2018

CHALLENGES AHEAD

WATER QUALITY AND HUMAN HEALTH

International Symposium
PROCEEDINGS

History Culture Ecosystems Biodiversity Sustainability Livelihood Services Leisure Future

All begins with water

13th & 14th July 2018

Postgraduate Institute of Science (PGIS) University of Peradeniya - Sri Lanka

Organized by the

BOARD OF STUDY IN ENVIRONMENTAL SCIENCE
POSTGRADUATE INSTITUTE OF SCIENCE (PGIS)
UNIVERSITY OF PERADENIYA, SRI LANKA

PROCEEDINGS

6th International Symposium on
WATER QUALITY AND HUMAN HEALTH: CHALLENGES AHEAD

13-14 July 2018

Editorial Board

Namal Priyantha (Editor-in-Chief)
Sudharma Yatigammana
Chaminda Wijesundara

Message from

the Director
Postgraduate Institute of Science (PGIS)
Sri Lanka

I am pleased to issue this message to mark the 6th International Symposium on "Water Quality and Human Health: Challenges Ahead" to be held on the 13th and 14th of July 2018 at the Postgraduate Institute of Science (PGIS), University of Peradeniya. This is the sixth International Symposium, which is an annual event of the PGIS. Prof. Sudharma Yatigammana has been the Coordinator of the Symposium series. We are extremely grateful to her and the Organizing Committee for their effort in arranging it. This Symposium is an excellent event to share expertise, experience and knowledge of water researchers with their colleagues through exchange of ideas in technical sessions and discussions.

Surface unpolluted water is an essential element for the existence of all ecosystems and organisms on Earth. This unique resource is an essential component for the life and socio-economic development. It is mainly needed for food production, energy generation, and industrial and domestic uses. With continuous increase in human population, the demand for water has been dramatically increased day-by-day. Global warming and rapid changing of weather patterns influence the quality of freshwater, especially in the countries located in the equatorial region.

Sharing the knowledge of different disciplines of water is an essential requirement to save this precious resource. Cooperation of different social groups, economic sectors, countries, and present and future generations, is crucial not only to ensure the sustainable and equitable use of water but also to create and maintain peaceful relations among the global communities.

Our sincere thanks go to the reviewers and the committee members for ensuring the quality of papers.

Thank you.

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

TABLE OF CONTENTS

Keynote

WATER QUALITY AND HUMAN HEALTH – GLOBAL, REGIONAL AND LOCAL PERSPECTIVES

E.I.L. Silva

Chairman, Water Resources Science and Technology, Sri Lanka

The World Health Organization (WHO) considers water to be polluted when it is altered in composition or condition, directly or indirectly, as a result of human activities so that it becomes unstable or unsuitable, for any or all of the functions or purposes for which it would be suitable in its natural state**.** In other words, water pollution causes for a range of threats arising from human activities, which eventually disturbs the aquatic life, biogeochemical cycles and human health. Although global attention has focused primarily on water quantity, water-use efficiency and allocation issues, poor wastewater management and agricultural practices have created serious water-quality problems in many parts of the world, worsening the water crisis. The 2030 Agenda for Sustainable Development acknowledges the importance of water quality and includes a specific water quality target in Sustainable Development Goal (SDG) 6. The 2030 Agenda for Sustainable Development is expected to strongly influence future policies and strategies and to ensure that the control of water pollution is included in international and national agendas. Human settlements, industries and agriculture, which includes, cropping activities, livestock and aquaculture, are identified as the major sources of aquatic pollution.

Indeed, it is important to preserve the aquatic life in aquatic ecosystems to sustain nature. Declining populations and disappearance of species in aquatic ecosystems are not uncommon in Sri Lanka. It has been attributed to application of agrochemicals. Some of these species are endemic to Sri Lanka, evolved for millions of years. Providing good quality water to the consumptive and non-consumptive users, including human, industry, recreation, navigation and agriculture and aquaculture, is a responsibility of the country. When sharing of water for the benefit of all existing and potential users, whether they obtain their water from watercourses, underground water or overland flow, it must be in good quality and eco-friendly so that future generations too will inherit healthy water resources with the capacity to provide our drinking water needs, capacity to support productive agriculture and preserve the ecosystem with a diverse range of flora and fauna.

Currently, about 4.6 million out of the 21.2 million inhabitants in Sri Lanka, predominantly those living in the rural areas, do not have access to safe drinking water. They have to meet their water requirements from ground or surface water resources mainly, wells, reservoirs and rivers, the quality of which water is questionable. Further, the urban population in Sri Lanka is projected to increase to 45 percent by 2015 and 65 percent by 2030. Under its current programme of cooperation with the Government of Sri Lanka (2013-2017), UNICEF works with the Ministry of Water Supply and Drainage, the National Water Supply and Drainage Board, the Ministry of Education Services, schools and NGOs to support national capacity development to ensure that at least 80 percent of communities in low-coverage areas have equitable access to use safe water and improved sanitation facilities. The expanding water requirements of growing urban populations are worsening the scarcity of water and seriously encroaching onto the water resources that were previously devoted to agricultural use, particularly in the dry zone.

Driven by population growth and the need for increased agricultural production, water resources are coming under intense pressure across Asia. Annual water withdrawal and return flows are higher than in any other region. The volume of wastewater generated annually, excluding agricultural drainage is enormously high. Inadequate provision of sanitation facilities, sewerage and wastewater treatment results in significant quantities of this wastewater reaching water bodies that may serve human consumption. The impacts are being felt by nature and people: 42 percent of the deaths associated with an unsafe or inadequate supply of water, sanitation, and hygiene occur in Asia. Asian countries are making concerted efforts to address these problems. But, the pace and scale of this policy response must increase urgently. Rivers in Asia are highly polluted with domestic waste. Many of the region's rivers contain up to three times the world average of human waste derived bacteria measured in faecal coliforms. Further, agricultural production in the region increased 62 percent from 1990 to 2002, and consumption of mineral fertilizer increased by 15 percent. The Asian region continues to face serious water quality issues that contribute to freshwater scarcity, ill-health, and even deaths. In many places, quality is continuing to decline, and insufficient efforts are being made to monitor and remedy the situation amid institutional and social challenges. However, there are also robust efforts to correct the situation and cause to be hopeful. Positive examples exist in the region that must be shared, learnt from, and replicated.

Sri Lanka, being a country based on an agricultural economy, with a long history of water resources development since ancient time, some polluter industries are in operation in many parts of the country, and further, sanitary facilities are not optimum in both rural and urban sectors. A wide variety of pesticides are being used throughout the country, and Sri Lanka imports about 7000 tons of pesticides per year since early 1980s, far exceeding the actual requirement. Many reports reveal that chronic kidney disease of unknown aetiology (CKDu), which is prevailing in the North Central and North Western Provinces has some bearings on water hardness, fluoride, fertilizer impurities (arsenic and cadmium) and pesticide residues. Some eutrophic reservoirs in the dry zone are being used as source water for drinking after conventional treatment. Certain water treatment plants in Sri Lanka add chlorine to raw eutrophic water rich in organic matter, facilitating the release of the cyano-toxins and halo-methane into water. Gneisses and granite rocks are rich in fluoride containing minerals, the main sources of high fluoride in groundwater in certain parts of Sri Lanka. Exposure to high fluoride levels in drinking water cause endemic dental and skeletal fluorosis, and crippling. Phosphate rocks by their very geological and mineralogical nature, contain lot of environmentally hazardous chemical elements such as Cd, Pb, Hg, U, Cr and As among others. Some reports reveal high concentrations of arsenic in water analyzed from paddy fields in the Dry Zone of the country. Nevertheless, concentrations of pesticides either in surface or groundwater in Sri Lanka are unknown to date. Apparently, most of the impaired water related human health problems in Sri Lanka, including chronic, mainly renal, acute pathogenic problems, could be eliminated by conventional water treatment, if proper guidelines are followed.

VARIATION OF WATER QUALITY OF CASCADE RESERVOIRS OF MAHAWELI RIVER DOWNSTREAM OF POLGOLLA: A REVIEW

A.G.P. Aravinna[1, 2], N. Priyantha[3*], H.M.T.G.A. Pitawala[2,3] and S.K. Yatigammana[2,4]

[1]*Chemical and Environmental Section, Central Engineering Consultancy Bureau, Colombo 05, Sri Lanka.*
[2]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[3]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[4]*Department of Geology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[5]*Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Long-term water quality (WQ) changes of cascade reservoirs represent the status and trends of the pollution in their catchment. Three cascade reservoirs of Mahaweli River (MR) downstream of Polgolla, *viz.* Victoria, Randenigala and Rantembe, are major storage reservoirs of irrigation water for three agricultural schemes of Mahaweli Development Project (*Mahaweli Systems B, C and E*). The impounding history of these reservoirs is more than twenty years. A significant fraction of the catchment of MR is utilized extensively for agricultural and municipal demands. Thus, pollutants may accumulate in these reservoirs affecting the quality of their water. Therefore, water quality parameters analyzed in recent years were compared with reliable WQ data published in the literature for the same reservoirs. Long-term (from year 1986 to 2015) variation of basic physiochemical parameters (pH and electrical conductivity) and major cations (K^+, Na^+, Ca^{2+} and Mg^{2+}) in water of these reservoirs is insignificant. Further, variation of sodium adsorption ratio (SAR) in water is insignificant and their long-term range is 0.3 - 0.7. This shows that the long-term impact of sodium hazard to the downstream irrigation lands is negligible. Although short-term eutrophication and blooming conditions have been observed in Victoria and Randenigala reservoirs, their long-term variation is insignificant. Many literature reports show that the maximum levels of Cd, Cr, Cu, Ni and Pb in the water of these reservoirs are below the minimum guidelines for drinking water as stipulated by the World Health Organization. The levels of Cd (< 0.6 µg L^{-1}) and Pb (< 2.0 µg L^{-1}) in water of these reservoirs, reported in this study, were very close to the levels of those reported in the literature for the same region of MR. This shows that long-term variations of these trace metals are insignificant. Even though some point source pollution was observed in the catchment of MR, the overall anthropogenic activities upstream the cascade reservoirs of MR do not reach critical stage to pollute reservoirs significantly. Although the status of WQ of these reservoirs of MR is good enough for most of the purposes in the past and present, exponential rate of urbanization would change the rate of pollution, threatening the water bodies of MR. Therefore, a proper catchment management plan is required at the river basin levels to safeguard the quality of the water of Victoria, Randenigala and Rantembe reservoirs.

Keywords: Victoria, Randenigala, Rantembe, Reservoirs of Mahaweli River, Water quality

*namal.priyantha@yahoo.com

METHOD OPTIMIZATION TO DETECT GEOSMIN IN WATER BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GCMS) USING SOLID-PHASE MICRO-EXTRACTION (SPME)

S. Ganegoda[1], S.D.M. Chinthaka[2] and P.M. Manage[1*]

[1]*Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*
[2]*Department of Chemistry, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*

Geosmin (trans-1,10-dimethyl-trans-9-decalol) is a key compound which causes earthy taste and odor (T&O) in water. Despite no recorded health hazards, water consumers reject water with geosmin due to its unpleasant T&O. As the minimum human sensory threshold level of geosmin is very low (5 ng L^{-1}), determination of geosmin at such a low level is highly challenging. In this study, a quantitative method for the determination of geosmin in water below human threshold level is developed by solid-phase micro extraction (SPME), followed by gas chromatography - mass spectrometry (GCMS) for the first time in Sri Lanka. Various SPME fibers have been compared for their efficiency in extracting geosmin from water. Medium polar SPME fiber [divinylbenzene/carboxen/polydimethylsiloxane (DVB/CAR/PDMS) microfiber with film thickness 30-50 µm] was selected as the most appropriate device for geosmin extraction as the compound is a semi-volatile compound. Extraction conditions, including the extraction time, temperature, salting out agent and sample volume, were optimized. A 10 mL water sample, 15 min extraction time and 40 °C temperature are the optimized conditions. Sodium chloride (3.0 g) was found to be the best salting out agent. The best GC desorption temperature and duration were found to be 270 °C and 5 min, respectively. Injection port was operated in pulsed splitless mode and helium was used as the carrier gas at a flow rate of 1.1 mL min^{-1}. The ion source energy of the mass spectrometer was selected at 70 eV, and the selected ion current monitoring (SIM) mode was used with base peak of m/z 112 and molecular ion m/z 182 for geosmin. Geosmin was dissolved in deionized water to make a stock solution at a concentration of 200 µg L^{-1}. The solution was stored at 4 ºC and used after dilution with deionized water to prepare calibration standards of concentrations 5.0, 10.0, 30.0, 50.0 and 100.0 ng L^{-1}. The results showed good linearity over the concentration ranged from 5.0 to 100.0 ng L^{-1}. The minimum detectable concentration was calculated to be 1.5 ng L^{-1}, and the minimum level of quantification was 3.5 ng L^{-1}. Both values are below the minimum threshold concentration of geosmin, and the detectable concentration range is 5 - 40 ng L^{-1}. Solid-phase micro extraction integrates sampling, extraction, concentration and sample introduction into a single solvent-free step, and analytes in the sample are directly extracted and concentrated into the extraction fiber. The method proposed in this study is cost-effective and saves sample preparation time.

