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Contents

MISSION

- Initiate, promote and engage in advanced research in fundamental studies for the enhancement of scientific knowledge and development of human resources contributing to national development.

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Message from the Director

As the present Director of the Institute, I have a great pleasure in making this note on the occasion of the 2015 Annual Research Review. The Institute of Fundamental Studies was established in September, 1981 by the Parliament Act No. 55 and shiftedits location from Colombo to Kandy on 04th December 1985. The name of the institute was changed to National Institute of Fundamental Studies (NIFS) Sri Lankaby the Act No. 25 of 2014. NIFS is the only national institute, which, by its Act, has the main objective asto, engages in scientific research to facilitate fundamental and advanced studies with an emphasis on basic research for national development as well as for the advancement of science.

Over the years, NIFS has achieved several goals with the limited number of senior scientists it has. Progress achieved during the year 2015 under review has been excellent and the research carried out at NIFS has made a significant contribution towards science, in general, and the development of the country. Basic research leading to useful applications in numerous scientific fields, especially in the development of low-cost environmental friendly biofilm biofertilizer, novel methodologies for environmental remediation, new diagnostic techniques for pulmonary diseases, novel technologically important materials for solar energy conversion, nano-water filters for water purification, biochar research on environmental remediation has made excellent progress. The research scientists have published their findings in reputed international journals and the Institute has gained a wide recognition as a leading research centre. Sixty two research papers in referred journals including --- in SCI/ SCI expanded journals, 06 book chapters and 109 conference papers/ abstracts have been published in the year 2015along with two patents (one International and one National). At present there are 16 senior scientists, and 81 research students (12 PhD, 69 MPhil candidates) are carrying out postgraduate research work under their supervision. In the year 2015, 09research assistants obtained their postgraduate degrees (02 Ph.D.s and 07 M.Phil.s). In addition, several M.Sc. students and undergraduatesfrom different parts of the island completed their research projects at NIFS. Science Education and Dissemination Unit (SEDU) has concluded another excellent year and many school children and teachers,and the general public have benefited theinspiringprogrammes conducted by SEDU. During the past year,the Consultation and Collaborative Division (CCD) has strengthened national and international collaborations of NIFS by extending the services and collaborations to various government and non-government organizations. With a dedicated staff as well as advanced research facilities, NIFS aims to reach greater heights in its future scientific endeavors.

Director
National Institute of Fundamental Studies


Geophysical Investigations

Research Areas

Biological Sciences

Biofuel Production/ Carbon sequestration & Management
Cell Biology
Ecology & Environmental Biology
Functional Food Product Development
Microbial Biotechnology
Natural Products
Nutritional Biochemistry
Plant Biology

Physical Sciences

Chemical & Environmental Systems Modeling
Condensed Matter Physics & Solid State Chemistry
Nanotechnology/Physics of Materials
Photochemistry
Renewable Energy, Natural Resources & Cleaner Environment
Single Bubble Sonoluminescence

Biological Sciences

Sampling at paddy fields in Jaffna, Sri Lanka

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Biofuel production / Carbon Sequestration and Management

Currently research is being carried out in 2 main areas; Biofuel and soil C sequestration with sub projects in each category. A fair amount of studies have been reported and some data are available on the above ground C-sequestrations of the major vegetational types of Sri Lanka. However, very little or no information is available on the below ground or soil C sequestration. In consideration of the importance as well as the long term stability of soil stored C it is essential to fill this gap of knowledge on soil C-sequestration in Sri Lanka with respect to the country's carbon budget. Therefore in this project soil C sequestration potential and its dynamics will be studied in the different major vegetation types of Sri Lanka. Major vegetations of Sri Lanka include natural and plantation forests, agricultural plantations, farm lands and small holder cultivations, wetland paddies, dry and wet grasslands or patanas, mangroves etc.

The biofuel project aims to explore the microbial flora of Sri Lanka to isolate efficient degraders of cellulose, hemicellulose and lignin, study the effect of biofilms and/or co-cultures on degradation of cellulosic biomass. Lignocellulosic materials from plants are a rich source of sugars. However, current production processes are economically unviable partly due to the costs of pre-treatment and hydrolyticezymes. The present project aims to study possible enhancement of enzyme production by formation of co-cultures or biofilm formation. In addition, the possibilty of overcoming nitrogen limitation during enzyme production by co-culturing cellulolytic fungi with nitrogen fixing bacteria is being studied. For the purpose of biological pre-treatment, a number of basidiomycetes have been grown *in vitro* and screened for ligninolytic enzymes and their potential for degrading lignin is being explored. Organic component of algae could also be used as raw material for biofuel production. Algae are rich in poly unsaturated fatty acids hence; enhance the potential as a source for biofuel. This research examines the possibilities of using cyanobacteria and algal species available in fresh water bodies of Sri Lanka for biofuel production.

Renuka Ratnayake obtained her Ph.D. from the University of Peradeniya in 2006 and joined the NIFS in 2009. She was a Postdoctoral researcher at the World Forestry Center, USA and Murdoch University, Australia

Assessment and Mapping of Soil C Stocks in Knuckles Forest Region of Sri Lanka

Forest soils play an important role as a carbon sink, which means that it can absorb and hold carbon for hundreds to thousands of years without releasing it as CO2 into the atmosphere. This study is based on soil C sequestration in different landuse types of Knuckles Forest Region; where a wide range of climatic conditions and vegetation types are available. Montane forests (MF), Sub Montane forests (SMF), Open and Sparse forests (OSF) and Grasslands (GL) were selected for the study (Figure 1).

Figure 1. Sampling in Sub Montane Forest

In addition to C sequestration, soil nutrient levels of these landuse types were also estimated. Results showed that TOC content was significantly highest in MF followed by SMF and lower in both OSF and GL. Montane forests also recorded higher MBC, LC and WSC contents (0.14 %, 715.2 mg/kg, 0.46 % respectively) compared to the other studied landuse types. Soil C stocks varied significantly ($p<0.05$) among these forest types, where MF recorded the highest soil C stock in top soil layer (0-15cm). The results show that MF and SM forests have a greater ability of sequestering compared to other studied landuse types in the Knuckles forest region.

Carbon stocks and carbon fractions in paddy soils of northern Sri Lanka

Paddy represents a large portion of global agriculture and grown largely in South and East Asian countries. Soil organic carbon accumulation in paddy ecosystems was faster and more pronounced than the other arable ecosystems as organic matter decomposition is lessened in lowland rice fields, apparently due to excessively reduced conditions.However no research has been done in Sri Lanka to study soil C stocks in lowland paddy soils. The objective of this study was to assess the total organic carbon and its fractions and nitrogen availability in the paddy soils of Northern Province of Sri Lanka. This study was carried out in Jaffna, Kilinochchi, Vavuniya, Mannar, Mullaitheevu districts of Northern Province of Sri Lanka. There were significant variations in total organic carbon and its fractions, nitrate and ammonium availability among soil great groups of paddy fields of Northern Province of Sri Lanka.TOC content of top soils in ton/ha was highest to the grumusols (54.83 tons/ha) and lowest to the regosols (10.55 tons/ha) in paddy fields of Northern Province.

Biodiesel production from freshwater cyanobacteria and micro algae of Sri Lanka and their morphological and molecular characterization

Biofuels are considered as an important means of reducing greenhouse gas emissions and increase energy security by providing a viable alternative to fossil fuels. Algae biomass is a potential source of 3rd generation biofuel that could surpass all the others due to its rapid growth and extremely high yield potential. Therefore, the aims and goals of the present study are: Morphological identification of cyanobacteria and other algae in fresh water bodies of Sri Lanka as a suitable feed stock for biodiesel production, Optimizing semi-mass culturing of selected cyanobacteria and other algal species, Isolating the other algal products and value added compounds of commercial interest from the residue of algal biomass, Extraction of fatty acids from selected cyanobacteria and other algal species, Molecular characterization of isolated cyanobacteria and other algae, Producing bio diesel from extracted lipids. For the last 12 months a total number of 52 uni algal cultures were isolated from 25 fresh water bodies representing three climatic zones of Sri Lanka (Figure 2). The morphological identification of the isolates were also carried out. Isolates were tested for antioxidant, anti-pathogenic activities. The results indicated that cyanobacteria are rich in antioxidants with anti-pathogenic properties.

Figure 2. Semi mass culturing of cayanobacteria

At the same time, different type of pigments such as phycoerytherin (PE), phycocyanin (PC) & allophycocyanin (APC), Chlorophyll-*a* (Ch-*a*), Chlorophyll-*b* (Ch-*b*) and Carotene (C_{x+c}) were extracted from selected cyanobacteria which can be used in food and pharmaceutical industry. Also cyanobacteria species were tested for treating waste water and found that there is a potential to use in waste water treatment.

Isolation, identification and screening of microbial strains and development of biofilm/co-cultures for lignocellulose degradation

The enzymes involved in degradation of lignocelluloses include cellulases, hemicellulases and lignin degrading

enzyme Cellulases can be further categorized as endoglucanases, exoglucanases and β glucosidases. Different microbes produce different proportions of these enzymes. Therefore, co-culture of different microbes may result in a more efficient mixture of enzymes for degradation of enzymes. Also, biofilms of the enzyme producing may have enhanced expression of the enzymes. Among the fungal-fungal co-cultures tested so far, those between*Trichodermareesei* and*Eupenicillium*sp have been found to produce more efficient enzyme mixture than their monocultures. Fungal-bacterial co-cultures have been found to be less effective.

Nitrogen level in the medium is another factor that can limit enzyme production. Co-culture of enzyme producing fungi with nitrogen fixing bacteria is being studied to determine whether the bacteria can replenish nitrogen in the medium. Lignin degrading enzymes (laccases, Mn peroxidases, lignin peroxidases etc) are mostly produced by the basidiomycetes group of fungi. So far 42 different basidiomycetes have been isolated and screened for the lignin degrading enzymes. Isolates with high enzyme activities were tested for their ability to degrade lignin in culture medium. Pycnoporussanguineus (Figure 3) was found to degrade alkali lignin in monoculture, while isolate M14 was found to degrade akali lignin in mixed culture with Cellulomonasbiazotea.

Figure 3. Pycnoporussanguineus: Capable of degrading lignin

Ph.D. Students: K. Mohanan, Md. Fuad Hossain
M.Phil. / M.Sc. Students: Kumari Rajapaksha, Bimali Kangararachchi

Key publications

1) Ratnayake RR, Seneviratne G, Kulasooriya SA (2011). The Effect of Cultivation on Organic Carbon Content in the Clay Mineral Fraction of Soils. Int. J. Soil Sci. 6: 217-223, 2011.
2) Ratnayake RR, Seneviratne G, Kulasooriya SA (2013). Effect of soil carbohydrates on nutrient availability in natural forests and cultivated lands in Sri Lanka. Eurasian Soil Sci., 46: 579-586.
3) Mohanan K, Ratnayake, RR, Mathaniga, K, Abayasekara CL, Gnanavelrajah N.(2014). Effect of co-culturing of cellulolytic fungal isolates for degradation of lignocellulosic material, J. Yeast Fungal Res., 5: 23-30

From Left: Standing: Ms. HATA Hangawatta, Ms. IK Edirisinghe, Ms. K Thayalini, Ms. R Nadarajah, Ms. SMS Malika, Ms. J Kanchana, Mr. K Mohanan, Mr. MD.F. Hossain, Sitting: Ms. RBK Ranawaka, Ms. S Jayalath, Ms. RPSK Rajapaksha, Dr. RR Ratnayake, Ms. PWD Shamari, Ms. GGNT Ariyasinghe

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Cell Biology; understanding specific diseases and microorganisms at the molecular level

In the Cell Biology lab, we use molecular tools to identify microorganisms as well as to investigate the mechanisms of diseases causation by microbes and other environmental factors. We focus our efforts on basic and applied science and there is a clear need in each of these research areas, and their underlying biology is fascinating and tractable.

