding stable nZVI. Gases evolved during the biomass pyrolysis reduce the iron salt, simultaneously encapsulating nZVI particles. Decoration of nZVI on pre- and post-pyrolyzed lignin, produces surface-deposited (Lig-s-nZVI) and embedded (Lig-e-nZVI) composites, respectively. Utilization of two distinct production routes leads to the dispersion of nZVI with varying encapsulation properties. Herein we comparatively report the characteristics and remediation potential attributed to the effect of encapsulation of nZVI in both materials. Surface morphologies and elemental compositions were compared using scanning electron microscopy (SEM) and SEM-energy dispersive spectroscopy. Pyrolyzing biomass with iron salt increased the porosity of Lig-e-nZVI. Proximate and ultimate analyses showed high surface iron content in Lig-s-nZVI, while the total iron content in both materials remained the same. Crystallinity and zero-valent state of loaded iron were confirmed by powder X-ray diffraction peak patterns. Fourier transform infrared spectra indicated reduced surface functionality of high-temperature-treated BC. The overall surface charge and porosity were studied by point-of-zero charge and Brunauer-Emmett-Teller analysis, correspondingly. High resolution transmission electron microscopy images proved the core-shell structure of nZVI, and an interlayer spacing of 0.36 nm of the shell verified that the Fe^0 particles of both material were encapsulated with graphene while an iron carbide inner layer was also observed, thinner in Lig-e-nZVI and thicker in Lig-s-nZVI. Graphene favors the electron transfer mechanism whereas Fe_3C hinders the process. Maximum capacities at pre-optimized pH and time of Lig-BC, Lig-e-nZVI, and Lig-s-nZVI for Cd(II) were reported as 6.7, 9.7 and 8.1 mg g^{-1}, respectively. These values for Pb(II) were 24.8, 35.7 and 52.4 mg g^{-1}. The main reason for the less uptake of Cd(II) compared to that of Pb(II) is its inability to undergo redox reactions with Fe^0. Therefore, the major mechanism of Cd(II) removal is adsorption, leading to higher uptake by the more porous Lig-e-nZVI, in contrast to Pb(II). Regeneration and leaching studies exhibited a higher initial removal of 35% for Pb(II) by Lig-s-nZVI due to the available surficial Fe^0, whereas for Lig-e-nZVI, a removal of 30% was observed. High sustainability and stability for Lig-e-nZVI were evident over the regeneration cycles, as only a four-fold decrease in uptake was seen, in contrast to the 4.7% reduction in Lig-s-nZVI due to higher iron leaching. Therefore, it can be concluded that the effect of encapsulation does not directly affect the HM remedial efficacy of the BC-nZVI composites but, the availability of the iron and material porosity has a major contribution towards the process.

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Keywords: Biochar, Heavy metal remediation, Lignin, Nanoscale zero-valent iron

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WATER AND HUMAN HEALTH

WH01

PHYSICOCHEMICAL ANALYSIS OF GROUNDWATER TO IDENTIFY POSSIBLE CONTRIBUTORS OF CKDu IN POLONNARUWA DISTRICT, SRI LANKA

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Groundwater is the main source of drinking water in the North-Central Province, which is one of the major agricultural areas in Sri Lanka. Chronic Kidney Disease of unknown etiology (CKDu), prevailing significantly in the North-Central Province of Sri Lanka, is suspected to have an association with the water quality of the area. Therefore, the determination of chemical and physical characteristics of groundwater is important to find out their association with human health issues and to ascertain its suitability for drinking purposes. The main objective of this study was to determine the physicochemical status of water of selected shallow dug wells in Polonnaruwa District and to identify possible contributors of CKDu. Groundwater samples were taken from fifty shallow dug wells in seven District Secretariat divisions in Polonnaruwa District, namely Welikanda, Dimbulagala, Lankapura, Medirigiriya, Elahera, Hingurakgoda and Thamankaduwa. Water samples collected were analyzed for water quality parameters, such as pH, turbidity, alkalinity, ammonia, nitrite, nitrate, phosphate, iron, chloride, fluoride, total dissolved solids and total hardness, at the regional laboratory attached to the National Water Supply and Drainage Board, Polonnaruwa, in accordance with the Sri Lankan Standards (SLS−614) of drinking water quality. The results revealed that all aforementioned parameters, except fluoride, were within the maximum permissible limits of drinking water as per SLS-614. However, fluoride in 26% of the groundwater samples exceeded the maximum permissible limit of 1.5 mg L^{-1} of drinking water. Although the fluoride content of groundwater seems to have a considerable impact on CKDu in the study area, there is no clear association between other water quality parameters and the prevalence of CKDu since they were within the maximum permissible limits of drinking water. Therefore, further studies should be conducted to identify the contributing factors of CKDu in the North-Central Province of Sri Lanka.