Keywords: Geosmin, Solid-phase micro extraction (SPME), Semi volatile

*pathmalal@sjp.ac.lk

DIVERSITY AND ABUNDANCE OF RIPARIAN VEGETATION AND THEIR EFFECT ON WATER QUALITY IN A SELECTED AREA OF MAHAWELI RIVER AT PERADENIYA, SRI LANKA

V. Alahakoon and S.K. Yatigammana[*]

Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.

Mahaweli River is the main drinking source for a large portion of 2.5 million inhabitants in the Central Province of Sri Lanka. Kandy is the largest city of the Province which contributes to a large amount of effluent loaded into Mahaweli River. Riparian vegetation plays a significant role in improving water quality. Therefore, the present study was carried out to determine whether riparian vegetation affects the water quality in Mahaweli River and its tributary Sarasavi Oya which is important for the restoration of riparian vegetation along the polluted river. Both onsite and laboratory measurements of selected environmental variables were taken monthly from ten sampling stations to understand spatial and monthly variation of pH, temperature, conductivity, dissolved oxygen, total dissolved solids, flow rate, nitrate, phosphate, sulfate and metal ions (Na, K, Mg, Ca) for the study period (February-July 2017). Riparian vegetation was estimated using quadrat established in transect method. Multivariate statistical techniques, such as Cluster Analysis (CA) and Canonical Correspondence Analysis (CCA), were applied to evaluate species and environmental data. Effluents are loaded within the studied area through various point and non-point sources, including urban runoff, hotels, households, schools, government institutes and polluted tributaries. Gatambe area is the most polluted area of Mahaweli River within the study area, where Mada Ela meets Mahaweli River. Thirty-six plant species were identified within the study area. *Saccharum spontaneum*, *Arundo donax*, *Panicum maximum*, *Commelina* sp., *Ricinus communis*, *Mikania micrantha* and *Therminalia arjuna* were the most abundance species recorded along the riparian vegetation in Kandy area. Spatial variation of abundance of riparian vegetation and water quality parameters clearly showed that riparian vegetation improves water quality in the studied area. Concentration of nutrients (nitrate, phosphate), metal ions, conductivity and total dissolved solid are lower and DO level is the highest at Gannoruwa and Warathanna areas, where abundance of plant species are also higher. However, excess effluent loaded into Mahaweli River appears exceeding the capacity of riparian vegetation to absorb nutrient in some areas. It is apparent that riparian vegetation improves water quality in the studied area of Mahaweli River and its tributary, Sarasavi Oya.

Keywords: Mahaweli River, Water quality, Riparian vegetation

[*]*sudharma_y@yahoo.com*

PLANKTON ABUNDANCE AFFECTS THE FLAMINGO NUMBERS IN THREE MAJOR LAGOONS IN THE JAFFNA PENINSULA, SRI LANKA: A PRELIMINARY STUDY

K.T. Dilrukshi, S.K. Yatigammana and W.M.C.S. Wijesundara[*]

Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.

The Greater Flamingo, *Phoenicopterus roseus* (Phoenicopteriformes; Phoenicopteridae), is a migratory bird species which can be seen in brackish water lagoons mainly in the Jaffna peninsula, Sri Lanka. They inhabit three major lagoons in the peninsula: Jaffna Lagoon, Uppu-Aru Lagoon and Thondaimanaru (including Vallai) Lagoon. The objective of the present study was to determine whether there is a relationship in the flamingo abundance, plankton diversity and their relative abundance. Flamingos were censured using a 25×50 spotting scope and 8×40 binoculars from January to June 2017. Planktons were collected using 30 µm mesh planktons net and identified to the genus level. The relative abundance of planktons was determined to understand the dominance of species in each site. Pearson's correlation test was used to measure the strength of the association between two variables: abundance of plankton and Greater Flamingo. Fifty-seven phytoplankton species were identified, and among them, *Nitzchia* sp. was determined to be the dominant and highly abundant species in all sites except one (relative abundance 20.29%), and *Navicula* sp. was distributed in all the sites having the second highest abundance (18.61%). *Spirogyra* sp. (11.35%), *Pinnularia* sp. (7.58%) and *Chorella* sp. (9.63%) also had comparatively higher abundance and wider distributions. Six zooplankton types were recorded, and crustacean larvae were the dominant and highly abundant forms (relative abundance 47.05%) distributed in all sites except Mamunai and Kappoothu. Though Greater Flamingo is a migratory species, they could be seen in Jaffna peninsula throughout the study period. The results of the Pearson correlation test indicated a simple positive correlation between flamingo abundance and zooplankton abundance ($r = 0.735$; $p > 0.05$) and that there is no correlation between flamingo abundance and phytoplankton abundance ($r = 0.142$; $p = 0.416$). Canonical Correspondence Analysis revealed the phytoplankton variation in different sites and all of the measured environmental variables appeared to be important. Among them, pH, wind speed and humidity were the more important environmental variables in indicating species variation. This study indicates the interaction between biotic-biotic factors, such as the interaction of flamingo with both zooplankton and phytoplankton. As the greater flamingo is a major attraction among the avitourists and is an uncommon species, it is a significant component of the avifauna of the Jaffna peninsula. Furthermore, this study will be useful for environmental predictions, and it highlights the importance of preserving the interactions in the ecosystem.

Keywords: Greater Flamingo, Plankton, Environmental variables, Lagoon ecosystem

[*]*chaminda@hawaii.edu*

ROOSTING CORMORANTS, A POSSIBLE CONTRIBUTOR TO THE NUTRIENT CYCLES IN KANDY LAKE

T. Hettiarachchi[1], S. Wanniarachchi[1*], S.K. Yatigammana[1] and A. Senanayake[2]

[1]*Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Kandy Lake, a man-made ornamental lake located in the middle of the Kandy city, was built during 1810 - 1812 with a surface area of 18 ha attaining a depth of approximately 20 m and a capacity of approximately 8.67×10^5 m^3. The perimeter of the lake is about 3.4 km. The lake-round comprising of a belt of large and spacy trees provide attractive roosting and nesting sites for birds. Among the waterbirds occupying the site, Little Cormorant (*Phalacrocorax niger*) and Indian Cormorant (*Phalacrocorax fuscicollis*) flocks are frequently observed roosting on the trees of the lake round. Waterbirds, such as cormorants, produce fecal matter rich in nitrogen and phosphorus. Additionally, the high metabolic rate results in frequent defecation. The majority of aquatic birds form flocks and communal nesting sites with several hundreds of individuals near water sources, becoming mass scale active nutrient loaders to the water source. Contribution of birds in nutrient cycling in lakes and reservoirs is often not quantified or thought to be insignificant. Nonetheless when the birds' populations are comparatively larger relative to the volume of the water body and the aggregations are long term, the role towards the nutrient cycle is significant. Therefore, the aim of the present study was to carry out a preliminary estimation on the daily and yearly contribution of birds towards the nitrogen and phosphorus input to the Kandy Lake to be used as reference for further studies. Individual counts of Little Cormorant and Indian Cormorant were taken two days per month for a period of four months starting from January to April 2017 using point-count method by direct observations. The amount of fecal matter for the cormorants was estimated using the literature surveys from previous studies. Daily defecation weight of Little Cormorants was used as the reference values, while calculations were done for the daily and yearly input of total nitrogen (TN) and total phosphorus (TP) into the lake assuming that nesting and roosting populations do not completely defecate in to the lake.

According to the available literature, the daily excretion of TN and TP by an individual cormorant was 4.59 g and 3.55 g, respectively. Average population size of the Little Cormorants was 247 individuals, while the average Indian Cormorant population size was 405. Calculations revealed that the daily inputs of TN and TP by the flocks are 1.73 μg L^{-1} and 1.33 μg L^{-1}, respectively, while yearly inputs of TN and TP by the flock are 629.80 μg L^{-1} and 480.42 μg L^{-1}, respectively (assuming only half of the fecal pellets are directly causative to the nutrient loading). Thus, a total of 542.41 kg of N and 422.17 kg of P are loaded by the Cormorant populations into the lake yearly. According to literature, the TP of Kandy Lake in 2000 was 38.7 μg L^{-1}, while in 2016, the TP has drastically increased up to 480 μg L^{-1}. TP amounts in 2016 are comparatively closer to the yearly input of P by the Cormorant populations. As the study revealed, there is a possibility of a considerable contribution of roosting Cormorants towards the nutrient loading of the Kandy Lake apart from the anthropogenic waste water. Imbalance loading of N and P to the water can boost the potential of eutrophication in such lakes. Therefore, it is recommended that further investigation be carried out to evaluate the exact amounts of nutrients that are being added to the lake by the roosting fauna to take necessary steps to conserve the Lake Ecosystem.

Keywords: Kandy Lake, Cormorants, Nutrient cycles

*csaumyaw@gmail.com

ENVIRONMENTAL COMPLIANCE ASSESSMENT OF AUTOMOBILE SERVICE STATIONS IN KANDY DISTRICT CORRESPONDING TO EFFLUENT MANAGEMENT

A.G.S.M. Dayarathna[1,2] and A.C.A. Jayasundera[1,3*]

[1]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Central Province Environmental Laboratory, Central Environmental Authority, Polgolla, Sri Lanka.*
[3]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Automobile vehicle service stations are rapidly increasing in Sri Lanka with the rise in transportation. Effluent from such facilities is one of the major causes associated with point water pollution in Sri Lanka. Most of the vehicle service stations are located near urbanized areas, facing several problems with regards to treatment of effluents. According to the Extraordinary Gazette No. 1533/16 of 2008, an automobile service station does need Environmental Protection License from the Central Environmental Authority (CEA). Automobile service stations deal with petroleum-based waste that is potentially hazardous to humans and to other life forms. Hence, there should be proper arrangements for the management of effluents to mitigate environmental pollution. Therefore, the present study was aimed at assessing physio-chemical characteristics of treated effluents in automobile service stations in Kandy District and to find out their compliance with tolerance limits for the discharge of industrial waste into inland surface water bodies. Forty service stations were randomly selected from Kandy District for this study. Grab sampling was done at each site, and effluent quality parameters, such as pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD) (open reflux method), oil and grease (partial gravimetric method), and turbidity (Nephelometric method), were recorded. All laboratory analyses were carried out in accordance with the standard methods for examination of water and wastewater. Results revealed that pH (100%) was the most compliance parameter and the compliance decreased in the order, oil and grease (86.0%), COD (76.7%), TSS (72.0%) and BOD (55.8%). According to the findings, 46.5% of service stations discharge effluents that were complied with tolerance limits for the discharge of industrial waste in the inland surface water body stipulated under the National Environment Act. The pH of treated effluent sample ranged 6.2 – 9.6, complied with effluent quality stands without any pH adjustment. However, pH reduction was slightly recorded in a few stations as a result of excess amount of aluminium sulfate addition. COD of all samples was within the range of 38 – 667 mg L^{-1} and BOD was within the range of 1 – 135 mg L^{-1}, where tolerance limits were 250 mg L^{-1} and 30 mg L^{-1}, respectively. The study also found that all service stations had oil interceptor as a primary treatment. Hence, oil and grease values were within the range of 1 – 23 mg L^{-1} but their performances depend on various factors. This study revealed that there was a positive correlation between TSS and Turbidity, although there was no relationship observed between BOD and COD values. This study recommends that automobile service stations in Kandy be further upgraded to suitable and effective effluent management systems to treat effluents before discharging into the environment. Furthermore, regular compliance monitoring is required and research could be conducted in developing an efficient, cost effective and sustainable system for the management of effluents from service stations.