In the area of cyanobacterial research, first comprehensive study on diversity, molecular phylogeny and cyanotoxin (microcystin) production, was completed in which cyanobacteria belonging to 37 genera were identified with DNA sequencing. We were the first to record genus *Chroococcidiopsis* in Sri Lanka and currently their toxin production is being investigated. Additionally we confirmed the presence of cyanotoxin producing cyanobacterial species in the dry zone lakes including *Cylindrospermopsisraciborskii* species in Anuradhapura reservoirs, and in well waters in chronic kidney disease of uncertain aetiology (CKDu) prevailing areas of Sri Lanka.

In the area of pulmonary diseases, we developed a molecular assay to detect mutations in Mycobacterium tuberculosiscomplex (MTC) strains and were able to obtain the Sri Lankan patent (17423) for it. This assay could be used to direct rapid diagnosis of drug susceptibility in tuberculosis (TB) which will reduce the time taken for traditional culture based assays. In molecular epidemiological studies on TB, we found that *M. tuberculosis* strains isolated from TB patients of Kandy had originated both from ancestral and modern lineages, which is important in controlling TB transmission in the country.

Currently our studies are based on biomarker identification for CKDu, rapid differentiation of non-tuberculous mycobacteria (NTM) from MTC, Programmed Cell Death (PCD) and cyanotoxin release from cyanobacterial cells and the airborne microbes in atmospheric particulate matter.

Dhammika Magana-Arachchi obtained her Ph.D. from the University of Colombo, Sri Lanka in 2001 and joined the NIFS in year 2004. She was a Postdoctoral researcher at the University of Nebraska Medical Centre, Omaha, USA

Gene expression analysis in chronic kidney disease of uncertain aetiology (CKDu)

CKDu is an increasing health problem in certain agricultural regions of the tropical world including Sri Lanka. Gene expression analysis was used to determine cause of the disease and identify possible biomarkers. Preliminary studies using a selected gene panel showed oxidative stress in a CKDu endemic area with up regulation of the GCLC and GSTM1 genes. Regulation of kidney injury related genes, FN1 and KIM1, was also noted. The study was thus expanded to analyze whole transcriptome patterns in blood of CKDu patients by using microarrays. Differentially expressed genes (fold change ≥ 2 or ≤ 0.5) specific to each of Stage 2 (403 genes), Stage 3 (612 genes) and Stage 4 (31 genes) CKDu were identified (Figure 1). Seven genes were identified as commonly differentially expressed in all the three stages. These genes have functions related to hypertensive response (ADM), gap junction channel activity (GJB4) and infectious/immune response (IFIT1, PI3, DEFA1, HBZ, RN7SK). The results are being analyzed further to understand underlying molecular mechanisms.

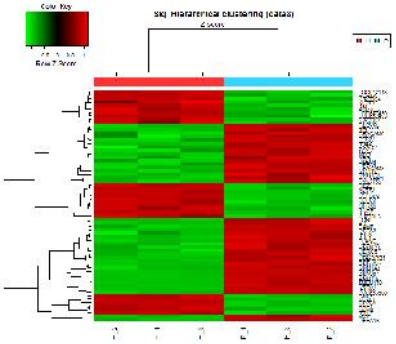


Figure 1. Cluster image of Stage 4 CKDuvs Healthy

Molecular epidemiology of tuberculosis in Central Province

The study was performed on 150 isolates obtained from sputum specimens of patients having tuberculosis (TB), which included patients from the general population attending the Chest Clinic, Kandy, patients having TB in Bogambara prison, Kandy and estate workers having TB. Data revealed that the majority of circulating *Mycobacterium tuberculosis* (MTB) strains in the Kandy district belonged to 19 distinct families, including six major families; East-African-Indian (EAI-55.7%), Haarlem (20%), Beijing (8.6%), Central European family T (6.5%), European Family X (5.2%) and Central and Middle Eastern Asian (CAS-0.6%) (Figure 2).

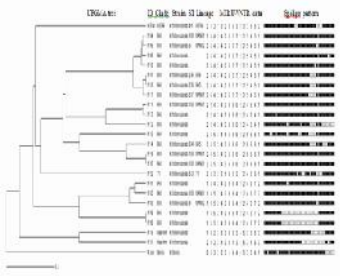


Figure 2. UPGMA- tree displaying the genetic relationships of 22 isolates (Group II) of *M. tuberculosis* based on 15 MIRU-VNTR loci and Spoligotyping

A few strains of MANU, EAI3-IND, EAI6-BGD1 and *M. tuberculosis* S sub-lineages were also identified. The results of this study showed a high degree of polymorphism in the DNA fingerprinting patterns of MTB isolates.

Beijing strains were only identified among the general population and Haarlem3 was the predominant strain among the estate workers. There was a close epidemiological relationship between the isolates of the prisoners and the estate workers in the population studied. The study concluded that the use of 15 loci MIRU-VNTR typing combined with spoligotyping is feasible for a country with a moderate TB incidence like Sri Lanka. This is the first study in Sri Lanka in which the MIRU-VNTR pattern of *M. tuberculosis* strains in conjunction with spoligotyping in a population has been examined.

Non-tuberculous Mycobacteria (NTM)

Non-tuberculous Mycobacterial infections present with clinical signs that are similar to patients with tuberculosis (TB), causing clinical misleading during therapeutic actions. Even though human pulmonary infections due to *Mycobacterium tuberculosis* complex (MTC) is common, other species of *Mycobacterium* causing diseases have been identified and found to be increasing in recent years. Mycobacteria have a spectrum of virulence and different susceptibilities to antibiotics. Thus, it's important to rapidly distinguish NTM from MTC to administer appropriate treatment. SYBR Green mediated multiplex real time PCR assay could be used as an effective tool for the diagnosis of pathogenic *Mycobacterium* species.

In our study multiplex real time PCR was used to rapidly identify *Mycobacterium* species present in bronchial washings. Twenty six isolates were identified as *Mycobacterium* genus positive. Two *Mycobacterium tuberculosis* isolates, three *M. avium* complex isolates and two *M. chelonae-M.abscessus* group isolates were further identified (Figure 3). The drug susceptibility was tested for the identified isolates and majority of the identified NTM species was resistant to clarithromycin. All strains were sensitive to amikacin while only a few isolates were resistant to ciproflaxacin.

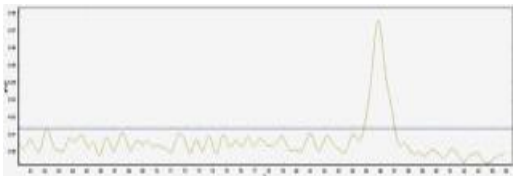


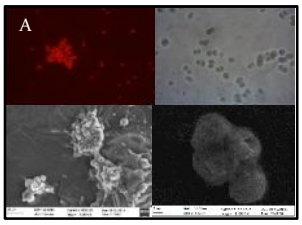
Figure 3. SYBR Green mediated Real Time PCR Melting curve (Tm = 85.8 ^{o}C) indicating the presence of the *Mycobacterium* genus.

Programmed cell death in cyanobacteria

Autocatalysis of Programmed Cell Death (PCD) is common in cyanobacteria. *Microcystis spp* are frequently occurring toxigenic bloom formers and is common in

eutrophicated water bodies in Sri Lanka. Though there are non-toxic *Microcystis* strains, most of them produce hepatotoxic and potential carcinogenic microcystin. Our hypothesis is that secretion of extracellular microcystin into the surroundings might have a correlation with the age of the cell and physical stresses of the environment. *Microcystin aeurogenosa* (EF051239) culture isolated from Beira Lake, Colombo was used for the study. Artificial induction of PCD by hydrogen peroxide (H_2O_2) revealed the positive correlation with protein damaging activities (pigment degradation). Molecular biological identification of caspase related geneses (metacaspases; p20 domain) in *M. aeurogenosa* confirmed the genetically mediated cell death events. Studies are being carried out to determine the relationship between apoptosis and toxin releasing.

Some Cyanobacteria have ability to tolerate stringent environments and they are being called as extremophiles. A unicellular cyanobacterium, *Gloeocapsa* sp.(KU375123) was isolated from Graphite sample, collected from Kahatagaha Graphite Mine, Kurunegala (Figure 4).



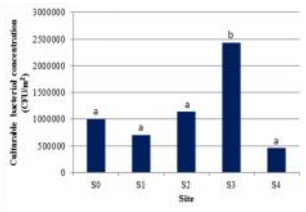


Figure 4. Fluorescent, light and scanning electron microscopic visualization of *Gloeocapsa* sp (left).
Figure 5. Culturable bacterial concentration (CFU/m^2) in five sites of Kandy city (right).

Study of airborne microorganisms

Atmospheric particulate matter causes range of human and eco system health problems increasing the budget allocation for mitigation strategies to minimize their adverse effects. Therefore for the first time in Sri Lanka the particulate matter associated micro-organisms are being identified and quantified in highly traffic congested areas in Kandy city using sequencing and enumeration methods (Figure 5).

The bacterial species *Sphingomonas* sp., *Pseudomonas aeruginosa, Pseudomonas monteilii, Klebsiella pneumonia, Ochrobactrum intermedium, Leclercia ade carboxylata, Exiguobacterium acetylicum, Exiguobacterium indicum, Bacillus pumilus, Bacillus aryabhattai, Bacillus megaterium, Bacillus amyloliquefaciens, Serratia marcescens, Providencia rettgeri* and *Kocuriakristinae* were identified which were opportunistic pathogens. The culturable microorganisms were relatively less when compared to total microrganisms in the atmosphere (0.0% to 28%). In the future, quantification of total microorganisms using molecular techniques (real time PCR) will be carried out.

Ph.D. student: S Sayanthooran
M.Phil. students: TP Keerthirathne, RWK Amarasekera
M.Sc. student: EGCK Priyadarshika

Key publications

1) Magana-Arachchi DN,* Wanigatunge RP, Liyanage M (2011). Molecular characterization of cyanobacterial diversity in Lake Gregory, Sri Lanka. Chinese Journal of Oceanology and Limnology. 29 (4): 898-904.
2) Magana-Arachchi DN*, Wanigatunge RP (2013). First report of genus Chroococcidiopsis (cyanobacteria) from Sri Lanka: a potential threat to human health. J.Natn.Sci.Foundation Sri Lanka 41(1): 65-68
3) Weerasekera D, Magana-Arachchi DN,* Madegedara D, Dissanayake N, Thevanesam V (2015). Genetic diversity of *Mycobacterium tuberculosis* isolates obtained from three distinct population groups in the Central Province, Sri Lanka Asian Pac J Trop. Dis. 5(5): 385-392

From Left: Ms. TP Keerthirathne, Ms. EGCK Priyadarshika, Mr. S Sayanthooran, MS. EMUA Ekanayake, Ms. RWK Amarasekara

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Ecology and Environmental Biology

Basic research in biodiversity covers every aspect of ecosystem function. Research in my laboratory focuses on understanding how ecosystems are modified by the loss of biodiversity. Ecosystems sustain human lives and diversity of species is important to maintain healthy ecosystems. We believe that biodiversity loss is the single most significant challenge facing not only Sri Lanka but also the entire planet. Biodiversity loss is also a hindrance to achieving sustainable development.