Keywords: CKDu, dug well, groundwater, North-Central Province, water quality parameters

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WH02

POTENTIAL ENVIRONMENTAL FACTORS ASSOCIATED WITH CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY IN A VULNERABLE COMMUNITY IN THE WILGAMUWA REGION, SRI LANKA

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Chronic Kidney Disease of unknown etiology (CKDu) poses a serious health risk to farming communities in remote lowland areas of Sri Lanka. Although case-control studies have been conducted to determine the causes of CKDu, none of these studies focused on the at-risk community to assess the influence of the quality of groundwater. The main objective of this study was to identify significant differences in the geochemistry of groundwater consumed by CKDu at-risk communities (dry zone) with the groundwater in CKDu non-prevalent regions (wet zone). Ninety-two drinking or historical drinking water sources and 20 drinking water sources were sampled from CKDu endemic (Wilgamuwa) and CKDu non-endemic (Dodamwela) regions in the Central Province of Sri Lanka. The samples were analyzed for major cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, Si^{4+}), anions (Cl^-, F^-, Br^-, SO_4^{2-}, NO_3^-, PO_4^{3-}) and trace elements (As, Cd, Pd, Mn, Ba, Sr). The major cation and anion concentrations in groundwater utilized by CKDu at-risk population in CKDu-prone region varied as $Si^{4+} > Ca^{2+} > Na^+ > Mg^{2+} > K^+$ and $HCO_3^- > Cl^- > SO_4^{2-} > NO_3^- > F^- > PO_4^{3-} > Br^-$, while in CKDu non-endemic area, it was $Na^+ > Ca^{2+} > Si^{4+} > K^+ > Mg^{2+}$ and $HCO_3^- > Cl^- > SO_4^{2-} > PO_4^{3-} > Br^- > F^-$. In the CKDu region, most of the water sources belong to Ca-Mg-HCO_3 hydrogeochemical facies. In contrast, 80% of groundwater in the wet zone was dominated by either Ca-Mg-HCO_3 or Na-K-HCO_3. Both regions were affected by rock-water interaction, and the chlorine-alkali index showed a prominent role of ion exchange in groundwater geochemistry. In addition, groundwater in the Wilgamuwa region was supersaturated with quartz and chalcedony, while calcite and dolomite also gradually transitioned from an under-saturated state to a saturated state. In addition, barite and fluorite in the CKDu region slowly reach the undersaturated stage to the equilibrium stage. Nevertheless, the groundwater in the disease-free region was slightly super-saturated with quartz. Consequently, higher average values of Si^{4+}, F^- and total hardness (TH) were reported in groundwater consumed by CKDu-vulnerable individuals (Si^{4+}-46, F^--0.62, TH-178; in mg L^{-1}), in comparison to residents in CKDu-free region (Si^{4+}-8.22, F^--0.03, TH-63; in mg L^{-1}). Furthermore, mean As, Cd, and Pb contents of groundwater were higher in the disease-free region (As - 3.43, Cd - 9.27, Pb - 32.06 in µg L^{-1}) compared to CKDu endemic region (As - 0.14, Cd - 0.43, Pb - 1.61 in µg L^{-1}). In addition, the average Ba and Sr concentrations in the CKDu prevalent area and those in the CKDu non-prevalent area were observed to be significantly different ($p < 0.05$). The elevated concentrations of certain parameters (Si^{4+}, F^-, TH) have been identified in groundwater consumed by CKDu at-risk communities, and a proper water treatment process is recommended before household use. Finally, continuous monitoring of CKDu vulnerable communities for environmental exposure could provide a green light to the etiology of CKDu in the dry zone of Sri Lanka.