Keywords: Automobile service station, BOD, COD, Effluent management

*acaj@pdn.ac.lk

EFFECTS OF ENVIRONMENTAL VARIABLES ON WATERBIRD DIVERSITY IN SELECTED WETLANDS IN THE JAFFNA PENINSULA, SRI LANKA

D.M.S.A. Dissanayake and W.M.C.S. Wijesundara[*]

Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.

Wetlands are among the world's most productive environments and are important for ecological processes as well as for their rich biodiversity. Jaffna Peninsula has several significant wetland sites of which some have been identified as important bird areas. The physico-chemical and biological parameters of wetlands are known to influence congregation of migratory and resident species of waterbirds. The present study deals with the interactions between abiotic and biotic factors and waterbird diversity in selected wetland sites in the Jaffna peninsula. The study was carried out from January to July 2017. The selected sites were Vallai, Nagar Kovil, Thondamanaru, Mankumban, Araly Junction, Kaithady, Chavakachcheri, Sarasalai, Karaveddi, Kaladaipiddy, Navatkuli, Avarankal East, Mamunai, Mandaitivu, Kappoothu, and Puttur-Bannathi bridge area. Waterbirds were counted according to their orders and identified through direct observations using standard field guides. Atmospheric temperature, humidity, wind speed, water temperature, pH, DO and conductivity were measured in the field. Water samples were collected from each sampling point. Salinity was calculated using conductivity and water temperature data. Each sample was observed in the laboratory to identify the plankton species. The waterbird density, diversity indices, and species richness indices were calculated. Data were analyzed using Minitab (v14) and Canoco for windows (v5) statistical packages. A total of 59 species of waterbirds (both resident and migrant) belonging to 9 orders and 17 families were recorded during the study period. Conductivity and salinity had a strong correlation with the main component which helps discriminate the sites. A total of 57 phytoplankton species were recorded during the study period. Waterbird diversity was mainly influenced by the environmental variables.

Keywords: Diversity, Richness, Density, Waterbirds, Phytoplankton, Abiotic factors

[*]*chaminda@hawaii.edu*

EFFECT OF SODIUM IONS ON THE REMOVAL OF HEAVY METALS FROM LABORATORY WASTEWATER USING CLAY SOIL AS A NATURAL ADSORBENT

C.A.U.K. Kumarihami and S.S. Subramanium[*]

Department of Chemistry, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka.

Adsorption is a widely used process for the removal of heavy metals from waste streams worldwide. Various studies have used clay as a potential adsorbent due to its promising capacity to remove heavy metals from wastewater. In Sri Lanka, both the state universities and private sector educational institutes lack laboratory wastewater management strategies. Thus, these institutes release untreated laboratory waste water, containing toxic heavy metals to the nearby surrounding. Preliminary studies were carried out to remove several heavy metals using clay soil as the natural adsorbent. There are many factors affecting the heavy metal adsorption process by clay soil, such as pH, initial metal ion concentration, and temperature and equilibrium time. Since sodium containing salts are frequently used in teaching laboratories, this research was conducted to determine the effect of sodium ions on removal of heavy metals from laboratory waste water using clay soil. In the present study, the interest was focused on lead and cadmium, which are very common and toxic heavy metals. Soil samples were collected from a clay mining site used for brick making purpose at Malwana area, and they were characterized using chemical methods. From these soil samples, Na^+ homoionic clay soil (the adsorbent) was prepared using the highest cation exchange capacity contained soil. Adsorptive removal of lead and cadmium on Na^+ homoionic clay soil, under different Na^+ concentrations (0.10 mol L^{-1}, 0.50 mol L^{-1}, 1.00 mol L^{-1}, 1.50 mol L^{-1}) were carried out by both batch and column methods in order to determine the effect of sodium ions on the adsorption capacities of lead and cadmium. Columns packed with Na^+ homoionic clay soil (15.00 g) were used for column studies at a flow rate of 0.56 mL min^{-1}. Flame atomic absorption spectrometer, having detection limits of 0.21 mg L^{-1} and 0.003 mg L^{-1} for lead and cadmium, respectively, was used for the determination of metal concentrations. The present study revealed a decrease in metal ion adsorption capacities on clay soil for both lead and cadmium when increasing the Na^+ concentration. Single element batch experiment with lead indicated that the lead adsorption capacity by clay soil has been decreased from 91.23% - 76.29% when increasing the Na^+ concentration from 0.10 mol L^{-1} - 1.50 mol L^{-1}, and it was 38.10% - 21.68%. For cadmium. Further, the decrease in adsorption capacity for cadmium is higher than that of lead in the presence of Na^+. A similar pattern was also observed for studies using clay packed columns. According to the results, column breakthrough volumes of lead in various Na^+ concentrations of 0.10 mol L^{-1}, 0.50 mol L^{-1}, 1.00 mol L^{-1}, 1.50 mol L^{-1} were 80.0%, 60.0%, 33.3% and 26.7%, respectively. The study showed that the presence of Na^+ affects the adsorption of lead and cadmium heavy metal ions to clay, and therefore controlling the Na^+ concentration in wastewater is critical in effective removal of lead and cadmium ions.

Key words: Adsorption, Heavy metals, Clay soil, Cadmium, Lead

[*]*sri@kln.ac.lk*

ROLE OF MACROPHYTES WITH RESPECT TO WATER POLLUTION IN URUWAL OYA

V.K.U.S. Ruparathna and S.K. Yatigammana[*]

Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.

The role of the macrophytes in water purification in Uruwal Oya, a tributary of Aththanagalu River, which flows through the municipal council area of Gampaha, in the Western Province of Sri Lanka was explored. The survey was conducted monthly for a period of six months from December 2011 to May 2012. The abundance of macrophytes and related physicochemical parameters, including total phosphorous (TP), nitrate, pH, chlorophyll-*a*, conductivity, turbidity and water temperature, were measured in three study sites which appear to have different characteristic features of the stream. Distribution of macrophytes of each site differs from one another and the multivariate statistical technique, Canonical Correspondence Analysis, reveals that macrophyte species composition is negatively correlated with TP, chlorophyll-*a* and conductivity. Turbidity was positively correlated with macrophyte abundance, and it was identified that the availability of macrophytes reduces TP in water significantly. In addition, chlorophyll-*a* plays a role in places where there is low abundance of macrophytes. *Typha angustifolia*, *Pistia stratiotes* and *Ipomoea aquatica* appeared to be effective in nutrient removal. Our study explains that efficiency of macrophytes in removing nutrients may differ according to the habitat conditions and characteristic features of the macrophytes. Especially, the presence of the macrophytes in littoral zone plays a significant role in purifying water. It is suggested that maintaining the littoral zone and frequent harvesting be needed to make the water purification process more effective.

Keywords: Water pollution, Macrophytes, Uruwal Oya

[*]*sudharma_y@yahoo.com*

PURIFICATION, CHARACTERIZATION AND STRUCTURE ELUCIDATION OF ANTIBACTERIAL ACTIVE COMPOUND OF *Chroococcus* SP.

W.A.M.A. Wijesekara and P.M. Manage[*]

Center for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Cyanobacteria, an archaic group of prokaryotic organisms originally found in the world, is recognized as a potent source of biologically active compounds with antiviral, antibacterial, antifungal and anticancer properties. In the present study, cyanobacterium *Chroococcus* sp. was isolated from a freshwater reservoir Padawiya in Sri Lanka, and pure monocultures and mass cultures were prepared. Extraction was carried out by hexane, methanol, dichloromethane and methanol/water (v/v), respectively, using standard methods. Antibacterial activity of crude extract of different concentrations was carried out by disc diffusion methods against Gram positive bacteria Methicillin-resistant *Staphylococcus aureus* (MRSA) ATCC 25923) Bacillus sp. and Gram negative bacteria of *Salmonella typhi* and *Escherichia coli* ATCC 25922, respectively. Minimum inhibition concentration (MIC) was determined by TTC bio assay. Purification of antibacterial active compound was carried out using Thin Layer Chromatography (TLC), followed by Bioautochromatography, Column Chromatography (CC), Solid Phase Extraction (SPE) and High Performance Liquid Chromatography (HPLC). Characterization of antibacterial active compound was done using primary chemical screening (crude extract) and secondary chemical screening on TLC plates. Structure elucidation of antibacterial active compound was carried out using Fourier Transform Infra-Red (FT-IR) spectroscopy, Gas Chromatography-Mass Spectrometry (GCMS). The antibacterial activity was recorded in methanol/hexane and methanol/water (v/v) extract, whereas that in dichloromethane extract was not detected. The highest antibacterial activity was recorded in methanol extract (21 ± 1 mm) against *S. aureus* within 24 h incubation. The lowest MIC in the methanol crude extract was 150 mg L^{-1} against *S. aureus*. The solvent system ethyl acetate:methanol:water (2:5:3) was used to separate active compounds on TLC. Bioutochromatography test gave inhibition zone against *S. aureus* (R_f = 0.7) and *S. typhi* (R_f = 0.6). Primary chemical screening gave positive results for alkaloids, terpenoids, flavonoids and antroglycosides, and secondary chemical screening confirms antibacterial active compounds belong to flavonoids and antroglycosides. FTIR analysis shows that the antibacterial active compound contains alkali and aromatic functional groups, and GCMS analysis shows the presence of fatty acid groups. Antibacterial activity of the purified compound was further confirmed using ABST, and it gave the highest activity against *S. aureus* (31 ± 1 mm) and *S. typhi* (29 ± 1 mm). Thus, the results of the study show that the *Chroococcus* sp. contained compounds having potential for pharmaceutical invention.

Keywords: *Chroococcus* sp., Antibacterial compounds, Disc diffusion, Bioautochromatography

[*]*pathmalal@sjp.ac.lk*

REMOVAL OF METHYLENE BLUE FROM AQUEOUS SOLUTIONS USING TEA WASTE DERIVED ACTIVATED CARBON

A.H.P. Hettiarachchi and C.S.K. Rajapakse[*]

Department of Chemistry, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka.

Textile and dyestuffs industries discharge dye-containing effluents into water bodies resulting in significant pollution unless effluents are treated prior to releasement. Therefore, removal of dyes from wastewater has become an important area of research in recent years. Among different treatment methods, adsorption by agricultural solid waste based activated carbon is considered to be an efficient and cost-effective method for the removal of various dyes from wastewater. The objective of this study was to investigate the potential use of tea waste derived activated carbon (TWAC) as a low-cost, natural adsorbent for the removal of methylene blue (MB) dye from aqueous solutions, and to conduct equilibrium and kinetics studies of the adsorption process. TWAC was prepared using two methods: microwave method and muffle furnace method. In both methods, chemical activation was carried out by impregnating with phosphoric acid (85%). The microstructure of the activated carbon was observed with Scanning Electron Microscopy. Textural characteristics, such as attrition and bulk density, were also measured using standard procedures. Due to the higher yield, TWAC prepared using the microwave method was used for further studies. Effects of various physicochemical process parameters, such as TWAC dosage, MB concentration, pH of the solution and shaking time, of MB adsorption on TWAC were investigated. The amount of MB removed under the conditions selected was determined using UV-Vis spectrophotometer. Further, fixed bed column experiments were conducted to study the practical applicability of the adsorbent. The optimum adsorption conditions were found at the initial MB concentration of 300 mg L^{-1}, TWAC dosage of 0.001 g, at pH 13 and contact time of 6 h. Isotherm data at 30 $^{\circ}$C satisfied the Langmuir model with an R^2 value of 0.982 resulting in a maximum monolayer adsorption capacity (q_o) of 303.3 mg g^{-1}, which is significantly higher compared to q_o values for adsorption of MB on various other biomass types reported. The pseudo-first-order model yielded the best fit for the adsorption kinetics data with R^2 values of 0.962 and 0.969 for initial MB concentrations of 300 mg L^{-1} and 200 mg L^{-1}, respectively. According to the results obtained from fixed bed column experiments the breakthrough time, length of unused bed and bed capacity for the elution rate of 10 mL min^{-1} were 50 min, 5.14 cm and 49.16 mg g^{-1}, respectively. The findings of the study reveal that tea waste would be a good candidate and a precursor for the production of an effective and environmental friendly adsorbent for MB removal. The removal efficiency of TWAC could be further enhanced by optimizing parameters, such as flow rate, particle size and bed height of the column.