Studies in my lab are currently based on plants and animals in terrestrial and freshwater ecosystems worldwide, with a special focus on the Western Ghats-Sri Lanka biodiversity hotspot. The primary focus however is the largely unchartered fields of invertebrate and small plant biodiversity. The invertebrate fauna of our country remains largely unexplored, with most studies originating during the colonial period.

Arthropod diversity estimates can be useful as indirect assays of ecosystem function or productivity or as direct estimators of ecosystem responses to human induced change. The groups of our focus are pseduoscorpions, spiders, bees and orchids, groups of high conservation necessity. These findings are then shared through papers published in peer reviewed journals.

Suresh Benjamin obtained his Ph.D. from the University of Basel, Switzerland and prior to join the NIFS was a Postdoctoral researcher at the University of California (Berkeley), The George Washington University and Smithsonian Institution in Washington, DC. He is also an Alexander von Humboldt Research Fellow.

Diversity of Goblin Spiders in Sri Lanka Revealed by a Genus Level Phylogenyof the Family

Dwarf hunting spiders or goblin spiders (Oonopidae) are an extremely diverse spider family with over 1444 described species in 113 genera worldwide. Members of this family are small (1-4 mm), haplogyne, six eyed species that dwell in litter or in the canopy. They do not build webs. Sri Lanka hosts a large diversity of oonopidae, with 23 species in 8 genera known. So far, no specific extensive study has been done for oonopids in Sri Lanka. The present study is aimed at assessing the diversity of goblin spiders in the island. Another aim is to infer the phylogeny of the family based on DNA sequence data.

Field visits were conducted in 115 sites in all provinces of Sri Lanka. Litter samples were sifted and left over night in a Winkler extractor. The collected specimens were examined using an Olympus SZX 7 stereomicroscope.

Our collections consist of 310 oonopid spiders of seven reported genera (*Aprusia, Brignolia, Camptoscaphiella, Ischnothyreus, Orchestina, Opopaea* and *Xestaspis*) and eight new genera for the country. Three new species of the genus *Xestaspis* (*X. nuwaraeliya*, *X. padaviya* and *X. pophami*) and three new *Brignolia*species are described.

DNA was extracted from selected specimens and PCR was performed to amplify 18S/28S fragments. Phylogenetic analysis was performed using combined 18S/28S sequenced data (2782 bp). Phylogenetic trees were constructed using MEGA 6.06 and TNT.

In addition, Sri Lankan Oonopids are included for the first time in a worldwide molecular analysis.

Xestaspis kandy Eichenberger 2012, male in life

Molecular Phylogeny and Systematics of Jumping spiders (Family: Salticidae) from Sri Lanka

The jumping spider (family Salticidae) contains more than 595 genera and about 5838 described species arranged in 7 subfamilies, making it the largest family with about 13% of all spider diversity. Sri Lanka possesses a relatively large jumping spider fauna of 64 species placed in 48 genera, with a large endemic component. However, this might be only a fraction of its true diversity. The aim of the project is to collect, identify, document and using morphological and molecular methods to characterize the jumping spider diversity of the island.

Spiders were collected by leaf litter sifting, general hand collecting, sweeping and beating off bushes and trees. All materials were preserved in either 70% or 100% ethanol for morphological and molecular analysis respectively. Male palps and epigynes were dissected and kept in methyl salicyclate for 4-5 hours for drawing. DNA extraction, PCR conditions and gel electrophoresis were followed based on the manufacturer's and lab protocols.

To date we have identified three new genera for Sri Lanka: *Macaroeris*, *Habrocestum* and *Bristowia*. Several species new to science and new records of the genera *Habrocestum*, *Phintella*, *Carrhotus*, *Cosmophasis*, *Evarcha*, *Curubis*, *Telamonia*, *Onomastus*, *Menemerus*, *Ballus*, *Marengo*, *Rhene*, *Colaxes*, *Hyllus*, *Flacillula*, *Ptocasius*, *Plexippus*, *Epidelaxia*, *Bianor*, *Harmochirus*, *Cyrba*, *Siler*, *Simaetha*, *Stenaelurillus*, *Hispo*, *Thyene*, *Tamigalesus*, *Thiania*, *Hasarius*, *Phausina*, *Irura*, *Epocilla* and *Phaeacius* have been recorded. To date, nearly 550 specimens have been identified up to genus and/or species level.

Onomustus nigricauda Simon 1900, male in life

Taxonomic revision of the Genera Dendrobium and Bulbophyllum (Orchidaceae) of Sri Lanka

Orchidaceae is one of the largest plant families in Sri Lanka found in all terrestrial vegetation types. Field work and data analysis of this project have now been completed. We were able to cover 47% of the photo documentation (62% of *Dendrobium* and 36% of *Bulbophyllum*). We have found six species of *Dendrobium* out of eight and seven *Bulbophyllum*out of eleven species reported for Sri Lanka. A further objective of this survey is to determine host plant specificity of our study species, which has now been completed.

Dendrobium heterocarpum, Wall, exLindl

Vegetative traits of all specimens were measured using a caliper and a measuring tape and dissected floral parts were drawn with the aid of a stereomicroscope equipped with a camera lucida. Vegetative and floral morphometric data will be analyzed using the delta software package. Results of this project have been reported in two manuscripts that are currently under review.

Systematics, Biogeography and Evolution of Stephanopinae Crab Spiders (Araneae: Thomisidae)

Crab spiders, family Thomisidae, are a specious family.They are mainly active during the day and ambush insects with their well-adapted first and second pairs of legs. Thomisids are behaviorally versatile exhibiting complex behaviors. Understanding the phylogenetic structure of this large family has always been problematic. Through this project, we aim to provide a stable phylogenetic hypothesis for the family Thomisidae by analysis of morphological and DNA sequence data. This study will also form the basis of future revisionary work of the family, its biodiversity and conservation. As a part of this project several genera have been revised and one new genus and three new species described.

M.Phil. Students: Ms. Nilani Kanesharatnam, Ms. Sasanka Ranasinghe, Ms. Ilesha Sandunika IleperumaArachchi

Post-doc: Dr. Crisenthiya I. Clayton

Key Publications

1) Benjamin SP (2010). Revision and cladistic analysis of the jumping spider genus *Onomastus* (Araneae, Salticidae). Zoological Journal of the Linnean Society, 159: 711-745.

2) Benjamin SP (2011). Phylogenetics and comparative morphology of crab spiders (Araneae: Dionycha, Thomisidae). Zootaxa 3080: 1-108.

3) Benjamin SP (2015). Model mimics: antlike jumping spiders of the genus *Myrmarachne* from Sri Lanka. Journal of Natural History 49: 2609-2666.

From Left: Dr. Crisenthiya I. Clayton, Ms. Nilani Kanesharatnam, Ms. Ilesha Sandunika IleperumaArachchi, Ms. Sasanka Ranasinghe

Loris (up) & Pangolin (down) at the Sam Popham Aboretum

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Functional Food Product Development

Functional food can be defined as a food products capable of reducing the onset of disease conditions and/or promoting good health. The Functional Food Product Development project was initiated in April 2013 with the intention of combating disease conditions which are significantly prevalent among the population of Sri Lanka. The primary focus of the project is to identify food items which demonstrate the ability to prevent or contain disease conditions. A special emphasis is laid on food products which are already part of the diet and contain bioactive constituents which have been scientifically identified to possess functional properties. The research group primarily targets at identifying food products which are able to combat diabetes, which is currently on the rise given Sri Lanka's recent entry into the lower middle income group of countries.

Currently, two major aspects are being investigated under this project: (1) Evaluation of the bioaccessibility of phenolic compounds in existence in edible plant products, and (2) increasing the bioaccessibility bioactive compounds by fermentation. Bioaccessibility is an important property when assessing the ability of a food product to combat disease conditions. Broadly, it refers to the release and subsequent availability of bioactive compounds for absorption via the gastro-intestinal tract. A higher bioaccessibility of bioactive compounds would infer an elevated ability of the food product to deliver the therapeutic effects to the human physiological system upon consumption. While *in vitro* methods have been used to determine the bioaccessibility and bioavailability of individual bioactive compounds, the focus of the activities of this research project is the gastric and duodenal digestion process – two major sites in which bioactive compounds are subjected to enzymatic activities, and therefore, structural changes.

Viduranga Y. Waisundara obtained her B ApplSci (2005) as well as her PhD (2010) in Food Science and Technology from the National University of Singapore. She was a Lecturer in Chemistry at Temasek Polytechnic, Singapore from July 2009 – March 2013.

Application of the Kombucha 'Tea Fungus' for enhancement of bioactive compounds in locally available plant products

Microbial fermentation has been known to result in the enhancement of therapeutic properties in beverages containing phenolic compounds. This category of compounds have been associated with the ability to prevent the onset of many non-communicable disease conditions. Thus, the objective of this project was to increase the bioaccessibility of phenolic compounds in commonly consumed beverages by fermentation with the Kombucha 'tea fungus'. This particular type of fermentation has been known to result in beverages containing enhanced therapeutic properties without the need to incorporate additional ingredients. The method is simple and can be applied in any domestic condition without a significant cost. The ability of this fermentation process to be applied for the development of novel beverages is currently being explored, since the processing method could applied in industrial as well as domestic contexts without significant hassle.

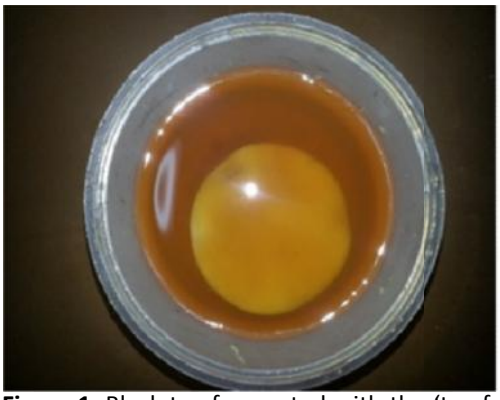

Figure 1. Black tea fermented with the 'tea fungus' – the resulting beverage has a light orange, sparkling hue as a result of the metabolic activities of the microbes present in the tea fungal mat.

As such, the ability of the 'tea fungus' to ferment coffee and king coconut water was explored and the outcome resulted in two novel functional food products with appealing sensory properties. Coffee contains several beneficial antioxidants and is one of the richest known sources of chlorogenic acid. As a phytochemical of dietary importance, coffee is considered as one of the major dietary sources for the incorporation of chlorogenicacid into the diet. Thus, it was of interest to determine whether the antioxidant potential of coffee can be enhanced through naturally occurring biochemical processes such as fermentation with the 'tea fungus'. As for king coconut water, recent evidence suggests king coconut water to possess functional properties which are associated with many health benefits. However, in most studies, the antioxidant properties of king coconut water were verified *in natura* and have been identified to reduce drastically with the use ofthermal treatments, or the actions of acids or alkaline as well as with the degree of maturation of the fruits. Thus, it was assessed whether any demonstrated antioxidant and starch hydrolase inhibitory properties of king coconut water can be enhanced by fermentation with the 'tea fungus'.

Overall, an enhancement of the antioxidant and starch hydrolase inhibitory potential of both coffee as well as king coconut water through the addition of the 'tea fungus' was observed. This had occurred in correlation with an enhancement of phenolic compounds present in both beverages. Both these studies serve as a proof-of-concept of a new food product development process, where the resulting beverages could be identified and promoted as a functional food product which can be easily prepared in households and even scaled-up for commercial production of novelty functional beverages.