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Keywords: CKDu, Dry zone, Groundwater quality, Silicon, Sri Lanka
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WH03

CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY (CKDu) IN SOUTH ASIA: A SYSTEMATIC REVIEW OF HOTSPOTS AND CONTRIBUTING FACTORS

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Chronic Kidney Disease of unknown etiology (CKDu) is a growing concern in South Asian countries, with various factors contributing to its prevalence. This systematic review aims to provide a comprehensive overview of CKDu in South Asia, focusing on identified hotspots and the various factors that influenced its prevalence in the region. CKDu has emerged as a significant health concern, particularly in agricultural communities, with a lack of clarity on its causative factors. Hence, a thorough systematic review of existing literature is presented. This review summarizes information on CKDu hotspots and explores multifaceted factors contributing to its occurrence in South Asian countries. The process of article screening was executed by adopting search keywords such as "Chronic Kidney Disease", "Unknown Etiology", "South Asia", "Hotspots", and "Risk Factors" using the Web of Science database. Thirty peer-reviewed articles published in English from 2014 to 2023 were exclusively considered in this study. Both content analysis and thematic analysis were performed on the data. The findings reveal that epidemics of CKDu are occurring in the South Asian regions, including Sri Lankan and Indian agricultural communities, and highlight the role of various contributing factors in the prevalence and progression of CKDu in these regions. Recent research emphasizes that heat stress emerges as a prominent factor exacerbating kidney injury. Among many modifiable environmental and personal factors, which largely determine the disease's occurrence, exposure to agrochemicals, pesticides, herbicides, heat, alcohol, and tobacco could be addressed by creating awareness among at-risk people. Moreover, the etiology of CKDu varies widely by geographic location and ethnicity, with diabetes mellitus and hypertension identified as leading causes globally. Glomerular diseases also contribute significantly to CKDu. In summary, CKDu hotspots in India, Nepal, Sri Lanka, Bangladesh, Bhutan, Afghanistan, and Pakistan are characterized by various environmental, genetic and socioeconomic factors. Contaminated water sources, consanguinity, low birth weight and inadequate healthcare infrastructure contribute to the high prevalence of CKDu in these regions.

Keywords: Chronic Kidney Disease, Hotspots, Mitigation strategies, Risk factors, South Asia, Unknown etiology

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WH04

DETERMINATION OF NEPHROTOXIC EFFECT OF FLUORIDE AND HARDNESS ON WISTAR RATS USING ENVIRONMENTAL WATER SAMPLES

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Chronic Kidney Disease of unknown etiology (CKDu) is a significant health issue in Sri Lanka, particularly impacting the rural agricultural population in recent decades. While the exact cause remains unknown, emerging evidence suggests that elevated levels of fluoride and water hardness induce renal injury. The present study was focused on determining the nephrotoxic effect of fluoride and hardness on Wistar rats using environmental water samples collected from Angunukolapelessa, Galnewa and Padaviya. The concentrations of fluoride were determined using fluoride ion selective electrode technology. The hardness and other water quality parameters (total nitrogen, phosphate, pH, electrical conductivity, temperature, and dissolved oxygen) in water samples collected were determined according to the standard methods. Twenty-eight Wistar rats were randomly assigned into four groups (n = 7) C, A, G, and P. Group C was treated with de-ionized water as the control group, and A, G and P groups were treated with environmental water samples collected from drinking water dug wells in Angunukolapelessa, Galnewa and Padaviya, respectively. Before treatment, the initial body weights of the rats were recorded. During the experiment, the body weights of each group of rats were recorded twice a week. On the day of sacrifice (after 90 days) the final body weight of each rat was recorded and the weight gain was calculated. Then, the rats were euthanized, and absolute organ weights and relative organ weights were calculated. Next, the histopathological observations of rat kidneys were made. According to the results, the fluoride concentrations in water samples collected from Angunukolapelessa, Galnewa and Padaviya were 0.281, 1.53 and 1.91 mg L^{-1}, respectively, while the corresponding hardness values were 92, 216 and 280 mg L^{-1}, respectively, and the other water quality parameters remained within the SLSI drinking water standards. The average body weight of rats increased slightly and there was no statistically significant difference in body weight gain between the test and control groups ($p > 0.05$). Absolute and relative weights of both kidneys in the test groups G and P increased compared to the control throughout the experiment and there was no statistically significant difference ($p > 0.05$). Renal tubular lesions including intraluminal proteins, vascular congestion, cellular swelling, nuclear condensation, proximal tubular necrosis, glomerular degenerations, and cytoplasmic eosinophilia were observed in test groups G and P (rat groups treated with high concentrations of both fluoride and hardness). Furthermore, normal histopathology was observed in the renal tissues of test group A (low concentrations of both fluoride and hardness) and control group C. Thus, the results indicate nephrotoxic effects in test groups G and P which received water from Galnewa and Padaviya, CKDu-prevalent areas. Group A which received water from Angunukolapelessa, CKDu non-prevalent area, and the control group C did not indicate renal tubular lesions. Therefore, the fluoride and hardness of drinking water may be a possible causative factor for the nephrotoxicity in CKDu prevalent areas.