Keywords: Tea waste, Activated carbon, Methylene Blue, Adsorption, Isotherm

[*]*shashikala@kln.ac.lk*

POLYCYCLIC AROMATIC HYDROCARBONS IN WATER BODIES AROUND KERAWALAPITIYA AND KELANITISSA POWER PLANTS IN SRI LANKA

H.M.H.B. Chandrasiri and S.S. Subramanium*

Department of Chemistry, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka.

Polycyclic aromatic hydrocarbons (PAHs) are a group of organic compounds, which are known for their carcinogenic and mutagenic properties. Water bodies and their sediments around Kelanitissa (KL) and Kerawalapitiya (KW) power plants, which are powered by fossil fuel, showed the presence of PAHs in significant amounts. Therefore, the present study aimed to determine the effect of the distance from the source on the PAH content. In addition to surface water samples and sediment samples (KL 8 sites, KW 5 sites), well water samples (3 wells) were collected from sites near KL and KW during rainy season. A surface water sample from a well close to University of Kelaniya was used as the reference. PAHs from water samples were extracted into dichloromethane and PAHs from sediment samples were extracted into methanol, and analyzed using High Performance Liquid chromatography (HPLC) with UV-DAD (254 nm) and HPLC- FLD (excitation at 250 nm, emission at 410 nm). The PAH contents in water and sediment samples were compared with that of the reference site.

This study indicated the presence of low and high molecular weight PAHs (HMW) in both sediments and water samples. The total PAH concentration in surface water samples of KW ranged from 5.35 to 7.79 µg L^{-1}, while it was in the range of 6.88 - 10.05 µg L^{-1} for KL. The total low molecular weight (LMW) PAH concentration in KL surface water ranged from 2.94 to 7.74 µg L^{-1}, whereas it ranged from 3.52 to 6.80 µg L^{-1} in KW. The concentration of LMW PAHs in the surface water was higher than the concentrations of medium molecular weight (MMW) and HMW PAHs in both KW and KL sites. The total concentrations of LMW PAHs, MMW PAHs and HMW PAHs of sediment samples in Kelanitissa ranged from 59.07 - 85.03, 1.20 - 5.90 and 10.42 - 24.01 µg kg^{-1}, respectively. The total concentrations of LMW PAHs, MMW PAHs and HMW PAHs of sediment samples in Kerawalapitiya were 24.69 - 81.41, 0 - 2.30 and 4.98 - 9.25 µg kg^{-1}, respectively. The total PAH concentrations in sediment samples from KL and KW were in 1.04 - 3.50 and 2.10 - 4.33 µg L^{-1} ranges, respectively.

At the KW site, an increase in the concentration of total PAH of surface water samples with increasing distance from the source was observed. Further, well water samples from KL and KW indicated the presence of low, medium and high molecular weight PAHs. One of the well water samples which was obtained near Kelanitissa plant showed higher values (0.025 µg L^{-1}) than the guideline value for Benz[a]pyrene (BaP) which is a carcinogenic PAH. Another well water sample obtained near Kerawalapitiya plant also contained higher amount of Benz[k]fluoranthene (BkF, 0.339 µg L^{-1}) than the guideline value. As the presence of significant amounts of PAHs in well water in both sites near Kelanitissa and Kerawalapitiya was noted, and further studies would confirm the findings.

sri@kln.ac.lk

USAGE OF *Strychnos potatorum* SEEDS FOR REDUCTION OF CHEMICAL OXYGEN DEMAND IN TEXTILE EFFLUENTS

D.P.C. Sonali[*] and Y.L.N. Mathotaarachchige

Department of Chemistry, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka.

The manufacture of textiles is one of the largest industries in Sri Lanka. Textile manufacturing industry consumes large amounts of water and chemicals for wet processing. Highly contaminated water discharged from textile factories poses serious environmental problems due to their color and organic matter. The objective of this study was to assess the reduction of chemical oxygen demand (COD) from textile effluents using raw *Strychnos potatorum* (SP) seeds (coagulant) and activated carbon prepared from SP seeds (ACSP) (adsorbent). Optimization studies for treatment time and coagulant/adsorbent dosage were done for each case to investigate suitable parameters to achieve the maximum reduction of COD. Before treatment, effluent was allowed to stand for 24 h to sediment the colloidal particles. Optimization of treatment time was done by agitating the effluent (800.0 mL) and SP seed pieces/ACSP particles (25.0 g). Samples (10.00 mL) were collected from the reactor at 10 min time intervals, and the entire treatment was conducted up to 100 min. A control study was done by keeping the same treatment conditions without using SP seed pieces/ACSP particles. Optimization of coagulant/adsorbent dose was done by agitating the sample (800.0 mL) with different doses of SP seeds/ACSP varying from 5 - 50 g.

The maximum percentages of reduction of COD under the optimized conditions were 74% and 70% for raw SP seeds and ACSP, respectively. Optimized treatment time and coagulant/adsorbent dosage for SP seeds were 70 min and 30 g/800 mL, respectively, and for ACSP, they were 70 min and 25 g/800 mL, respectively. This study revealed that both SP seeds and ACSP have potential to reduce COD in textile effluents. Therefore, both agents can be utilized as effective and less expensive coagulant/adsorbent for the reduction of COD in textile effluents.

Keywords: *Strychnos potatorum*, COD, Textile, Effluent

[*]*chanika.sonali@ymail.com*

COMPETITIVE ADSORPTION AND KINETICS STUDY OF HEXAVALENT CHROMIUM ON POLYANILINE/COCONUT COIR COMPOSITE

A. Dharmasiri[1], S.H. Ranasinghe[1], T. Divisekara[1] and S.S. Gunathilake[2*]

[1]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Department of Chemistry, University of Peradeniya, Peradeniya, Sri Lanka.*

Contamination of drinking water is a pragmatic problem, and one of the main contamination methods is by the release of heavy metal ions to water bodies. Chromium is a major element that is released to water bodies by many industries, including electroplating, leather tanning, painting, textile and steel production. Chromium can be released as hexavalent chromium [Cr(VI)] as well as trivalent chromium [(Cr(III)]. It is a known fact that the removal yield of Cr(VI) is very low. Therefore, removal of Cr(VI) from a solution was studied in the presence of other heavy metal ions in a competitive manner using a polymeric composite. For this, emaraldine base form of polyaniline was grown on coconut coir by chemical oxidation polymerization of aniline in the presence of coconut coir. The resultant polyaniline/coconut coir (PANI/CC) composite was tested as an adsorbent and experimented for adsorption kinetics. Initial studies performed on a mixture of solution containing chromium, copper, nickel, zinc and cadmium with Atomic Emission Spectroscopy showed that PANI/CC composite exhibits adsorption capacity of 34% for chromium, 7% for copper, 6% for nickel and >2% for zinc and cadmium. Since the adsorption capacity is considerably higher for chromium, the conditions for chromium adsorption on PANI/CC were optimized with a test solution of K_2CrO_7. The optimized conditions for adsorption were found to be pH of 5, 60 min of shaking time and 60 min settling time. With these conditions, the maximum adsorption capacity of 75% was observed for Cr(VI) on PANI/CC composite. Adsorption of Cr(VI) on the composite was further confirmed by XRF analysis. Adsorption data were fitted to the Langmuir adsorption isotherm at low concentrations and the Freundlich isotherm at higher concentrations unveiling the multilayer adsorption at higher concentrations. Adsorption kinetics fitted more to pseudo second order model with an R^2 value of 0.96, suggesting that the process is chemisorption.

Keywords: Polyaniline, Coconut coir, Hexavalent chromium, Adsorption, Kinetics

*smdhgunathilake@yahoo.com

LOW-COST FILTERS FOR REMOVAL OF FLUORIDE IN DRINKING WATER

S. Pathmasiri[1], N. Kottegoda[3, 4, 5] and A.D.L.C. Perera[1, 2*]

[1]Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.
[2]Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.
[3]Department of Chemistry, Faculty of Science, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.
[4]Sri Lanka Institute of Nanotechnology, Centre for Excellence in Nanotechnology, Nanoscience and Technology Park, Pitipana, Homagama, Sri Lanka.
[5]Center for Advanced Materials Research, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Excess fluoride in water causes serious issues on human health. Long term intake of fluoride may have adverse impact on teeth, tissues and bones in humans. According to the World Health Organization and The United Nations Children's Fund reports, more than 25 countries including Sri Lanka currently face problems due to high fluoride in drinking water. Recent research findings suggest that there is a possibility of formation of toxic substances, such as CaF_2 and CdF_2, which can damage the kidneys causing CKDu. Almost 50% of the wells studied in the dry zone regions of Sri Lanka had fluoride levels greater than 1.0 mg L^{-1} and the highest reported fluoride level was 13.7 mg L^{-1} from a well located in Anuradhapura district. At the same time, a considerable number of people suffered from CKDu and many deaths have occurred due to CKDu in the dry zone. The present project focused on a low-cost adsorption method using activated coconut coir (ACC)–alginate (AG) composite as an adsorbent for defluoridation of water. ACC was prepared by treatment of raw coconut coir dust with 40 wt% phosphoric acid followed by pyrolysis, and AG was used to make ACC-AG beads. These ACC-AG beads were characterized using Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Energy Dispersive X-ray Fluorescence and Powder X-ray Diffraction. Under optimized conditions, 1.500 g of ACC-AG beads were closely packed to a burette column and 50 mL of natural well water samples collected from Anuradapura, Polonnaruwa and Kekirawa were filtered through the column at 50 mL h^{-1} flow rate. The percentage removal of fluoride ions after a single filtration through the column is in the 60-70% range. After the first filtration, the eluted solutions were again filtered through a separate column of ACC-AG beads. After repeated filtrations of three times, the percentage removals of fluoride ions from water samples achieved up to 80-90% range. The ACC-AG beads enhanced fluoride ion removal efficiency of ACC in water by 1.5 times. The regeneration of ACC-AG beads were attempted with distilled water, NaCl, $CaCl_2$ and NaOH, and it was found that 50% recovery of defluoridation capability of ACC-AG beads could be achieved simply by rinsing with distilled water. Due to simplicity, reproducibility and cost efficacy, ACC-AG beads have future potential in domestic water filters.

Keywords: Filters, Fluoride, Defluoridation, CKDu

*chandanip@pdn.ac.lk

FACTORS AFFECTING SPECTROPHOTOMETRIC DETERMINATION OF Pb(II) USING PORPHYRIN: TMPyP

A.H.P. Hettiarachchi[1], D.G.T.N. Dikella[1], M. Zamadar[2] and C.S.K. Rajapakse[1*]

[1]*Department of Chemistry, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka.*
[2]*Department of Chemistry and Biochemistry, Stephen F. Austin State University, Nacogdoches, TX 75962, USA.*

Water pollution by heavy metals is one of the serious environmental problems, and detection of heavy metals in contaminated water has became a challenging task due to lack of cost-effective techniques. In recent years, water soluble porphyrins have gained growing attention as possible colorimetric agents for heavy metal detection by UV-Vis spectrophotometry. Porphyrins are known to be highly sensitive to metal ions and display photometric changes in the region of the Soret band (~400 nm) as well as the minor Q bands (500–700 nm) upon metal ion chelation. This property has been widely used for sensing heavy metal ions in aqueous solutions. In this work, sensing properties of an aqueous solution of 5,10,15,20-tetrakis(1-methyl-4-pyridinio)porphyrintetra(*p*-toluenesulfonate) (TMPyP) for detection of Pb(II) ions by UV-VIS spectroscopy was examined. The influence of pH, water hardness and the presence of other metal ions, such as Cd(II), Cu(II), Cr(III) and Fe(II), on Pb(II) detection by TMPyP under the selected experimental conditions was investigated. Removal of metal bound and metal-free TMPyP from aqueous solutions using chitosan was also investigated.

Changes in the characteristic Soret band of TMPyP in the UV-Vis spectrum at 478 nm allows it to be used as an optical sensor for the detection of Pb(II). The detection limit for Pb(II) was 0.02 mg L^{-1}, which is below the maximum permissible contamination level (0.05 mg L^{-1}) according to Environmental Protection Agency (EPA) drinking water standards. A clear isosbestic point was observed at 446 nm which indicates that the metal-free TMPyP and Pb(II)-bound TMPyP [TMPyP and Pb(II)-TMPyP] were in equilibrium. The best pH range for Pb(II) detection using TMPyP was pH 2-9. The intensity of the Soret band at 478 nm was reduced upon addition of aqueous solutions of Ca(II), Cd(II), Cu(II), Cr(III) and Fe(II), indicating that the presence of other metals could influence the sensitivity for Pb(II) detection. Interestingly, metal-TMPyP complexes as well as unbound TMPyP were removed successfully from the test aqueous solutions using chitosan. This study indicates that the detection method developed possesses many advantages, such as simplicity, rapidity and considerable sensitivity for detection of Pb(II) ions in aqueous solutions.