Investigation of the antioxidant and starch hydrolase inhibitory activities of herbs and spices in an *in vitro* model of digestion

Measurement of antioxidant and starch hydrolase inhibitory activities before and after *in vitro* digestion offers a method of ranking food products in order of their protective and disease preventive capabilities. For this particular study, herbs and spices which are commonly consumed in Sri Lanka were assessed for their ability to maintain any demonstrated antioxidant and/or starch hydrolase inhibitory properties when subjected to gastric and duodenal digestion. Antioxidants found in herbs and spices are thought to contribute towards positive health outcomes in cases such as diabetes, cardiovascular disease and cancer. In addition, the starch hydrolase inhibitory property is a currently accepted mechanism of action for the controlled release of glucose, which is beneficial for those who have been contracted with diabetes. Crucially, the results of this study showed that antioxidant capacity and starch hydrolase inhibitory activities are relatively stable throughout the digestive process in majority of the selected herbs and spices, suggesting that these food products may be a significant source of bioaccessible bioactive compounds. Additionally, this research work also highlights the importance of using multiplemethods of analysis for the measurement of total antioxidant capacity (TAC) in the absence of any single accepted assay. This is an important aspect which was highlighted, since TAC measurement can be carried out via different methodologies, all of which assess the ability of food material to inhibit the progression of various radical sources via different pathways. Although cell culture-based, animal-based, or clinical trial-based studies are able to provide more conclusive evidence, the *in vitro* digestion model used in this study could be used as a preliminary screening step prior to embarking on study models which require much more resources and planning.

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Volunteer Research Students: Ms. Ruchini T. Jayathilaka, Mr. Shakkya J. Ranasinghe, Ms. Pavithra N. Herath

Key Publications:

(1) Watawana MI, Jayawardena N, Waisundara VY (2015). Evaluation of the antioxidant activity, polyphenol contents and starch hydrolase inhibitory activities of coffee drinksfermented with Kombucha 'Tea Fungus'. *J. Food Proc. Pres.* 39, 2596–2603.

(2) Waisundara VY, Watawana MI, Jayawardena N (2015). *Costusspeciosus* and *Cocciniagrandis*: Traditional medicinal remedies for diabetes (Mini Review). *South Afr. J. Bot.* 98, 1–5.

(3) Lee YH, Choo C, Watawana MI, Jayawardena N, Waisundara VY (2015). Evaluation of the total antioxidant capacity & antioxidant compounds of different solvent extracts of Chilgoza pine nuts (*Pinus gerardiana*). *J. Funct. Food.* 18, 1014–1021

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Microbial Biotechnology

The research program focuses on investigations of the role of developed microbial biofilms in agriculture, plantations and the environment. With the invention of development of microbial biofilms [fungal-bacterial biofilms (FBBs) in particular] in vitro in 2002, several basic research studies were conducted to evaluate their potential as microbial ameliorators in the soil and also in the environment. The studies yielded very promising results. Consequently, biofilm-based biofertilizers called Biofilm biofertilizers (BFBFs) were developed for agriculture and plantation crops (especially non-legumes, e.g. tea, rice, vegetables etc.), tested extensively under field conditions, and were commercialized in 2014. At present, the BFBFs are also being tested as biofertilizers for tea cultivation in South India with very promising initial results.

It is a well-known fact that conventional agronomic practices, particularly chemical fertilizer (CF) application, deplete the diverse microbiome. Most of the disappeared biodiversity as a response to CF application enter into an inactive or dormant phase to bypass the unfavourable conditions, by forming 'seeds', which are stored in soil seed bank.The role of BFBFs is to reinstate sustainability of degraded agroecosystems through breaking dormancy of the soil microbial seed bank, and in turn restoring microbial diversity and ecosystem functioning. Wider array of biochemicals secreted by the biofilms against mono or mixed microbial cultures with no biofilm formation is the key for the dormancy breaking. The biofilm applications for heavy metal (e.g. chromium) removal from contaminated sites have also been developed.

Current studies are centered around, 1) basic research investigations on microbial biofilm mediated dormancy breaking of soil microbial seed bank, 2) developing quality parameters for BFBFs based on crop response, 3) microbial biofilm induced carbofuran biodegradation, and 4) evaluating BFBFs for diverse agricultural, plantation and floricultural crops.

Gamini Seneviratne received his PhD in Soil Biology from the University of Peradeniya, Sri Lanka in 1993. In the same year, he accepted a Research Fellow position of the NIFS, and promoted to Research Professor in 2009. He got post doctoral trainings from Katholieke Universiteit Leuven, Belgium and University of Sydney, Australia.

Soil ecosystem deteriorates due to natural and anthropogenic disturbances, which interrupt the ecosystem functions and sustainability. As a consequence of this retarded soil system, a part of plant and microbial diversity becomes dormant, making a seed bank, which poses a major threat to the below and aboveground diversity. In order to address above issue, a basic study was conducted to investigate the potential of a developed FBB against bacteria alone that are in the FBB, in resuscitating the soil seed bank. The results showed that there is a significantly higher possibility of using FBBs over bacteria alone to break the dormancy of soil bacterial seed bank for enhanced biodiversity (Figure 1). Further, the bacteria emerged from the dormancy breaking with the treatment of the FBB formed a separate cluster in the FTIR based dendrogram, indicating that the biofilm action has tended to break dormancy of a group of soil bacteria that are unculturable (Fig. 2). This study has very important implications in culturing yet-unculturable bacteria.

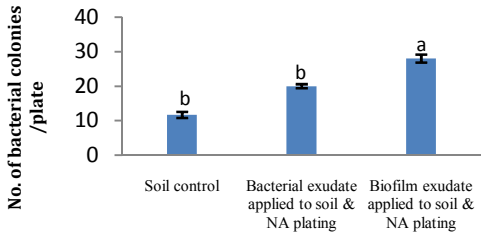

Figure 1. Number of bacterial colonies appeared after 7 days incubation of soils treated with bacterial and fungal-bacterial biofilm (FBB) exudates

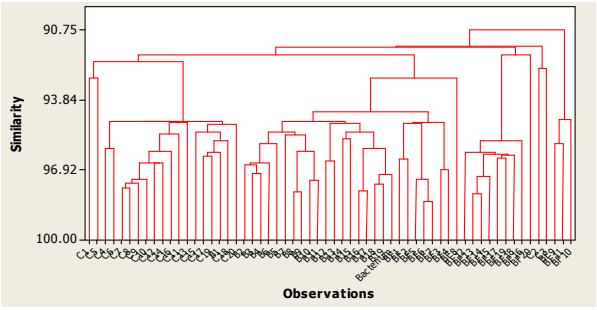

Figure 2. FTIR based dendrogram of bacteria isolated from microbial treatments after 7 days of soil incubation.

Quality of biofertilizers is one of the most important factors. Quality of the product results in their success or failure, and it also determines the acceptance or rejection by the farmer. The most important qualitative factor is crop response or yield. Relationship between quality parameters and the yield can be used to predict the yield response of a crop to a biofertilizer. A study consisting of both laboratory analyzes of biofertilizer and their field evaluations for crop response was conducted using Biofilm-T, the biofilm biofertilizer used for tea cultivation. Results showed that laboratory parameters of Biofilm-T, i.e. bacterial colony forming units (CFUs) after 24 hours in nutrient agar plates (NA24), CFUs after 48 hours in combined carbon medium plates (CCM48), sum of peaks of SH region (thiol compounds), sum of peaks of amide compounds (AM) and seedling length average (SL) were the factors which predicted tea yield in the field.

$$Tea\ yield = 6.29 + 0.09[CCM48] - 9.08[SH] - 0.06[NA24] + 3.44[AM] + 103[SL] (R^2 = 0.83, p<0.01)$$

Further, it was found that Biofilm-T performs better than the recommended chemical fertilizer practice of tea cultivation (i.e. 100% CF), if we apply the biofertilizer manufactured 4-14 months before (Figure 3). Thus, the expiry date of Biofilm-T can be extended up to 14 months.

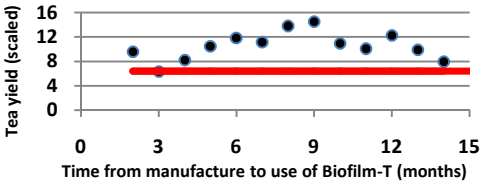

Figure 3. Tea yield response to different batches of Biofilm-T manufactured in different times.

Carbofuran is one of the powerful and massively used carbamate pesticides which are used to control insects in a wide variety of field crops. As a result of its widespread use, Carbofuran has been detected in ground, surface and rain waters, in soils, air, foods and wildlife. Therefore, the degradation process of Carbofuran is very important to maintain the balance of the ecosystem and their sustainability. Degradation of Carbofurans is usually a combination of a number of processes, including chemical hydrolysis and microbial degradation. In soils, biodegradation of Carbofuran is activated by bacterial populations, particularly in biofilm mode. Thus, a study was conducted to evaluate the effect of developed microbial biofilms on Carbofuran degradation. One bacterial biofilm, one fungal biofilm and a fungal-bacterial biofilm (FBB) based on the bacterium and the fungus were used as treatments.

The bacterial biofilm showed the highest Carbofuran degradation compared to the other treatments (Table 1). This study indicates that microbial biofilms can be used as a potential bioremediation technique to remove problematic chemical compounds from the environment. Further studies are however needed to examine full potential of this technology.

Table 1. Carbofuran degradation in different treatments

Treatment	Carbofuran degradation (%)
Bacterial biofilm	68
Fungal-bacterial biofilm	47
Fungal biofilm	40
Control	11

Foliage plants are an important sector in Sri Lanka, because they earn 90% out of total floriculture industry trade. *Draceana sanderiana*and *Cordyline fruticosa* have a high demand among the cut foliages. Due to perishable nature in foliages they are highly susceptible to pest and pathogens which cause loss of appearance and thereby reduce the ornamental value of the plants. Tip burning, leaf spots, Fusarium stem and root rot are some of the major diseases in these plants. Thus, a study was conducted to identify the possibility of the using Biofilm-F, the Biofilm biofertilizer developed for floriculture, in order to control the diseases of *D. sanderiana* "white", *D. sanderiana* "gold" and *C. fruticosa*. It was found that the Biofilm-F applied with half strength CF was more effective than full strength CF to reduce the diseases by up to 35% of the two foliages, while promoting plant growth.

M.Sc./M.Phil Students: P. Wijepala, S. Gunaratne
Ph.D. Students: A. Hemagamage, D. Sinhalage, R.D.A. Gunasekara

Key publications

1) Seneviratne G, Jayasekara APDA, De Silva MSDL, Abeysekera UP (2011). Developed microbial biofilms can restore deteriorated conventional agricultural soils, *Soil Biol. Biochem*., 43, 1059-1062.
2) Seneviratne G, Kulasooriya SA (2013). Reinstating soil microbial diversity in agroecosystems: The need of the hour for sustainability and health. *Agric. Ecosyst. Environ*., 164, 181-182.
3) Herath HMLI, Rajapaksha AU, Vithanage M, Seneviratne G (2014). Developed fungal-bacterial biofilms as a novel tool for bioremoval of hexavelant chromium from wastewater. *Chem. Ecol*., 30, 418-427.

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Natural Products

Natural Products are compounds produced by plants, fungi marine organism etc. These compounds can be used to improve the quality of human life. The use of natural products in the management and treatment of diseases in humans and plants is more acceptable and offers less risk than use of synthetic compounds.