Keywords: CKDu, Fluoride, Hardness, Nephrotoxicity, Wistar rats

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WH05

POTENTIAL OF USING HOT SPRING EXTREMOPHILE BACTERIA FOR THE PRODUCTION OF ANTIMICROBIAL DRUGS

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Antibiotic resistance of pathogenic bacteria is a major global public health concern and hence there is impetus to discover new antimicrobials to treat newly emerging bacterial and fungal infections and diseases caused by microorganisms resistant to existing antibiotics. The productivity and storage conditions for antimicrobial drugs can be maximized using temperature-stable antibiotics over thermolabile antibiotics. Therefore, in the present study, the potential of the hot spring microbial community in Sri Lanka to produce antimicrobial drugs was investigated. Water samples were collected from the surface and bottom of Maha Oya, Wahava, Madunagala, and Kivlegama hot springs in Sri Lanka. The temperature, conductivity, pH and dissolved oxygen (DO) were measured at the site using portable meters. To analyze the microbial community (bacteria and archaea) of hot springs, extracted DNA was sequenced through 16s rDNA amplicon sequencing on the Illumina MiSeq platform. Sequencing data were analyzed using Mother V. 1.42 software. METAGENassist web server tool was used to predict the metabolic functional diversity of bacterial and archaeal communities. Then, whole genome sequencing was performed for DNA isolated from the hot spring, which exhibited the highest temperature. A metagenomics analysis was performed to analyze the gene code for antibiotics. The temperature, conductivity, pH and DO of the hot springs ranged from 33.7-55.4 °C, 801-1507 µS cm^{-1}, 7.20-8.27 and 1.0-3.5 mg L^{-1}, respectively. According to the microbial community analysis, the bacteria were the dominant prokaryotic fraction compared to archaea in all tested samples. *Chloroflexus, Rubellimicrobium, Acinetobacter, Tepidomonas,* and *Deinococcus* were the major genera of bacteria detected in the Maha Oya hot spring while *Acenetobacter, Pseudomonas, Methylobacterium, Hydrogenophaga, Tepidomonas, and Romboutsia* were the majors in Wahava spring. The genera *Reinheimera, Porphyrobacter, Hypomonas,* and *Acinetobacter* were the dominant forms in Madhunagala hot spring, while in Kivlegama hot spring, *Flevobacterium, Caulobacter, Brevivacillus, Vogesella,* and *Acinetobacter* were the major genera. According to the metabolic inference analysis of the microbial community, hot springs were comprised of antibiotic-producing pathways like streptomycin. Further, the antimicrobial compound-producing genes, *viz*., *norM, dinF, matE,* and antimicrobial peptide transport system genes were detected from Maha Oya metagenomics sample. Thus, the results of the present study implied that the hot springs could be a useful source of bacteria to produce antimicrobial drugs.

Keywords: Community analysis, Extremophiles, Extremozymes, Hot springs, Organic fertilizers

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AUTHOR INDEX

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