Keywords: TMPyP, Pb(II), UV-Vis spectrophotometry

*shashikala@kln.ac.lk

SCREENING OF DENITRIFYING BACTERIA TOWARDS REMOVAL OF NITRATE FROM GROUNDWATER

A. Thurairajah[1,2], N. Gnanavelrajah[1] and R.R. Ratnayake[2*]

[1]*Faculty of Agriculture, University of Jaffna, Jaffna, Sri Lanka.*
[2]*National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka.*

Nitrate contamination in groundwater resources is becoming a serious problem in many parts of the world. World Health Organization's acceptable level for nitrate is 50 mg L^{-1} as nitrate ion (or 11 mg L^{-1} as nitrate-nitrogen) and for nitrite, it is 3 mg L^{-1} as nitrite ion (or 0.9 mg L^{-1} as nitrite-nitrogen) to protect bottle-fed infants (short-term exposure) against methaemoglobinaemia. Nitrate is considered to be a very important water pollutant in Jaffna District. Most of the well water in Jaffna District has exceeded the recommended level of nitrate, and many available methods for nitrate removal are expensive. Therefore, research has been initiated to study the potential of using microorganisms for this purpose. The aim of the present study was to identify the efficient nitrate reducing bacterial species isolated from different samples collected from Jaffna district. Morphologically different bacterial species (128 numbers) were isolated, and primary screening was carried out by modified bromothymol blue medium supplemented with KNO_3. Among them, 70 strains were selected for secondary screening as they are nitrate reducers. In secondary screening, assimilatory and dissimilatory nitrate reduction test was performed with nitrite (sulfanilic acid and α-naphthylamine) and Nessler's reagent, respectively. About 37 bacterial strains were identified as assimilatory nitrate reducers from secondary screening (nitrate reduced to nitrite and observation of gas bubbles). Among them, 15 strains were selected for further study with different carbon sources based on their efficiency in removing either nitrate or nitrite (more than 50%) on medium. Among these, fifteen strains GMC (sample ID) had the highest nitrate and nitrite reduction percentage (more than 80%) than others. More than 75% of nitrate reduction was observed with the strains of GMC IIIb II, GMC V, GMCVa, PM I and MSW XIb. Tentative identification of strains was carried out using biochemical tests towards carbon sources utilization and gram staining. GMC showed positive results for both glucose acid and starch hydrolysis test, and it was identified as a gram-positive bacillus. Other five strains reported above showed positive results with one of the carbon sources. It is concluded that there is a great potential in using locally available bacterial strains in removing nitrate from ground water either with glucose or starch as carbon sources.

Keywords: Methaemoglobinaemia, Bottle-fed infants, Assimilatory nitrate reduction, Dissimilatory nitrate reduction

*renukar@ifs.ac.lk

EFFECT OF PROCESS PARAMETERS ON BORON REMOVAL IN GROUNDWATER BY MAGNESIUM HYDROXIDE

M.N.A. Mubarak[1] and S. Malavipathirana[2*]

[1]*Residue Analysis Laboratory, Industrial Technology Institute, Colombo 07, Sri Lanka.*
[2]*Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, Belihul Oya, Sri Lanka.*

Boron content in surface water and groundwater in certain regions of the world is reported to be too high making them unsuitable for human consumption and agricultural practices. Boron is of special concern in irrigation water because it can have both beneficial and toxic effects on plants. At the correct level, it is an essential micronutrient for plants, animals and humans. However, the demarcation between the deficiency and the excess of boron is so narrow that higher boron concentrations in water can be disastrous to the health of living beings. Available water treatment technologies are either not effective in removing excess boron or unaffordable. Therefore, it is necessary to develop effective, affordable and economical treatment technologies for boron removal. Previous studies show that poorly crystalline $Mg(OH)_2$ could be used as an adsorbent to remove boron from ground, surface and seawater. In the present research, the effect of process parameters and relevant adsorption isotherms for boron removal from ground and surface water using $Mg(OH)_2$ adsorbent was studied. A continuously mixed batch method has been applied for the adsorption experiment. The adsorbent with different grain sizes were prepared and their rates of adsorption, and removal efficiency of boron were determined at three different initial boron concentrations. Regardless of the initial boron concentration and grain size of the adsorbent, the rate of adsorption increased initially (for 30-45 min) and sharply decreased with time. The highest rate of boron removal was obtained for grain size 0.5-1.8 mm, and the removal efficiency decreased with increasing initial boron concentrations.

Quantification of boron adsorption capacities of adsorbent is essential for better understanding and optimization of the process of adsorptive boron removal. A laboratory scale batch experiment was developed to determine the capacity of boron adsorption. The adsorption experimental data obtained in four different background solutions were fitted to the Langmuir and Freundlich isotherm models with regression coefficients greater than 0.95 for both isotherm models. However, the maximum adsorption capacity of the adsorbent changes sharply when the background water quality was changed from de-mineralized to natural conditions. This suggests that the common ions, which are normally present in natural waters, influence boron adsorption. The highest adsorption capacity of 0.345 mg g^{-1} was obtained when demineralised water was used as background solution, whereas with model water mirroring the groundwater, the adsorption capacity becomes significantly lower.

Keywords: Adsorption, Boron, Groundwater, Isotherm models, Water treatment

*malavisarath@gmail.com

NANOTECHNOLOGY IN WATER AND WASTEWATER TREATMENT: A REVIEW

R.A.C.B. Ranaweera[*]

Department of Science and Technology, Faculty of Science and Technology, University of Uva Wellassa, Badulla, Sri Lanka.

Lack of safe drinking water is a major concern in many countries. Worldwide, many people obtain their drinking water from local sources. Water from such local sources consists of chemical substances and micro-organisms in hazardous amounts. Nanotechnology provides more effective approaches, such as nanomaterials for water purification, sensors for testing water quality and electrochemical methods for water purification. The present review outlines the recent approaches to water purification using nanotechnology, their advantages and limitations, and research needed for commercialization. This work covers the unique properties of nanomaterials for sustainable management of water.

Water is the most necessary resource for life. However, contamination of water leads to significant problems which the world is facing today. Due to technological progress, there are various ways to solve these problems. Among them, nanotechnology is one of the most advanced ways for water and wastewater treatment. It is also a popular technology due to new innovations. Due to small size of nanoparticles, they have high absorption and capability of interaction and reaction. Therefore, nanomaterials can be successfully used in water and wastewater treatment. Nanoparticles have the capability of treating water at any location and depth. It is a great advantage when compared with other conventional technologies.

Nanotechnology is also used to treat unconventional water sources to provide the expanded water supply. Adsorption, disinfection and membrane processes are major applications of nanotechnology in water and wastewater treatment. Nanoadsorbents provide high specific area and tunable pore size. They can be integrated into filters, adsorbers or reactors. Nanomaterials, such as fullerenes, carbon nanotubes, nano-TiO_2 and nano ZnO, provide effective disinfection without forming byproducts. Nano-filtration is a pressure driven membrane process. The reuse of nanomaterial is a key aspect of nanotechnology which makes it a cost-effective method for water purification. This review outlines advances in nanotechnology for water and wastewater treatment.

Keywords: Disinfection, Electrochemical methods, Nanofiltration, Nanomaterials, Nanotechnology

[*]*chandibuddhika@gmail.com*

A FIELD-SCALE STUDY OF LEACHATE TREATMENT USING STABILIZATION POND SYSTEM

G.G.T.A. Ranathunge and G.B.B. Herath*

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka.

In any form of solid waste management, there is always a portion of refuse that needs final disposal. Among techniques in use today, landfilling still continues to play a major role for its simplicity and cost effectiveness. Although landfilling, which results in poorly managed fills, is a common practice in the developing world, it is not entirely trouble free. Consequently, land filling leads to many harmful side-effects including water and soil pollution. In this regard, controlling the contamination from the leachate generated through solid waste landfilling is considered to be a challenge. In this study, a system of stabilization ponds to treat leachate, a low-cost option suitable for tropical countries was evaluated.

Past laboratory scale studies both with artificial and natural leachate have shown promising removals of biological oxygen demand (BOD), chemical oxygen demand (COD) and ammonia with the aid of stabilization ponds. In the present study, the performance of a field-scale stabilization pond system to treat leachate located at Udapalatha-Gampola in Sri Lanka, was investigated. This pond system consisted of an anaerobic pond, a facultative pond and an aerobic pond. Hydraulic retention times of each anaerobic, facultative and aerobic pond were 19 days, 19 days and 13 days, respectively. This field scale pond system was fed with real leachate produced in a lysimeter with domestic garbage operated at the site. Feeding rate was initially set at 160 L day^{-1}, but fluctuated over time depending upon the generation. The organic loading rate also showed variations. Samples were collected from four points; influent and effluent of each pond. All samples were tested for BOD_5, COD, and ammonical-N. This pond system was operated for 245 days. Average BOD_5/COD ratio of the influent leachate for the first pond was 0.21. The pond system showed over 95% BOD reduction, over 84% of COD reduction and over 90% ammonical-N reduction. The local climatic conditions, such as humidity, temperature and rainfall, were found to affect treatment efficiency.

Keywords: Hydraulic retention time, Land filling, Leachate, Solid waste, Stabilization pond

*gemunuh@gmail.com

POTENTIAL OF USING LATERITE SOIL, RED SOIL AND COCONUT SHELL BIO CHAR TO TREAT HEAVY METAL CONTAMINATED LEACHATE

D.M.I.S. Dissanayake, M.S. Balendra, N.A.K.L. Seneviratne[*] and G.B.B. Herath

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka.

In developing countries, such as Sri Lanka, solid waste is mostly disposed of in open dumps, which are well known to cause several environmental and social problems, including water, air and soil pollution. Leachate is generated from landfill sites due to the percolation of rain water, resulting in various negative impacts, such as health issues and oxygen depletion, when it is released to groundwater. Permeable Reactive Barrier (PRB) is an *in-situ* treatment method which is used to treat groundwater contaminated with leachate. This method has many advantages, such as low operation cost, low maintenance cost and low on-going energy requirement. It is a subsurface emplacement of reactive materials through which a dissolved contaminant plume must move as it flows, typically under a natural gradient. The present study was carried out in order to select the effective reactive materials to treat leachate-contaminant groundwater. Selection of materials is based on reactive efficiency, mechanical stability, cost effectiveness and hydraulic conductivity. The column study was carried out using a physical model, consisting of six cylindrical columns with the dimensions of 5 cm in diameter and 30 cm in height. Synthetic leachate using Cu, Fe, Pb and Cd was used for the column test. Four locally available materials, coconut shell biochar, *Bangadeniya* soil, red soil and laterite soil, were selected as reactive materials. Individual materials (100%) and material mixtures (50:50) were used to fill the columns. All the experiments were conducted to determine the removal capacity of the four target heavy metals. The results obtained after feeding 30 L of synthetic leachate for all columns in a duration of 82 days, indicates that the column containing the mixture of laterite soil with coconut shell biochar shows more than 90% removal efficiency for Cu, Pb and Cd. In conclusion, laterite soil and coconut shell biochar was the best material for PRB.