The overall objective of the Natural Products Project of the NIFS is the identification of bioactive extracts and compounds from natural sources, as potential resources for control of human and plant diseases.Research activities in the Natural Product Project have been focused on the chemistry and bioactivity of secondary metabolites from plants, fungi (including endophytic fungi) and edible fruits of Sri Lanka. Another area of research has been the identification of polyphenols found in tea, medicinal plants, edible fruits and spices using Liquid Chromatography – Mass Spectrometry (LC-MS).

In our studies, the bioactivities of extracts and compounds are assessed using bioassays; [DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay to detect the presence of natural antioxidants; the brine shrimp (*Artemia salina*) lethality assay to detect cytotoxicity; the lettuce (*Lactuca sativa*) seed germination assay to detect the presence of phytotoxic and allelopathic compounds, the TLC bioautography method to detect the presence of antifungal compounds, α-amylase, α-glucosidase and lipase inhibitory activity assays to detect drug targets for the treatment of diabetes, obesity and hyperlipidemia. Bioactive extracts are subjected to activity guided fractionation using chromatographic techniques to isolate bioactive compounds. Structures of isolates are determined by detailed analysis NMR, MS spectral data. Partial syntheses of isolates are carried out to enhance the bioactivity of isolates.

B.Sc(1985) & PhD (1992) from the University of Peradeniya and joined the NIFS in 1992; Alexander von Humboldt Research Fellow at the University of Hohenheim, (1999/2000) & Jacobs University Bremen (2011 & 2015) Germany; Fellow of the National Academy of Sciences Sri Lanka (Since 2012).

Research activities of the Natural Products Project of the NIFS is mainly on the following three areas.

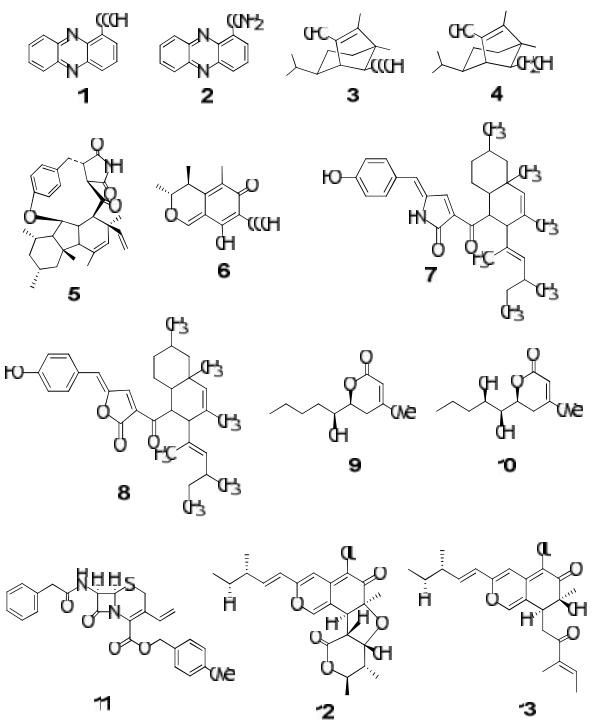
(1) Exploitation of extracts from plant sources and common fungal pathogens for use in agriculture and human health
(2) Chemistry and Bioactivity of edible fruits
(3) Plant secondary metabolites and LC-MS profiling of bioactive extracts

Chemistry and bioactivity of fungi associated with medicinal plants and edible fruits.

Fungi can be mainly categorized as endophytic and epiphytic fungi. Endophytes are found in the inner tissues or even in the cells of their host while epiphytic fungi grow on the surface of the host. Endophytes are considered to be a rich source of secondary metabolites with novel structures and interesting bioactivities. These metabolites have found extensive applications as agrochemicals, antibiotics, immune suppressants, antiparasitic and anticancer agents. Some endophytic fungal strains produce natural products that are either identical or closely related to those produced by the host plant. A well-known example is the production of Taxol, an anti-cancer drug obtained from the Pacific Yew tree *Taxus brevifolia*, which was also produced by the endophytic fungus *Taxomyces andreanae* isolated from the bark of *T. brevifolia*. Recently we have studied the chemistry and bioactivity of secondary metabolites produced by the endophytic fungi isolated from some medicinal plants – *Amaranthus viridis* (Koora Thampala), *Camellia sinensis* (Tea), *Coccinagrandis* (Kowakka), *Costus speciosus* (Thebu), *Passiflora edulis* (Passion fruits), *Piper nigrum* (Gammiris) and some endophytic fungi isolated from some popular edible fruits *Artocarpusaltilis* (Del), *Averrhoa carambola* (Kamaranga), *Carica papaya* (Papol), *Flacourtia inermis* (Lovi), *Garcinia mangaostana* (Mangostin), *Manilkara zapota* (Sapodilla), *Musa* sp. (Banana), *Pouteria campechiana* (Lavulu) and *Syzygium samarangenes* (Jambu). Several secondary metabolites with interesting structural features and some useful bioactivities were isolated. Structures of some selected compounds are given below. Phenazine-1-carboxylic (**1**) & phenazine-1-carboxamide (**2**) {from *Nigrospora oryzae*from *C. grandis*}; helminthosporal acid (**3**) and helminthosporol (**4**) {from *Bipolaris sorokiana* – *C. speciosus*}, GKK1032B (**5**) and citrinin (6) {*Penicillium citrinum* from *G. mangostana*); Taloroconvolutin A (**7**) and its furanone analogue (**8**) {from *Fusarium purpurogenum* from *P. campechiana*); pestalotin (**9**) and hydroxypestalotin (**10**) {*from M. zapota*}, Cephem derivative (**11**) (from *Aspergillus awamori* from *Musa* sp.}; Chaetomugilin A (**12**) and Chaetomugilin J (**13**) {from *Chaetomium globosum* from *A. viridis*).

Profiling of some medicinal plants and edible fruits

The major bioactive groups of compounds in dietary plants are polyphenols. Phenolic acids, such as chlorogenic acids, phenolic glycosides, proanthocyanidins and saponins have been reported to be present in some of the herbs consumed by people. Most of the dietary plants have physiologically active components with a health enhancing role. Polyphenols are receiving more attention from scientists due to their beneficial effects as antioxidants, anticancer, cardio protective, antimicrobial, antiaging, anti-inflammatory agents etc. Several epidemiological studies suggested that regular consumption of food and beverages rich in polyphenols is associated with a reduction in the risk of a range of pathological conditions ranging from hypertension to coronary heart disease, stroke and dementia. Chlorogenic acids (CGAs) are the most important single class of dietary polyphenols. By definition, chlorogenic acids are esters of quinic acid, most commonly characterized by hydroxycinnamate ester moieties. CGAs display a wide range of fascinating biological activities including anti-HIV, anti-viral, anti-plasmodic, inhibit glucose transporters or show opioid receptor activity. Since a majority of the Asian population consumed a large number of dietary medicinal plants it is important to profile the chemical constituents in these plants.



LC-MS is a powerful technique to analyze chemical constituents present in a mixture. Structures of the chemical constituents are generally identified on the basis of their retention times and mass fragmentation pattern by LC-MS studies. Recently, we have identified a series of phenolic compounds from the fruit extract of *Flacourtia indica* (Ugressa) and *Flacourtia inermis* (Lovi), which were investigated qualitatively by HPLC tandem mass spectrometry and high resolution mass spectrometry. Thirty-five phenolic compounds were detected and characterized on the basis of their unique fragmentation pattern in the negative ion mode tandem MS spectra. Twelve were extracted for the first time from these sources and four have not been reported

previously in nature. It was also possible to distinguish between the isobaric (same molecular weight) phenolic compounds dicaffeoylquinic acids and caffeoylquinic acid glycosides. For the positive identification of phenolic compounds by LC-MS^n, a series of experiments were carried out. This was the first report for the full characterization of phenolic compounds of the fruits of *F. indica* and *F. inermis*by LC-MS^n.

Edible fruits as a source of Bioactive Compounds

Fruits have been consumed for centuries by animals and humans and are reliable source of non-toxic and environmentally friendly bioactive compounds. Most of the studies on edible fruits are limited only to their nutritive value. Consumption of fruits has been associated with a reduced risk of chronic diseases and the reduction of functional declination associated with aging. Bioactivity studies of compounds specific to tropical fruit plants have led to the discovery of new chemical entities with interesting bioactivities and reduced toxicity. The presence of inhibitors of carbohydrate hydrolyzing enzymes eg. α-amylase, α-glucosidase in plant derived foods is of immense importance in the control of blood glucose level in patients with type-II diabetes.

Antioxidants help to prevent free radical induced oxidative stress and also to either prevent or delay diseases related with aging. Fruit extract that display antifungal activity could lead to the isolation and identification of environmentally friendly pesticides and antifungal agents. Our recent studies led to the identification of some antifungal, phytotoxic and antioxidant active compounds from *Aegle marmelos* (Beli) and some phytotoxic compounds from the fruits of *Averrhoae carambola* (star fruit).

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Post doc: Dr. HMDK Kanatiwela (NSF)

Key Publications

1) Bandara HMSKH, Kumar NS, Jayasinghe L, Masubuti H, Fujimoto Y (2015). A 3-vinyl cephem derivative, useful intermediate in the synthesis of cephem antibiotics, from *Aspergillusawamori* associated with banana fruit, *Natural Product Communications*, 10, 1663-1666.
2) Thanabalasingam D, Kumar NS, Jayasinghe L, Fujimoto Y (2015). Endophytic fungus *Nigrospora oryzae* from a medicinal plant *Coccinia grandis*, a high yielding new source of phenazine-1-carboxamide, *Natural Product Communications*, 10, 1659-1660.
3) Alakolanga AGAW, Siriwardane AMDA, Kumar NS, Jayasinghe L**,** Jaiswal R, Kuhnert N (2014). LC-MS^n identification and characterization of the phenolic compounds from the fruits of *Flacourtia indica* (Burn.F.) Merr. and *Flacourtia inermis* Roxb. *Food Research International*, **62**, 388-396.

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Morella Forest

Ruvini Liyanage

Ruvini Liyanage obtained her Ph.D. from Obihiro University of Agriculture and Veterinary Medicine, Japan in 2009 and worked as a Postdoctoral Research Fellow at the same University. She joined the NIFS in 2011.

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Nutritional Biochemistry

Nutritional Biochemistry project focuses on various aspects of functional and nutritional properties of foods and covers a wide area like functional and nutritional properties of food, bioavailability of food, food safety, novel method development, functional food product development, and nutritional surveys.

Functional and nutritional properties of food: Under this research theme, studies are done to assess the antioxidant, enzyme inhibition (amylase, glucosidase, lipase), radical induced DNA damage prevention and identification of active compounds. In addition, *in vivo* studies are also done for further confirmation of functional properties.

Novel assay development: A novel assay was developed to determine α-amylase activity. α-Amylase is an enzyme responsible for hydrolysing α bonds in such as starch and glycogen, yielding glucose and maltose. Although there are several methods to determine α-amylase activity, the novel method is more convenient, less costly, and less laborious.

Food Safety: Heavy metals are trace elements that cause negative impacts on human health, even at very low concentrations. In this study Heavy metal concentration in broiler tissues and broiler feed were analyzed.