Keywords: Coconut shell biochar, Laterite, Leachate, Permeable reactive barrier, Red soil

[*]*kasunlaka@gmail.com*

ENHANCEMENT OF NICKEL(II) REMOVAL USING CHEMICALLY MODIFIED JACKFRUIT PEEL

S.H. Ranasinghe[1,2], T.P.K. Kulasooriya[1,2], A.N. Navaratne [1,2] and N. Priyantha[1*]

[1]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Removal of heavy metals from contaminated water using naturally available low-cost adsorbents has become an interested area of research. Among many natural adsorbents, fruit waste has been widely investigated for their potential to remove metal ions from water. Jackfruit is a common fruit available in many areas of the world, and Jackfruit Peel (JFP), which is otherwise wasted, was selected as the natural adsorbent with chemical modification using NaOH and ethylenediaminetetraacetic acid (EDTA). Functional groups, such as carboxyl, hydroxyl and amino groups, available in JFP would be responsible for heavy metal removal, which can be enhanced through chemical modification. Adsorption of Ni(II) on NaOH-treated JFP (NJFP) increases upon increasing the concentration of NaOH, while the enhancement becomes less with the increase in the EDTA concentration. Therefore, 0.20 mol dm^{-3} of NaOH and 0.01 mol dm^{-3} of EDTA were selected as the optimum concentrations for the modification process. Under the optimized conditions, the adsorption capacities, according to the Langmuir adsorption isotherm model, are 1.01×10^4 mg kg^{-1} for NJFP and 5.21×10^4 mg kg^{-1} for EDTA-treated JFP (EJFP), both of which are higher than that of untreated JFP (1.04×10^3 mg kg^{-1}). Further, the variation of the amount of Ni(II) adsorbed on NJFP with respect to the initial concentration reflects Type IV(b) isotherm of IUPAC classification, suggesting the formation of monolayer, followed by multilayer, while adsorption of Ni(II) on EJFP reflects Type I(b) isotherm, suggesting monolayer formation over a broad range of Ni(II) concentration. This fact supports the higher monolayer adsorption capacity of EJFP in comparison to NJFP. Adsorption of Ni(II) on both modified adsorbents follows pseudo second order kinetics signifying the involvement of chemisorption. X-ray fluorescence spectroscopic analysis further supports the involvement of Ni(II) in sorption on both modified adsorbents, and scanning electron microscopic images confirm the enhancement of the surface area upon modification with NaOH, while surface structural changes have occurred upon modification with EDTA. The enhancement of adsorption capability of JFP by modification with NaOH would be due to increase in the surface area, and surface negativity through surface hydroxyl moities. Treatment with NaOH would also improve the ion-exchange ability, mainly by Na$^+$ ions. On the other hand, EDTA forms stable chelates with metal ions which may be the reason for significant enhancement of monolayer adsorption capacity for Ni(II), even at low concentrations of EDTA. It is thus evident from the experimental findings that the adsorption capacity of JFP has enhanced by chemical modification of JFP using NaOH and EDTA, suggesting that modified JFP be used as effective adsorbents to remove Ni(II) from contaminated water.

Keywords: Adsorption isotherms, Jackfruit peel, NaOH, EDTA, Kinetics

* *namal.priyantha@yahoo.com*

SELECTION OF SUITABLE CLADOCERA SPECIES FOR THE APPLICATION IN BIOMANIPULATION

S.N. Rathnayaka[1], M.W.A.S.U.K. Wijesuriya[2] and S.K. Yatigammana[2*]

[1]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Department of Zoology, University of Peradeniya, Peradeniya, Sri Lanka.*

Eutrophication has currently been a major issue around the globe. There are several ways to solve this problem. Biomanipulation is an effective, low-cost and an environmentally friendly method to alleviate eutrophication. It is a technique used for the management of the health of the aquatic systems by balancing the communities of natural populations of organisms. This study attempts to identify suitable Cladocera species for application in biomanipulation. For this, fives species of Cladocerans (*Ilyocryptus* sp., *Alona verrucosa, Chydorus* sp., *Alona affinis* and *Karualona* sp.) were used as filtering organisms. Five species of algae (*Monoraphidium* sp., *Chlorella* sp., *Scenedesmus quadricauda, Selenastrum* sp. and *Crucigenia* sp.) were separated and cultured. Thereafter, filtration of the targeted algae by these Cladocerans were performed. For this, the number of cells of selected algae species present in a unit volume of water was recorded for three months, and results obtained were analyzed. Temporal variation of algae indicated that the algae cells have increased with time showing the blooming ability in Cladocera absent systems. However, in Cladocera introduced systems, the control of algae growth was observed, but at different capacities. Surface dwelling *Monoraphidium* sp. is effectively controlled by all Cladocerans except littoral *Ilyocryptus* sp. Benthic living *S. qudricauda* is effectively controlled by all littoral Cladocerans and prominently controlled by benthic *Ilyocryptus* sp., *Selenastrum* sp. and *Crucigenia* sp. found in the water column are effectively controlled by *Ilyocryptus* sp. According to these results, it is apparent that the effectiveness in biomanipulation is higher when larger sized Cladocerans are exploited. Highly nutritional *Chlorella* sp. is well controlled by small bodied Cladocerans. *Selenastrum* sp. and *Chlorella* sp. are also well controlled by littoral *Alona affinis*, which exhibit accelerated growth when the nutrients are not limited. The results indicated that the control of algae mostly depended on size, habitats, expansive time and feeding habits of Cladocerans. Therefore, it is suitable to use integrated method with Cladocerans, which used different habitats, large size and with short expand times for application in biomanipulation.

Keywords: Biomanipulation, Cladocera, *Alona*, *Chlorella*, *Monoraphidium*

[*]sudharma_y@yahoo.com

TREATMENT OF LEACHATE FROM KARADIYANA DUMPING SITE USING A LABORATORY SCALE MICROBIAL FUEL CELL

H.G.L. Madusanka, F.S. Idroos and P.M Manage[*]

Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Microbial fuel cells (MFCs) are bioreactors that convert chemical energy into electricity through biocatalysis of microorganisms. Moreover, several organic compounds present in municipal and industrial wastewater have shown feasibility to be used in MFCs in generating power and simultaneously degrading pollutants, thus becoming an alternative technology for cleaning water with zero or positive energy budget. The present study records the use of a laboratory scale MFC to treat leachate obtained from Karadiyana dumping site. The constructed MFC consisted of a cathode compartment and an oxygen-free anode compartment separated by a cation exchange membrane. Graphite electrodes were inserted into the compartments; the anode compartment was filled with ten times-diluted leachate and sealed to maintain an anaerobic environment. The cathode compartment was filled with raw water collected from Boralesgamuwa Lake and it was maintained with continuous aeration. Finally, both electrodes were connected to a 12 Ω external resistor, and voltage generation was observed using a multimeter. The control setup of the MFC was maintained without connecting the anode and cathode compartments. The physico-chemical parameters, such as temperature ($^{\circ}$C), electric conductivity, pH, nitrate concentration, nitrite concentration, and chemical oxygen demand, were determined. The initial optical density (OD) at 595 nm of the raw water from Borelasgamuwa was measured. Following the introduction of the leachate sample to the anode chamber, the above mentioned physico-chemical parameters were determined continuously for 12 h at 2 h interval in both experimental and control setups. In addition, the voltage generated at each sampling time was recorded in both set-ups. The temperature of both experimental and control set-ups recorded a mean of 28.2 ± 0.23 $^{\circ}$C and 28.5 ± 0.97 $^{\circ}$C, respectively. The pH reduced from 8.60 ± 0.02 to 7.14 ± 0.11 in the experimental set-up, while in the control sample, the pH was maintained at a mean value of 8.09 ± 0.33. The conductivity of the experimental set-up reduced from 1835 ± 8.89 µS cm^{-1} to 462 ± 4.37 µS cm^{-1}, while in the control set-up, the conductivity was maintained at a mean value of 1859 ± 6.52 µS cm^{-1}. The nitrate concentration of the experimental MFC increased from 0.84 ± 0.002 mg L^{-1} to 1.94 ± 0.32 mg L^{-1}, while the mean nitrate concentration in the control set-up was maintained at 0. 89 ± 0.03 mg L^{-1}. The nitrite concentration reduced from 19.57 ± 1.43 mg L^{-1} to 2.78 ± 0.06 mg L^{-1} in the experimental set-up, while in the control set-up, a significant reduction in nitrite was not observed. The COD in the experimental set-up reduced from 2768 ± 10.56 mg L^{-1} to 365 ± 6.98 mg L^{-1}, while in the control set-up, the COD was maintained at a mean value of 2984 ± 9.67 mg L^{-1}. The OD of the cathode chamber of the experimental set-up had a 78.76% increase at the end of the experimental period. The maximum voltage generated by the MFC was 1.8 ± 0.06 mV with a current of 0.15 ± 0.001 mA. The maximum power density recorded was 72 µW m^{-2}, while the maximum current density was 40 µA m^{-2}. Therefore, the laboratory scale MFC employed in this study could be effectively used in the treatment of leachate while generating electricity.

Keywords: Microbial fuel cell, Leachate, Waste water treatment, Electricity generation

[*]*pathmalal@sjp.ac.lk*

ISOLATION, IDENTIFICATION AND OPTIMIZATION OF CI DIRECT BLUE 201 TEXTILE DYE DECOLORIZING FUNGI FROM TEXTILE DYE EFFLUENT IN SRI LANKA

E.M.M.S. Ekanayake and P.M. Manage[*]

Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Textile industry poses a great threat to the environment as its partial or untreated effluent finally ends up in natural water bodies negatively affecting aquatic flora and fauna. The industrial sector demands efficient bio-treatment processes as the existing conventional treatment methods are commercially unattractive. Therefore, the present study focused on isolation of decolorizing fungi from textile dye effluents, and optimization of experimental conditions for decolorization of textile dyes using isolates. The textile dye, CI Direct Blue 201, which is extensively used in Sri Lanka, was selected as the model dye for the study. Water and soil samples were collected from textile dye waste effluents in Awissawella, Sri Lanka, and samples were enriched with selected textile dye for 14 days under static conditions. Fungi which show different morphological features were isolated separately on Potato Dextrose Agar (PDA) medium and their textile dye decolorizing ability was screened on solid medium experiment, followed by liquid medium experiment. Out of thirty-eight total isolates, two isolates showed remarkable decolorization. Those species were identified as *Aspergillus nomius* and *Aspergillus aculeatus* through 18s rRNA analysis. *A. nomius* and *A. aculeatus* showed 98.67 ± 3.74% and 95.38 ± 2.98% decolorization, respectively, at 6 days of incubation under static conditions. The analysis of FTIR spectrum revealed that the peak area relevant to the C-H groups stretching (2850 - 3000 cm^{-1}) decreased with incubation time. The infra-red absorption wavelengths at 2362.65 cm^{-1} 1642.22 cm^{-1} and 1097.52 cm^{-1} were relevant to the changes of dye structure with the incubation. Thus, FTIR and biomass adsorption test (*A. nomius*; 6.31 ± 1.45 mg L^{-1} and *A. aculeatus*; 7.32 ± 2.61 mg L^{-1}) confirmed that the decolorization of CI Direct Blue 201 dye was not due to surface adsorption. Therefore, the present study suggests that the *A. nomius* and *A. aculeatus* be used as potential biological candidates for dye decolorization in future as alternative green applications.

Keywords: Decolorization, Textile dyes, *Aspergillus nomius*, *Aspergillus aculeatus*

[*]*pathmalal@sjp.ac.lk*

DIVERSITY, ABUNDANCE AND HABITAT PREFERENCES OF ODONATA IN MAHA OYA, PERADENIYA

D.D.S. Jayasinghe and S.K. Yatigammana[*]

Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.

Maha Oya stream provides various habitats and micro-habitats for aquatic and semi aquatic organisms as it flows through different landscape types, including primary and secondary forests in the mountain region, pinus plantations, villages and the University of Peradeniya premises. Odonata is one of the notable orders of invertebrates associated with water as they have a life cycle that alternates between aquatic and terrestrial habitats. Therefore, the habitat and environmental changes appear to affect the diversity and abundance of this group. The present study was designed to investigate the species composition of order Odonata in different habitats in the study area and to see the environmental factors that help discriminate distribution of species. The entire study region was divided into four sites based on the elevation and the relative flow rate. In each site, four transects were used to collect data on the ecology of Odonata species and water quality parameters. Field measurements and laboratory analyses were done every month from March to September 2015. Temperature, pH, total dissolved solids (TDS), conductivity, salinity, flow rate of water and dissolved oxygen (DO) were determined, and elevation was considered as an important environmental variable. Each site was visited once every month for a period of seven months. Data analysis was done using Minitab (v14) and Canoco for Windows (v5) statistical packages. Thirty-one Odonata species were recorded including 18 damselfly (suborder Zygoptera) and 13 dragonfly (infraorder Anisoptera) species. A clear change in TDS, conductivity and salinity was recorded near Maha Oya Bridge, where the stream gets outflow from the Faculty of Science. According to the results, diversity and abundance of Odonates were strongly correlated with elevation, water flow rate, DO and the temperature. The present study shows that Odonata species can be used as an environmental indicator. Further, the study indicates that dragonflies are more suitable than damselflies as a bioindicator.