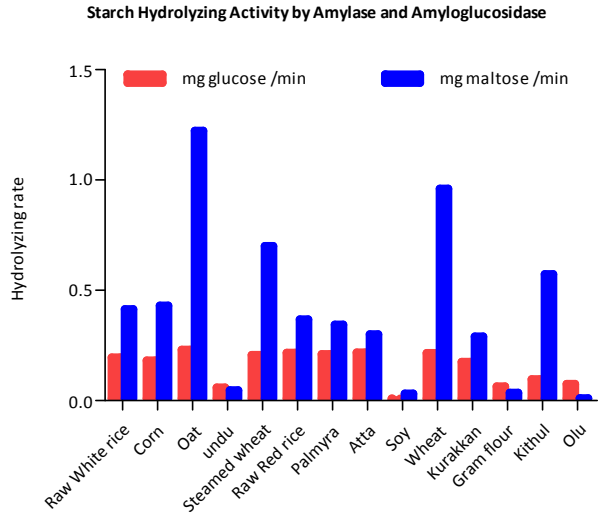
Functional Food Product Development: Under this two novel functional food products were developed. *Moringa* leaf powder incorporated soy drink was developed as a substitute for cow milk and Avacado incorporated butter was developed to increase the Monounsaturated (MUFA) and Polyunsaturated (PUFA) fats in conventional butter.

Ruvini obtained her B.Sc (Hons) in Agriculture from University pf Peradeniya in 2000, Master's and Ph.D. from Obihiro University of Agriculture and Veterinary Medicine, Japan and worked as a Postdoctoral Research Fellow at the same University. She joined the NIFS in 2011.

Functional properties of foods: Recently, the interest in medicinal plant usage for treating several disease conditions has increased due to exerted beneficial properties such as antioxidant, anticancer, hypoglycaemic and hypolipidaemic activities. Therefore, a study was conducted to assess the *in vitro* functional properties of hot water extracts of 10 commonly used medicinal plants in Sri Lanka. Among the tested plants, the Nelli extract was found to exert extremely high antioxidant and amylase inhibitory activities

Samples of dried medicinal plants

As one possible way to overcome diabetes, a great interest has been stimulated in understanding the relationship between different types of dietary carbohydrates and appetite regulation. Starch is one of the main energy sources in Sri Lankan diet. Thus, the hydrolyzing rate of fourteen different types of available flours was assessed against the enzymes α-amylase and amyloglucosidase. According to the results, soy, oat, Olu, chick pea, Kithul, Undu and Palmyra starches showed slower digestibility compared to the commonly used flours wheat, Atta, raw white rice, kurakkan, raw red rice and steamed wheat.



To better understand the bioavailability of these functional compounds a study was conducted to assess the antioxidant and prebiotic activity of undigested and digested jackfruit seeds and jackfruit bulbs by mimicking natural digestion process using swine stomach and intestinal juice. Results showed a significant increase in antioxidant and prebiotic activity after *in vitro* digestion of mature jackfruit seeds and bulbs.

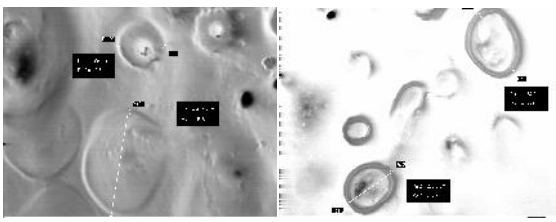
These insights are of significance for pinpointing the beneficial properties of naturally available food sources and in the context of selection of these commodities in food processing, agriculture and medicine. On pharmacological grounds identification of the functional properties of active compounds paves the way for the development of natural remedies for treating diseases.

Novel assay development: There are numerous methods used for the determination of α-amylase activity among which the DNSA assay, that measures the reducing power of a solution is the most widely used method. However, these methods share common problems, being labor intensive, time consuming and costly when the number of the samples is large, as is the case with herbal plants. Therefore, our research group developed an easy, microplate based assay method for the determination of the α-amylase inhibitory activity of plant compounds. As compared to the DNSA method, the new method is more convenient for kinetic studies where the reagents and plant extracts are put into the microplate and the readings are taken at once.

Food Safety: Heavy metals are incorporated into poultry feed as a supplementary diet, to fulfill protein requirement and as a mineral supplements. Thus in this study the heavy metal concentration in broiler tissues and broiler feed was analyzed. From the results it was found that heavy metal concentration in some poultry tissues were higher than the permissible level determined by WHO. As the results were alarming more comprehensive study will be conducted in the future.

Functional Food Product Development:

There has been an explosion of consumer interest in the health enhancing functional foods at present. In our research group with the collaboration of Department of Animal Science, Faculty of Agriculture, University of Peradeniya, we developed two novel functional foods; as Avocado Incorporated Butter and *Moringa* leaf powder incorporated soy drink with various health benefits. Consumer acceptability for both products was satisfactory and biochemical analysis confirmed the presence of expected physico chemical properties.



SEM images of conventional (left) and Avacado incorporated butter (right)

Nutritional Surveys:

The ultimate objective of this study was to develop household food security models to ensure nutritional security and food safety in poverty stricken areas of Sri

Lanka. This study was restricted to poverty stricken two DS Divisions in Kandy and Matale. According nutritional survey only 26.9% of children in Ududumbara and Minipe DS divisions in Kandy had satisfactory nutritional status and 73.1% had some form of malnutrition.

In Ambangaga and Yatawatta DS divisions in Matale district (n=26), only 11.6% had satisfactory nutritional status and 88.5% had some form of malnutrition. It is therefore, almost important to ensure nutritional security through the intended home garden model

M.Sc./M.Phil Students: Oshini Perera, Chatuni Jayathilake, Rizlliya Visvanathan, Uditha Premarathne, Indeewari Ihalage

Key Publications

1) Liyanage R, Perera OS, Weththasinghe P, Jayawardana BC, Vidanarachchi JK, Sivakanesan R (2014). Nutritional properties and antioxidant content of commonly consumed cowpea cultivars in Sri Lanka**.***Journal of Food Legumes***.** *27*,215-217.

2) Jayawardana BC, Liyanage R, Lalantha N, Iddamalgoda S, Weththasinghe P (2015). Antioxidant and antimicrobial activity of Drumstick (Moringaoleifera) leaves in herbal chicken sausages.*LWT - Food Science and Technology* 64:204-1208.

From Left: Ms. I Thumpela, Ms. …., Dr. R Liyanage, Ms. C Jayathilake, Ms. R Visvanathan, Ms. U Premarathne

M.C.M. Iqbal

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Plant Biology

Our research interests are addressing issues related to our environment and how research conducted in the field and laboratory can provide solutions. The project on Forest Ecology is investigating the degradation of our forests, particularly the dry forests in the dry zone of Sri Lanka. Forest degradation is due to illegal activities such as chena cultivation, extraction of timber and non-timber forest products. To restore the forest as nearly as possible to their original status, it is necessary to quantify the degradation in terms of diversity of the plant species, and structure of the forest as well as changes to the nutrient quality of the soil. This research is being done in the Hurulu forest in the Pollanaruwa district, Nuwaragala forest in the Ampara district and our own forest arboretum in Dambulla.

The project on Environmental Remediation is concerned with pollution of waterways by heavy metals and textile dyes. These are discharged by Small and Medium scale industries. We are using the ability of plants to take up these pollutants – called phytoremediation – and also the use of biomass derived from plants to soak up metals and dyes. Certain aquatic plant species have the ability to absorb pollutants without causing any harm to the plants. Biomass derived from waste plant material can bind the pollutants depending on the oppositely charged ionic surface of the biomass and the pollutants.

Iqbal obtained his B.Sc in Agriculture from the University of Peradeniya in 1980, Master's from Swiss Federal Institute of Technology (ETH), Zurich and Ph.D from the University of Göttingen. He is a recipient of the Freedom from Hunger Award from the Rotary Foundation and Research Fellowships from the German Academic Exchange Service.

Forest degradation and restoration

Although most studies on forest degradation and restoration have been done in rain forests, so far no comprehensive phyto-sociological studies linking sociological aspects and forest restoration has been done in the dry forests in Sri Lanka. It is apparent that the rising socio-economic impacts from development activities, human settlements, irrigation systems, agricultural projects, wild fires and alien invasive plants have extensively degraded dry forests in Sri Lanka. Therefore, forest restoration studies are urgently needed for the degraded dry forests. This research project is principally focused on phyto-sociological and human sociological variations associated with dry forests in two different Agro Ecological Regions in the dry zone: Hurulu and Nuwaragala forest reserves. The study has selected *Khaya senegalensis* (Desr.) A.Juss. and *Tectona grandis* L.f. plantation and NIFS Popham arboretum in the dry zone as other study sites in which restoration options has been already adopted. Plot experiments were conducted to assess phyto-sociology of Hurulu and Nuwaragala forest reserves with different forest degradation regimes and different restoration options. Socio ecology of local communities living in and around the above forest reserves will be assessed by using questionnaire survey. The key outcomes of this study will be significant to implement sustainable and efficient biodiversity conservation strategy in the dry zone of Sri Lanka.

Another study is being carried out in a recently discovered Moraella relict forest in the Kandy plateau in Sri Lanka. Rain forests in the Kandy plateau were heavily deforested and degraded in the mid-19th century for conversion to coffee, cinchona and tea plantations. Remaining relict forests also are highly degraded due to various anthropogenic activities, encroachment by alien invasive plants, forest fragmentation and isolation of climax forest. To date, very few phytosociological studies have been done on these forests. The objective of this study is to assess the phytosociology of Moraella forest and how effective this forest community is as a floristic diversity refugia in the Kandy plateau.

Extracting of soil samples

Bioremediation of heavy metals

Contamination of water bodies due to textile dyes and heavy metals create socio-economic problems and health problems to living organisms. These pollutants enter the environment mostly through wastewater discharge. Treatment of contaminated waste water is an expensive process where, expensive instruments and regular maintenance is required. Therefore Small and Medium scale Entrepreneurs (SME) are hesitant to adopt these methods. To prevent further decontamination of the water bodies' from these pollutants and to enable waste water treatment by SME, low-cost treatment methods should be introduced. Biosorption is a cost effective alternative method to treat waste water.

Biosorbent prepared from *Mimosa pigra* seed pods

In the biosorption technique, non-living plant materials are used to adsorb pollutants form the contaminated wastewater. Non-living biomaterials consist of hard woody structures such as primary and secondary cell walls. These structures are made out of biopolymers such as cellulose, hemicellulose and lignin. Functional groups present in these biopolymers readily form interactions with the pollutant present in the wastewater. These can be chemical or physical interactions. Depending on the interactions between the pollutant and the plant materials suitability of the plant material as an adsorbent will be decided. Interactions between the pollutant and the plant material depend on the external parameters of the environment. External parameters include pH of the system, duration of contact, shaking speed, rate of contact, pollutant concentration and amount of biosorbent.

To increase the efficiency of the biosorbent, simple modifications such as protonation of the biosorbent and grafting of chemical groups can be used. After determination of a suitable biosorbent and the external parameters the selected biosorbents will be used in fixed-bed column reactors to determine the fixed-bed column parameters which can used to design a large scale biosorbent system for use by SMEs.

Bioremediation of organic dyes

Addressing environmental pollution is one of a major concern since it adversely affects environmental, social and economic aspects. Environmental remediation is the removal of pollutants or contaminants from the water (both surface and ground water) and soil to ensure the protection of environmental and human health. Apart from the physico-chemical remediation techniques, the biological methods have a major role in terms of cost effectiveness, easy operation and eco-friendliness. In our project we are using two biological remediation methods: Phytoremediation and Bio-sorption. Phytoremediation is the removal of pollutants from water or soil by using live plants while bio-sorption stands for the removal of pollutants by using non-living biomass. Our research interests are focused on removing textile dyes and heavy metals from aqueous systems.

Synthetic textile dyes are complex organic compounds and classified as carcinogenic, mutagenic and teratogenic. Owing to their high stability, dyes can persist in a variety of environments and traverse through the food chains ending up with bioaccumulation and bio-magnifications in living organisms. Hence, dyes can cause adverse health impacts on humans and animals. Color pollution of waterways also reduces photosynthesis by aquatic plants and microorganisms by preventing sunlight penetration through the water column.

Removal of textile dyes by using phytoremediation techniques

Phytoremediation has received increasing attention after the discovery of hyper-accumulating plants, which are able to accumulate, translocate, and concentrate high amounts of toxic heavy metals in their above-ground or harvestable parts. We are investigating aquatic plants that are easily available, tolerant and have a potential to absorb pollutants, for removing textile dyes from aqueous solution. Crystal violet dye is a model basic dye and is widely used in a variety of industries including textile industry. We have used water lettuce (*Pistia stratiotes* L.) and Salvinia (*Salvinia molesta* D. Mitch) plants to investigate their potential to remove the dye, crystal violet.

Experiments were conducted to determine the optimal conditions for the dye uptake process such as plant biomass, contact time, solution pH and dye concentrations and also for the maximum uptake capacity. These findings can be used in industries for planning treatment of effluent water such as small and medium scale construction of wetlands. Our results showed that water lettuce and salvinia, have a good potential to remove the crystal violet dye within a short contact period of 48 hours.

Removal of textile dyes by using Biochar

The term "biochar" refers to the biomass derived charcoal which are subjected to physical modification through the high temperature pyrolysis process. Using charcoal for remediation has been practiced by several ancient civilizations including Sri Lanka. Through this project we are focusing on using biomass derived charcoal or "biochar" for the removal of textile dyes. Biochar derived from different waste materials such as sawdust and rice husk are using for remediation with different pyrolysing temperatures, as the feedstock and pyrolysing temperature plays a key role in changing sorption properties. Experiments were conducted to determine the optimal operational parameters for the sorption process such as biochar dosage, solution pH, contact time and dye concentrations.

Apart from the basic experiments, we have predicted the fate of the dye and possible physical and chemical mechanisms through a mathematical modeling approach. We have used Gliricidia woody biochar and Lunumidella (*Melia azedarach* L.) sawdust biochar derived at three different temperatures, 300 °C, 500 °C and 700 °C, to investigate their potential for removal of crystal violet dye. Results showed that the sorption capacities increased with the elevation of the pyrolysis temperature and the optimal dye adsorption was at a higher solution pH.

From Left: Mr WWMAB Medawatte, Mr. RB Happukotuwa, Mr. JW Anukulan, Mr. DMREA Dissanayake, Prof. MCM Iqbal, Ms. WT Awanthi, Ms. LRC Premalal, Ms.WMKEH Wijesinghe, Ms. HPGRM Samarakkody, Ms. RMS Perera

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Biological Nitrogen Fixation

Biological nitrogen fixation (BNF) is the conversion of inert atmospheric dinitrogen (N_2) to a combined form by living organisms catalyzed by the enzyme nitrogenase. It is a process confined to certain prokaryotic, aerobic, micro-aerobic or anaerobic microorganisms which can be free-living, associative and symbiotic. Nearly 65% of the atmospheric nitrogen enters the global nitrogen cycle through BNF. This natural process has been studied since its discovery in 1888 in order to understand the process and utilize it as a natural resource for agriculture and forestry.

The BNF Project at the IFS commenced in 1983 and basic studies were conducted on nitrogen fixation by free living and symbiotic cyanobacteria and their possible utilization in rice cultivation, associative nitrogen fixation and its utilization in wetland and upland cereal and sugarcane production and symbiotic nitrogen fixation with leguminous plants. The project received a boost when the Katholiek University of Leuven (KUL), Belgium became a collaborative partner in 1991 with significant funding coming from them.

A landmark finding from these studies was the development of a coir dust based carrier for rhizobial inoculants. This carrier material has been used ever since and currently these inoculants are applied to 10,000 acres of soybean without the application of any urea fertilizer. Recent studies with such inoculants have given very promising results for vegetable beans, mung bean, cowpea and the forage legume white clover and further work is in progress with ground nut and black gram. The widespread use of such inoculants could significantly reduce the application of environmentally detrimental chemical N-fertilizers.

Key publications

Efficient use of sustainable biological nutrient management systems (Ed Ir. L. Van Holm Res Report 1991 – 1995, IFS-KUL BNF Project: 168p) and *Sesbaniarostrata*, A Potential Green Manure for Lowland Rice 1996 Ed Ir. L. Van Holm IFS-KUL BNF Project: 130p).

B. Sc. (Special Hons) Ceylon; Ph.D. (London). Re-joined the IFS in 2009 as a Visiting Research Professor. A Research Fellow, International Rice Research Institute, Philippines; Visiting Scientist, Weizmann Institute of Science, Israel; Visiting Professor, Washington State University, USA and Senior Fellow, Global Studies Institute, San Jose State University, USA.

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Natural Products

Edible fruits of Sri Lanka, a source of biologically active secondary metabolites
Flacourtia inermis (Sinh.Lovi), an under- exploited fruit, was found to be a good source health promoting anthocyanins and phenolics including chlorogenic acids. Antioxidant activity, α-amylase and α - glucosidase inhibitory activities (anti-diabetic activities) displayed by Lovi fruit extracts indicates a possible use of these fruits in food supplements. LC-MS was used to identify and establish the structures of 35 phenolic compounds in Lovi fruit extracts.

Separation and characterization of fungal metabolites
Monacrosporium ambrosium (ambrosia fungus), the ectosymbiote of shot-hole borer (SHB) beetle, an insect pest in tea plantations of Sri Lanka, produced fungicidal napthoquinones in fungal culture media. Isolation, identification and biological properties of five naphthoquinones have revealed a new aspect of the symbiotic association between SHB and the ambrosia fungus.

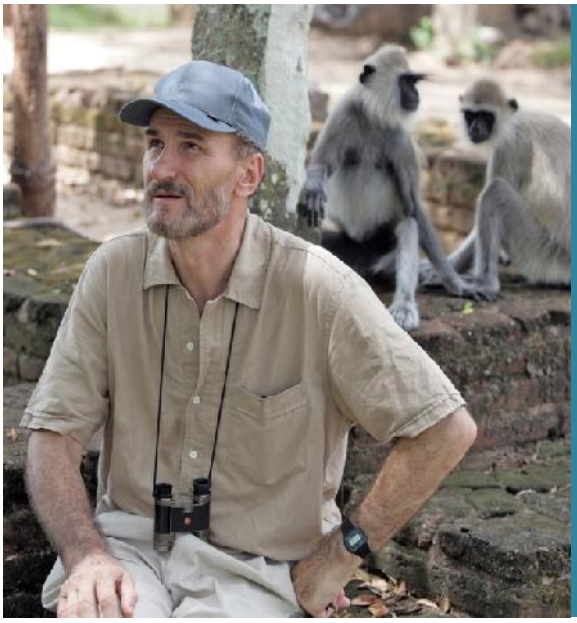
Common fungal pathogens for use in agriculture
An endophytic fungus *Chaetomomium globosum*, was isolated from *Amaranthus viridis*, an allelopathic plant. Fungal cultures of *C. globosum* yielded two compounds with phytotoxic activity and which have a potential use as environmental friendly herbicides.

Key publications
Alakolanga AGAW, Kumar NS, Jayasinghe L, Fujimoto Y (2015). Antioxidant property and α-glucosidase, α-amylase and lipase inhibiting activities of *Flacourtia inermis* fruits: characterization of malic acid as an inhibitor of the enzymes, Journal of Food Science and Technology, 52, 8383-8388.

Kumar NS, Bandara BMR, Hettihewa SK (2015). Isolation of a tetramericA-type proanthocyanidin containing fraction from fresh tea (Camellia sinensis) leaves using High Speed Counter-Current Chromatography, J. LiqChromatogr. Rel. Tech.38 1571- 1575

Piyasena KGNP, Wickramarachchi WART, Kumar NS, ,Jayasinghe L, Fujimoto Y (2015). Two phytotoxic azaphilone derivatives from *Chaetomium globosum*, a fungal endophyte isolated from *Amarathus viridis* leaves. Mycology, 6, 158-160.

B. Sc. Hons (Ceylon) 1965; PhD (London) 1971; Emeritus Professor, University of Peradeniya; Research Professor, IFS, Kandy (2009-Sept 2015). Fellow of the National Academy of Sciences, Sri Lanka; Research Fellow at University of British Colombia (1986), University of Stickholm (1985), York University, Ontario (1977-78).



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Primate Biology

The program involves observational studies of monkeys (primates) in their natural forest habitats. Our aims are: (1) to contribute new knowledge to the understanding of the evolution of social behaviour in primates (and by extension in humans); (2) to provide a scientific basis for the effective management and conservation of primates and other organisms; and (3) to disseminate new knowledge through scientific publications as well through professionally produced documentaryfilms. Such popular media serve not only to educate and entertain,but also to gain public support for conservation in the local and international communities. Our films (e.g., 2015, Disney Nature "Monkey Kingdom") also contribute positively to the image of Sri Lanka as a tourist destination.

Our scientific work has been buttressed by studies in population genetics, paternity exclusion, anatomy, epidemiology and physiology as they relate to the behavior, ecology and vital statistics of wild monkeys. Multidisciplinary data are fundamental for testing hypotheses regarding many sociobiological phenomena and the evolution of primate society. In practice, at our study site at Polonnaruwa (Sri Lanka), we have identified several thousand individual monkeys.For each macaque (*Macca sinicasinica* Linnaeus, 1771), we have traced its behavioural, genealogical, ecological and demographic history.Our methods are similar to those of actuaries; linking variables of behaviour and environment to those of survival. To this end, we require large samples over extended periods of time to assure statistical soundness (longevity in wild monkeys may exceed 35 years).Some time ago we have begun similar investigations of the gray [*Semnopithecus priamthersiites* (Blyth, 1848)] and purple-faced langur [*Semnopithecus vetulusphilbricki* (Phillips, 1927)] at our research site at Polonnaruwa.New studies focus as well on the slender loris (*Loris lydekkerianusnordicus* Hill, 1933).