Keywords: Water quality, Bioindicator, Dragonflies, Damselflies, Habitat preferences

---

[*]*sudharma_y@yahoo.com*

BIRNESSITE-ACTIVATED CHARCOAL HETEROSTRUCTURE AS A TRAPPING AGENT FOR TEXTILE DYES

U.K. Wijethunga and N. Priyantha[*]

Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.

Birnessite is a naturally occurring manganese containing mineral having a low point of zero charge, large surface area and strong acidic sites, allowing high adsorption capacity, excellent oxidation ability and catalytic activity. Birnessite has a layered sheet-like structure with a negative charge on their surface, where the cations in the interlayer regions bind the sheets together. On the other hand, activated carbon (AC) is also considered as an adsorption material, which has a porous structure resulting in a large surface area. The study focuses on the synthesis of Birnessite on AC, which are complementary to each other in terms of adsorption capabilities, to investigate the removal of dyes present in textile effluents, and to determine the optimum conditions for the dye adsorption process. Birnessite-AC heterostructure, synthesized using an aqueous solution of $KMnO_4$ and AC at warm temperatures for a sufficiently long period of time, exhibits excellent adsorption properties for Sumifix Blue Exf textile dye, showing 63.7% removal from a synthetic dye solution under ambient conditions, as compared to 38.0% and 48.1% removal by pure Birnessite and pure AC, respectively. The optimum extent of adsorption of the dye on Birnessite-AC heterostructure can be further improved by optimizing the shaking time, settling time and initial solution pH of the dye-adsorbent system. The solution analysis of the remaining dye content after adsorption equilibrium is reached indicates that the amount of the dye removed from the solution phase by Birnessite-AC heterostructure fulfills the requirements of the Freundlich adsorption isotherm model with a high regression coefficient of 0.9298. The adsorption capacity of the dye obtained for low initial concentrations is 23.1 mg g^{-1} according to the Langumuir adsorption isotherm model. The adsorption capability to trap ionic dyes could be further enhanced by introducing charged moieties on interlayers of Birnessite prior to the synthesis of the heterostructure.

Keywords: Birnessite, Adsorption, Dyes, Heterostructure, Optimum conditions

[*]*namal.priyantha@yahoo.com*

ASSESSMENT OF SURFACE WATER POLLUTION BY HEAVY METALS IN KELANI RIVER BASIN, SRI LANKA

M.G.Y.L. Mahagamage[1], S.D.M. Chinthaka[2] and P.M. Manage[1*]

[1]*Center for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*
[2]*Department of Chemistry, Faculty of Science, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*

Water is the most familiar and the most abundant liquid on earth, and it is an essential nutrient. Water pollution in Asian countries mainly results from population growth, agricultural and industrial activities. Although 79% of the Sri Lankan population has access to treated drinking water, the demand for water has been increasing in both urban and rural households. The Kelani River basin is the second largest watershed in Sri Lanka, and it provides about 80% of the drinking water supply to Colombo city. Kelani River flows through seven districts, and it could be ranked as the largest recipient of industrial effluents among all the rivers in Sri Lanka.

The present study was carried out to determine selected heavy metals (Al, Cr, Cu, Pb and Zn) in surface water of the Kelani River basin. Forty-five (45) sampling locations from head, transitional and meandering zones were selected for sampling. Samples were collected during the first inter-monsoon period from March to April 2015. Heavy metal analyses were carried out using Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS).

Heavy metals, Al, Cd, Cr, Cu, Pb and Zn, in surface water of the river basin ranged between 13.93 - 255.86 $\mu g\ L^{-1}$, 0.12 - 0.91 $\mu g\ L^{-1}$, < 0.025 - 24.85 $\mu g\ L^{-1}$, 0.56 - 14.45 $\mu g\ L^{-1}$, < 0.50- 9.21 $\mu g\ L^{-1}$ and 0.52 - 31.44 $\mu g\ L^{-1}$, respectively. The results revealed that Al, Cr, Cu, Pb and Zn concentrations remained within the Sri Lanka Standards Institution and World Health Organization standards for drinking water, except for high Al in some sampling locations. The results further showed that there is an increasing tendency of heavy metals transported from the head zone to the meandering zone of the river basin via the transitional zone. This is an alarming fact, and hence, co-operative strategic plan is needed to be implemented to protect the river basin for future generations.

Keywords: Kelani river basin, Surface water, Heavy metals

---

[*]*pathmalal@sjp.ac.lk*

CONTAMINATION STATUS OF CIPROFLOXACIN AND CLOXACILLIN IN SRI LANKAN HOSPITAL EFFLUENTS

G.Y. Liyanage and P.M. Manage[*]

Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Antibiotics are an important group of pharmaceuticals used extensively in health care for treatment and prevention of bacterial infections. Cloxacillin (CLOX) and Ciprofloxacin (CIP) are broad spectrum antibiotics, which are commonly used for pneumonia, skin infections, cellulitis, etc. The present study was carried out to quantify the contamination status of CLOX and CIP in waste water discharge drains in fifty hospitals in Sri Lanka. Triplicate waste water samples were collected from 50 sampling sites in different areas of the country for the present study. Solid-phase extraction (SPE) was employed and quantification of antibiotics was done using High Performance Liquid Chromatography. Recoveries for CLOX and CIP were detected as 83-95%. The concentrations of CLOX in hospital effluents ranged from 0.001 ± 0.001 mg L^{-1} - 0.815 ± 0.013 mg L^{-1}, whereas CIP concentrations ranged from 0.001 ± 0.001 - 0.078 ± 0.014 mg L^{-1}, respectively. Among selected locations, the highest concentration of CLOX (0.815 ± 0.002 mg L^{-1}) was recorded in Karapitiya hospital effluent, while the highest CIP (0.078 ± 0.014 mg L^{-1}) was recorded in Peradeniya Hospital. The contamination levels of antibiotics in most effluents have exceeded the maximum permissible level of 0.001 mg L^{-1} given by the World Health Organization for aquatic environments. Therefore, the results of the present study provide information on environmental contamination status of CIP and CLOX, which can be incorporated into environmental risk assessments of the particular contaminants in Sri Lanka.

Keywords: Cloxacillin, Ciprofloxacin, Hospital effluents

[*]*pathmalal@sjp.ac.lk*

DETECTION OF CYLINDROSPERMOPSIN IN WELL WATER IN CKDu ENDEMIC PADAVIYA, MEDAWACHCHIYA AND KEBITHIGOLLEWA AREAS IN ANURADHAPURA DISTRICT, SRI LANKA

H.A.S.N. Abeysiri and P.M. Manage[*]

Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

In recent years, a significant increase in the number of patients with Chronic Kidney Disease of uncertain etiology (CKDu) has been recorded in some parts of Sri Lanka, especially in the North Central Province. Cylindrospermopsin (CYN) is one of the most potent cyanotoxins affecting the functions of kidneys and liver, and hypothesized as a substance causing CKDu in the report published by the World Health Organization (WHO) in 2012. The present study was conducted to identify CYN in well water of randomly selected areas in Padaviya, Medawachchiya and Kebithigollewa Divisional Secretariats in Anuradhapura District, where high incidences of CKDu were recorded. Water samples were collected from 17 ground water wells and nine springs in 11 Grama Niladhari Divisions within the area. Water samples were subjected to quantification for CYN using ELISA Cylindrospermopsin Detection kit having the minimum detection limit of 0.1 ppb. Identification and enumeration of cyanobacteria were carried out under the light microscope (×400). *Cylindrospermopsis raciborskii* was identified as the dominant cyanobacteria from 13 ground water wells. *Cylindrospermopsis* sp. cell densities ranged from 16 ± 0.09 cells m L^{-1} - 615 ± 0.73 cells m L^{-1}, while mean concentrations of CYN ranged from 8.30 ± 0.01 µg L^{-1} - 5.98 ± 0.02 µg L^{-1}. The CYN concentrations reported have exceeded the 2 µg L^{-1} limit given by WHO and the Sri Lanka Standard Institute as drinking water quality standards. The results of the present study showed a relationship between cyanobacteria, cyanotoxins and CKDu patients in the study area. However, further comprehensive research is needed to confirm the relationship between CYN and CKDu in Sri Lanka.

Keywords: Cylindrospermopsin (CYN), *Cylindrospermopsis raciborskii*, Chronic Kidney Disease (CKD), ELISA

[*]*pathmalal@sjp.ac.lk*

MICROBIAL CONTAMINATION AND WATER QUALITY STATUS OF GROUNDWATER IN JAFFNA PENINSULA, SRI LANKA

M.G.Y.L. Mahagamage[1], P.S. Manage[2] and P.M. Manage[1*]

[1]*Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*
[2]*Faculty of Health Care Sciences, Eastern University, Vantharumoolai, Chenkalady, Sri Lanka.*

Typhoid or Enteric fever is a universal infection caused by the bacterium *Salmonella enterica.* In Sri Lanka, 2588 *Salmonella* positive cases have been recorded, and the highest incidences had been from Jaffna district during 2005 to 2013. Therefore, the present study was carried out to identify microbiological and chemical contamination status of 40 well water sources in Jaffna peninsula during the month of November, 2016. The study was focused to determine total coliform, fecal coliform, *Salmonella* spp. and *Shigella* spp. contamination along with some physico-chemical parameters of groundwater. Sampling, transportation and analysis were done following standard protocoles. GIS thematic maps and statistical analysis were also performed. Results of the study revealed that the entire peninsula was contaminated with both total and fecal coliform bacteria, and the values were not within the World Health Organization (WHO) and Sri Lanka Standards (SLS) drinking water quality standards. About 38% sampling locations were positive for *Salmonella* spp., and among them, six were used to extract water for drinking. This highly correlates with previous typhoid cases recorded by the Ministry of Health, Jaffna. However, *Shigella* spp. were not recorded during the study period. From the sampling locations, 35% recorded high hardness (>180 mg L^{-1}) and 80% samples were not within the guidelines given by the WHO and SLS drinking water quality for electrical conductivity. Apart from that, 15% sampling locations recorded greater than 10 mg L^{-1} nitrate concentration which was still below the SLS drinking water standard value given for nitrate (45 mg L^{-1}). The minimum and maximum values of pH and COD in groundwater were recorded as 6.55 - 8.72 and 8.98 to 303.46 mg L^{-1}, respectively, and the highest COD concentration was recorded in Point Pedro. The other tested water quality parameters; $N-NO_2$, $N-NH_3$ and total phosphorous concentrations met the Sri Lankan drinking water standards. Principal Component Analysis showed that Jaffna, Nallur, Tellippalai and Kopay Divisional Secretary areas had good correlation according to the water quality data.

Keywords: Groundwater, Jaffna peninsula, Water quality, *Salmonella* spp., *Shigella* spp.

[*]pathmalal@sjp.ac.lk

MICROCYSTIN CONTAMINATION STATUS OF SEDIMENTS IN SELECTED WATER BODIES IN SRI LANKA

K.R.V. Bandara, I.U. Hettiarachchi and P.M. Manage[*]

Centre for Water Quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Microcystins (MCs) are toxins produced by cyanobacteria which commonly occur in aquatic systems around the globe. Occurrence of health hazardous cyanotoxic MCs in both water and soil has been found in increasing frequency and magnitude. As MCs impose health risks to human and animals, it is essential to understand their fate in aquatic systems. The present study focused on analysis of MC-LR contamination status of soil in nine water bodies in Sri Lanka: Beira, Boralesgamuw and Kandy lakes; Kondawatuwana, Halmilla, Ampara, Kaudulla, Tissa and Padaviya tanks. Some of these water bodies are used for drinking and other activities, such as irrigation and aesthetic purposes. Soil samples collected were prepared for the quantification of MC-LR, following freeze drying and extraction of MC-LR and analyzed using High Performance Liquid Chromatography. Exactly 50 g of freeze dried soil samples were dissolved in 80% methanol, shaken for 2 h, sonicated for 30 min and vortexed. Thereafter, the extracts were centrifuged and the supernatant was concentrated through solid phase extraction. MC-LR was detected in all soil samples except those from Halmilla and Padaviya tanks, with concentrations ranging from 3.2 ± 0.1 to 20.7 ± 1.2 µg mL^{-1}. The highest MC-LR was detected in Boralesgamuwa Lake (20.7 ± 1.2 µg mL^{-1}), while the lowest was detected in Ampara Lake (3.20 ± 0.1 µg mL^{-1}). The different concentrations of MC-LR recorded in selected water bodies can be due to compositional changes of MC producing bacterial strains and different binding kinetics of MCs to soil. Further studies are needed to examine the factors responsible for the accumulation of different levels of MC-LR in different water bodies.

Keywords: Soil, Cyanobacteria, Cyanotoxins, Microcystin-LR quantification

[*]*pathmalal@sjp.ac.lk*

NUTRIENT CONTAMINATION OF WATER BODIES AROUND KARADIYANA SOLID WASTE DISPOSAL SITE

S.M.P.A. Koliyabandara[*], P.L.A.T. Cooray, S.S.L.W. Liyanage and C. Siriwardana

Department of Chemistry, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.

Municipal landfill leachate is a highly concentrated mixture of dissolved and xenobiotic organic matter and inorganic compounds. One of the severe problems associated with open dumps is infiltration of leachate into the surrounding environment, resulting in contamination of land and water. Nitrogen and phosphorous compounds are generally observed in high concentration in leachate, whose chemical composition may vary from time to time and from site to site due to variables, such as waste composition, temperature, moisture content and climatic changes. The effect of landfill leachate on eutrophication of the surrounding water bodies connected to Weras Ganga was studied in this project.

Leachate, surface water and ground water samples were collected and analyzed to assess their physicochemical characteristics in order to assess the interaction of leachate with natural water bodies. Sample locations were selected based on topography, and closeness to dumpsites and flow regimes. Groundwater samples were collected from two monitoring wells (~ 1.5 m) which were drilled at the landfill site. Surface water samples were collected from the water canal running close to the site. Initially, 10 leachate samples were collected and analyzed. Thereafter, only three sites were continuously monitored over a period of six months. Water sampling was done monthly, and samples were analyzed according to standard methods for the examination of water and leachate analysis. Ammonia-N, Nitrate-N and TP of surface water ranged between 0.08 - 320, 10 - 6000, 0.2 - 50 mg L^{-1}, respectively. For leachate samples, the above parameters varied in the range of 0.22 - 320, 18 - 13000 and 0.04 - 15 mg L^{-1}. The highest concentrations for nitrogenous species and TP were observed at the sampling point closer to the site marked by the GPS latitude 6.816 and longitude of 79.902 which is the point where all accumulated pollutants flow through. High dissolution of TP in groundwater can occur due to the low level of oxygen. At surface areas, TP dissolution in water decreases due to high level oxygen. It can be the reason of having low levels of TP as compared to leachate. Proposed Sri Lankan standards by the Central Environmental Authority for Ammonia-N and total N in leachate are 100 mg L^{-1}. Concentrations recorded in most of the sampling points around dumpsite exceed the proposed standard emission levels, which is 5 mg L^{-1} for TP. Interestingly, though high concentration of N and TP observed in surface waters, a dense algae growth was not observed. This may be due to the presence of Cu^{2+} in the range of 0.1 to 0.2 mg L^{-1}. Ammonia-N, Nitrate-N and TP in ground water of monitoring wells ranged in between 400 - 500, 40 - 62 and 1.6 - 160 mg L^{-1}, respectively. High ammonia levels in ground water may be due to the anoxic conditions and it is considered as a major long-term pollutant because of its stability under anaerobic conditions. The release of soluble nitrogen from waste into leachate continues over longer period. As a result, the concentration of Ammonia-N increases with the increase in age of the landfill which is due to hydrolysis and fermentation of nitrogenous fractions of biodegradable refuse substrates. An estimation based on full-scale landfill emission rates and long-term assumptions shows that nitrogen is a more important factor in eutrophication than COD, BOD or phosphorus. It is therefore necessary to pay a serious attention for treating landfill leachate before disposing.

Keywords: Leachate, Nitrate- N, Ammonia-N

[*]*arundathi@sjp.ac.lk*

GROUNDWATER VULNERABILITY: A STATUS REVIEW ON NORTHWESTERN COASTAL AQUIFERS OF SRI LANKA, BASED ON A GIS – DRASTIC ASSESSMENT

P. Ratha[1,2*], K.D.W. Nandalal[2], H.M.T.G.A. Pitawala[3], H.A. Dharmagunawardhane[3] and S.B. Weerakoon[2]

[1]*Department of Water Resources and Rural Infrastructures, Institute of Technology of Cambodia, Phnom Penh, Cambodia.*
[2]*Department of Environmental Engineering, Faculty of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka.*
[3]*Department of Geology, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Excessive exploitation of groundwater from coastal aquifers leads to sea water intrusion that could affect the use of water for agricultural and domestic activities. Construction of vulnerability maps of groundwater contamination is increasingly becoming popular due to expansion of industrial, agricultural, urban and domestic activities that pose threats to groundwater contamination in the north-western coastal areas. The aim of the present study was to gather, synthesize and analyze data from available sources to provide spatial analysis of parameters and conditions under which ground water in the North-Western coastal aquifers might be contaminated, and also to find out groundwater vulnerable zones in the shallow and deep aquifers of the areas by applying GIS based DRASTIC model.

The study covered Kalpitiya and Puttalam regions in the North-Western coastal belts of Sri Lanka. The overlap techniques were used to provide and produce the vulnerability maps for these areas considering weight coefficients of each layer. This was followed by combining the vulnerability and land-use maps to produce the final risk map of the study. The Kalpitiya unconfined aquifers were very shallow (extends 1-3 m below ground level) and shallow (up to 20 m below ground level), consisting of mainly unconsolidated sand, while limestone aquifers of Puttalam were shallow (< 20 m) and deep (20 - 160 m). The noteworthy feature in Puttalam is that the deep limestone aquifers often show confined conditions. The results of the vulnerability assessment indicated that, in Kalpitiya area, the intrinsic vulnerability to contamination ranged from high and very high due to shallow groundwater table and permeable sandy soils of the unconfined aquifer. Specific vulnerability due to nitrate was indicated as high to very high due to high nitrate content that has a clear relationship with land use pattern. Vulnerability due to phosphate was also high where phosphate content up to 10.4 mg L^{-1} was recorded. Additionally, seawater intrusion has caused high chloride content (up to 471 mg L^{-1}) in groundwater. In the Puttalam area, vulnerability to the contamination was moderate to high, mainly due to comparatively deep groundwater tables and less permeable soils. The nitrate-N content exceeds the permissible levels (10 mg L^{-1}) that was found more towards the Kalpitiya Peninsula. The phosphate contamination of groundwater in deeper aquifers was also identified in the Vanathavillu area (e.g. Eluwankulama, Rahalmadu, Serakkuliya), exceeding the permissible level (2 mg L^{-1}). The main sources of nitrogen loadings in the study areas appeared to be the excessive fertilizer application and contamination due to human waste. It was also found that the quality of groundwater in Puttalam is adversely affected due to high seawater intrusion, whereas in Kalpitiya area, it was mainly due to improper agricultural practices. It is proposed that the present model can be used as an effective tool for decision-makers in managing coastal groundwater resources and land-use planning in the areas.

Keywords: Coastal aquifers, Groundwater vulnerability, Human activities, Intrinsic, Kalpitiya, Puttalam

*rathaphok0621@yahoo.com

COMPARISON OF Pb CONTENT IN BATHALAGODA PADDY SOIL WITH AND WITHOUT APPLICATION OF GLYPHOSATE

T. Divisekara[1, 2], A.N. Navaratne[1, 2*] and A.S.K. Abeysekara[3]

[1]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[2]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
[3]*Rice Research and Development Institute of Batalagoda, Batalagoda, Sri Lanka.*

Pollution of water and soil is a major issue that occurred due to modern agriculture. Active and inactive ingredients of pesticides, and heavy metal impurities of agrochemicals are some pollutants to be concerned. Among agro-chemicals, N-phosphonomethylglycine (glyphosate) has become controversial in the recent past in Sri Lanka because glyphosate and its heavy metal complexes are suspected as a causative factor for Chronic Kidney Disease of unknown etiology (CKDu). Hence, it was banned in the year 2015 in Sri Lanka. In this study, the behavior of Pb in soil with respect to the application of glyphosate was studied using two experimental paddy fields at Rice Research and Development Institute (RRDI) in Batalagoda. One paddy field was treated with glyphosate over the last six years to reduce the tilling cost, and the other one was maintained as the control tilled field, adding all the other agro-chemicals without glyphosate. Soil samples were collected with three different depths ($d_1 = 30$ cm, $d_2 = 60$ cm, $d_3 = 90$ cm) at monthly intervals for a five-month period. The first sample set was collected before applying any agrochemical. Glyphosate had been applied only to the experimental paddy field (not tilled) when collecting the second sample set. The third sample set was collected after the application of other chemicals, such as triple-super-phosphate (TSP), muriate of potash (MOP), urea and MCPA, for both paddy fields. Further, no chemicals were added after collecting the third sample set. All the soil and agrochemical samples were digested according to the EPA 3050b method, analysis for Pb was done using Agilent Microwave Plasma Atomic Emission Spectrometer, and the data obtained were analyzed with two-sample t-test, using the statistical software Minitab 16. According to the analysis, there is no significant difference in the total Pb content in soil in two paddy fields except for a few sample sets. The Pb content of soil in the control paddy field (tilled) is lower than or equal to that in glyphosate treated paddy field (not tilled) before the application of TSP, MOP, Urea and MCPA. After the application of those agrochemicals, the Pb content in the first layer of the glyphosate treated paddy-field soil (5.22 ± 1.12 mg kg^{-1}) becomes significantly higher than that in the control (tilled) paddy field (3.84 ± 0.37 mg kg^{-1}). The total Pb content in commercial samples of TSP, MOP, glyphosate, MCPA and urea are (378 ± 15.64), (0.95 ± 0.25), (1.88 ± 0.04) and (1.15 ± 0.54) mg kg^{-1}, respectively. In the presence of glyphosate (glyphosate treated paddy field, not tilled), more Pb is adsorbed into the soil, thus by indicating more Pb is retained in soil when glyphosate is present.

Keywords: Glyphosate, Herbicide, Paddy field, Bathalagoda soil, Lead

[*]ayanthi.pdn@gmail.com

DETERMINATION OF ANIONIC SURFACTANT PRESENCE IN KELANI RIVER WATER

K.R.M. Gunaratne[1], K. Mahathanthila[1*] and C.V. Hettiarachchi[2]

[1]*Industrial Technology Institute, Bauddhaloka Mawatha, Colombo 07, Sri Lanka.*
[2]*Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Surfactants have different behavior and fate in the environment. Most surfactants can be degraded fully or partially by microbes in the environment, even though some surfactants may be persistent under anaerobic conditions. Anionic surfactants are one of the major types, used in the majority of detergents and cleaning-product formulations. They are widely used in household and industrial products, such as detergents, cleaning and dish washing agents, and personal care products. After use, these surfactant-based products are mainly discharged into the nature through effluents discharge as a raw, partially treated or fully treated sewage. Therefore, environmental pollution is taking place in different ways.

The present study was carried out in the Kelani River which is a major river in Sri Lanka. There are a considerable number of industries found along the Kelani River whose industrial waste is discharged in to the river. Kelani River is also a source to drinking water supply in Sri Lanka. This study aimed to quantify anionic surfactants (AS) present in river water, waste water and drinking water using the Methylene Blue Active Substance (MBAS) method. Anionic surfactants are one of the major compounds showing methylene blue (MB) activity. The method is relatively simple and precise. Sodium dodecyl sulfate is used as the reference material for the MBAS analysis. It comprises successive extractions from acid aqueous medium containing excess methylene blue into chloroform ($CHCl_3$). Intensity of the blue color is measured in $CHCl_3$ at 652 nm for quantification, and the resulting amount of surfactants is determined in mg of MBAS per liter.

The accuracy and the precision of the method showed satisfactory results as relative standard deviation was 4% and recoveries were within the range of 90 - 100%. According to the results obtained, Kelani River water contains considerable amounts of AS ranging from 0.079 to 0.318 mg L^{-1} as MBAS. Out of the 12 sampling points, two locations contained AS higher than the limits of Sri Lanka Standards potable water standard (SLS 614:2013). All the waste water samples collected from treated waste water outlets contained AS below the tolerance limits declared by the Extraordinary Gazette No. 1534/18 - 2008, the standard of effluent water discharged into inland surface water. The highest concentration of AS is reported from treated waste water obtained from clothing industry, while drinking water collected from two water purification centers located in Biyagama and Ambathale meets the requirements specified in potable water standard after purification.

Keywords: Anionic, Surfactant, Detergents, Kelani River

*kusheemahatantila@gmail.com