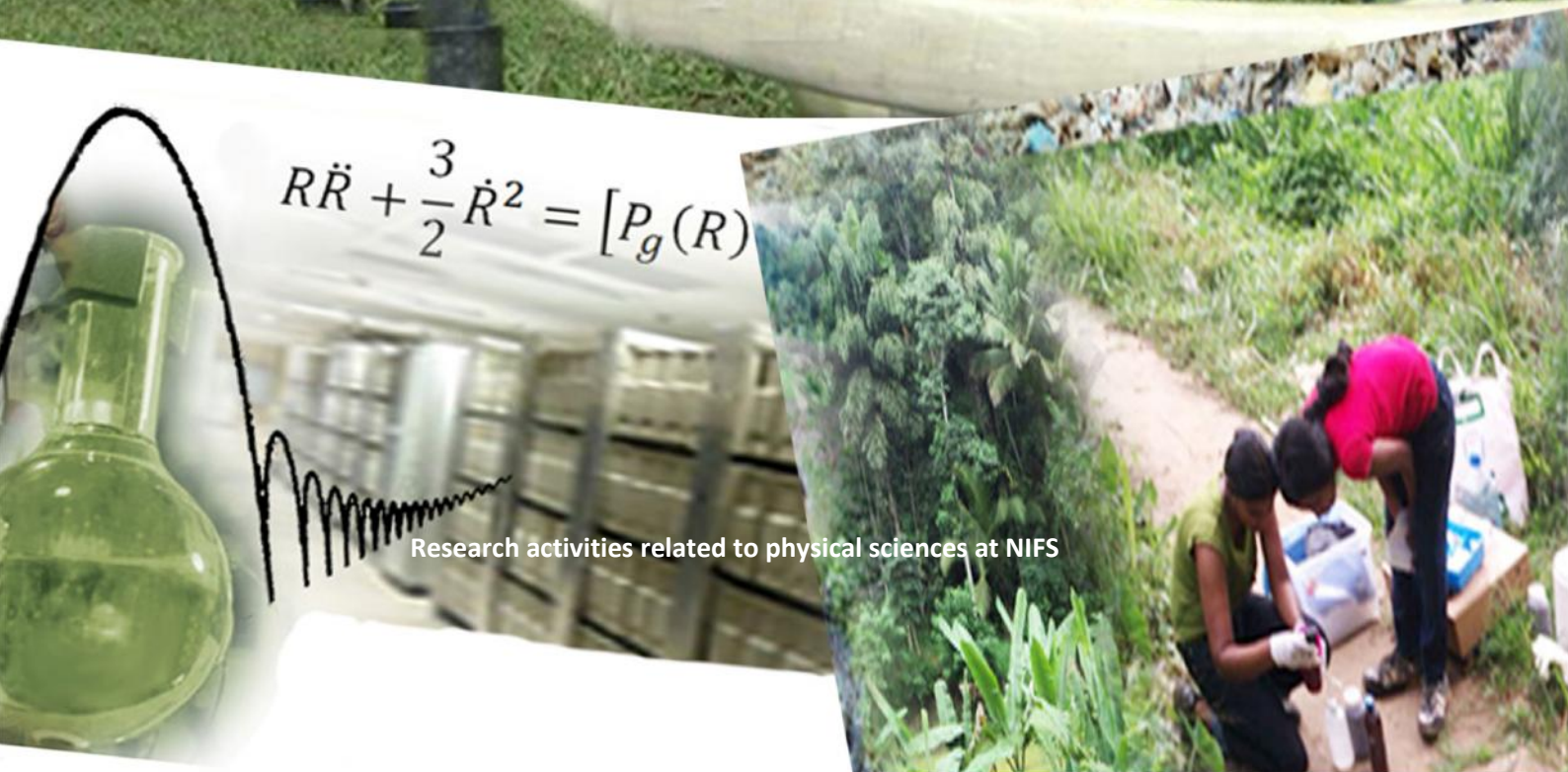
Key publications

1. Dittus W. (2013). Arboreal Adaptations of Body Fat in Wild Toque Macaques (Macacasinica) and the Evolution ofAdiposity in Primates. American Journal of Physical Anthropology, 152,333–44.DOI: 10.1002/ajpa.22351
2. Dittus W, (2013). Subspecies of Sri Lankan Mammals as Units of Biodiversity Conservation, with Special Reference to the Primates, Ceylon Journal of Science (Bio. Sci.), 42(2), 1-27.
DOI: http://dx.doi.org/10.4038/cjsbs.v42i2.6606
3. Goto K, Fukuda K, Senda A, Saito T, Kimura K, Glander K, Hinde K, Dittus,W, et al., (2010). Chemical characterization of oligosaccharides in the milk of six species of New and Old World monkeys, Glycoconugate Journal, 27:703–15. DOI 10.1007/s10719-010-9315-0

Primate Project staff
Mr. Sunil Gunathilake; Mr. Chameera Pathirathne, Mr. Sunil Rathnayake

PhD (Zoology) Univ. Maryland, USA; MSc (Zoology) McGill University, Canada; BSc (Science) McGill University, Canada. Conducts multidisciplinary research on wild primate populations Sri Lanka 1968-2016. An Associate Editor Am J. Primatology (past) & J. Primatology (present) and IUCN Primate Specialist for Asia

Physical Sciences



Research activities related to physical sciences at NIFS

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Chemical & Environmental Systems Modeling Research Group

Our research group is engaged in monitoring, research and modeling of water and soil systems that provides scientific support for restoration and management. Monitoring tells us what is happening, laboratory and field research tells why something is happening, and modeling helps to tell us what can happen. Soil and water pollution is common everywhere in the world due to excessive use of agrochemicals, antibiotics, polycyclic aromatic hydrocarbons, heavy metals, and metalloids, which are released to the environment from both non-point and point sources. Monitoring is essential to understand the fundamental mechanisms behind the release or removal in order to formulate a better remediation technique and/or a mitigation strategy. To accomplish this, our group is carrying out laboratory and field experiments on toxic metal release from soil and water, their removal using low cost materials such as biochar and nano-materials, and modeling pollutant plume dynamics.

Biochar has become a widely researched material as a soil conditioner for Carbon sequestration and soil quality improvement since none of the typical treatment materials was effective in both. Previously, we examined the potential of biochars produced from waste materials including municipal solid waste, agricultural waste, day-to-day waste generated from households and invasive plants to remove heavy metals, metalloids, antibiotics in water and soil systems, and results showed a high capacity for removal of several pollutants. Since 2012, our research group extensively worked in the field of Biochar for environmental remediation and we are one of the top 5 leading research groups in the world in terms of biochar publications. Our outputs are publications in high impact journals with high citations, patents, collaborative researches, finantial support through grants and postgraduate degrees. Our new approach is to investigate the potential of smart biochars as a universal material for water and wastewater remediation as well as restoration of contaminated soils and predict their mechanisms of removal through modeling.

In addition, our group is carrying out projects on (a) pollution monitoring of wastewater in particular from hospitals and municipal solid waste dump sites for assessing their quality, (b) synthesizing nano composites to integrate with environmental remediation processes, and (c) monitoring of atmospheric deposition for heavy metals and hydrocarbons and model their effect on human and ecological health.

Meththika obtained her PhD in 2009 in groundwater modeling from the University of Copenhagen. She joined NIFS as a Research Fellow in August, 2009. She is a Young Affiliate of the Third World Academy of Sciences and an award winner for research publications, science popularization and postgraduate supervision

Environmental Monitoring programs have been criticized as they cost high while delivering less however, environmental monitoring serves a vital scientific role by revealing trends that can lead to new knowledge, understanding of the system, and that is essential for environmental planning, policy and to provide solutions. Our research group is monitoring groundwater, landfill leachates from Gohagoda Municipal Solid Waste (MSW) dumpsites and hospital wastewater (HWW), which may be useful for environmental planning and policy making. To accomplish this, our research group is facilitated with many different analytical instruments such as, UV-Visible Spectrophotometer, Atomic Absorption Spectrophotometer, Gas chromatography-Mass spectrometry, Ion chromatography, Total organic carbon analyzer, multiparameter etc. Monitoring data reveal that the landfill leachate which is directly flows to the River Mahaweli is highly polluted with various pollutants with high concentrations including many volatile organic compounds, heavy metals, nutrients, organic carbons etc (Figure 1).

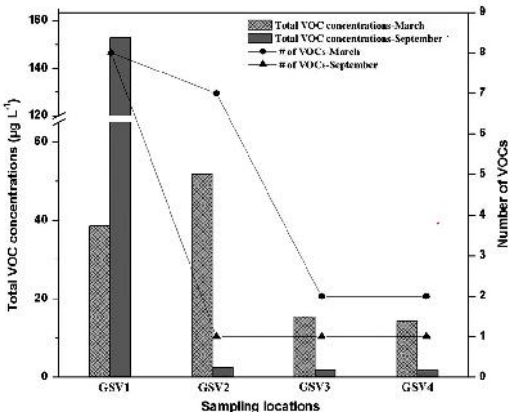

Figure 1. Presence of volatile organic compounds in landfill leachate from Gohagoda MSW dumpsite.

Perchlorate Research study was started in 2014. Perchlorate is an emerging contaminant in the earth as well as on Martian regolith. Currently, the role of perchlorate ion in different soil types in Mars regolith or in earth has not been systematically or experimentally investigated. This emphasizes the importance of modeling the potential of perchlorate interactions in soil as an environmental hazard on metal mobilization as well as its capability of destroying/removing organics in regolith. The objectives of this study include modeling of perchlorate on metals and organics using model regoliths such as serpentine soils and basaltic soils. Further, this study assesses the effect of perchlorate on soil carbon fractions, propose potential mechanisms of interaction and investigate amendments for perchlorate neutralization. The results illustrate that perchlorate, even at low concentrations, can both accelerate metal release and increase the bioavailable metal fractions in soils and regolith.

Biochar Research has gained immense attention recently due to its universal potential for remediation of soil and water from various pollutants whilst acting as a material that improves soil quality. Our previous research showed that the biochar (BC) produced from waste materials are highly capable of removing heavy metals, metalloids as well as antibiotics. Our recent attempt was focused on pesticide removal and improve soil quality by immobilizing pollutants using biochars generated as a byproduct from the dendro power industry. Simultaneously, we are researching on producing municipal solid waste biochar in order to test it potential to be used as a liner and capping material in landfill management to reduce the pollution from municipal solid waste dump sites. We conduct characterization, pot, incubation, batch, column experiments, modeling and spectroscopic techniques (Figure 2). Our future taskis to produce engineered smart biochars with high capacity and capability in environmental remediation.

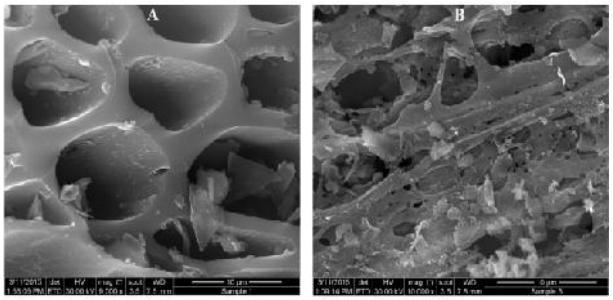

Figure 2. SEM images of steam activated Rice Husk BC (RHBC) (left) and non-activated RHBC (right).

Nano materials have been widely used for environmental applications. Our research group has previously produced a highly reactive nano zero valent irons using starch and mercapto acids as stabilizing agents. Recently, we synthesized a composite of starch stabilized nano zero valent iron (nZVI) with graphene nano particles. The composite (Gn-nZVI) nano particles were characterized for its properties using SEM, FTIR, XRD, BET surface area and zero point charge (pHzpc). The surface area and pHpzc of NZVI-Gn composite was reported as 525 m^2 g^{-1} and 8.5, respectively. It was then tested for hexavalent Cr removal in water. Cr(VI) is a highly toxic ion is industrial wastewaters. Highest Cr(VI) removal was achieved at pH 3 whereas 67.3% was removed within first few minutes, and reached its equilibrium within 20 min. The partitioning of Cr(VI) at equilibrium is perfectly matched with Langmuir isotherm and maximum adsorption capacity of the NZVI-Gn composite is 143.28 mg g^{-1}.

Atmospheric particulates and the associated pollutants can eventually deposit on ground surfaces as pollutant build-up and can subsequently be transported to receiving water bodies as pollutant washed-off during rainfall-runoff events. Kandy city is the second largest city in Sri Lanka situated in a valley at high elevation. The pollution of receiving waters has far reaching consequences as Kandy town is well-endowed with water resources including the Mahaweli River. As such,

degradation of water quality of Mahaweli River can have adverse consequences on its sensitive ecosystem. Additionally, they can have human health consequences as the river water is still been used for potable purposes. Hence, the objectives of the study are to monitor heavy metals and hydrocarbons attached to particulate matter around Kandy.

Table 1. Metal concentrations in selected samples

	Metal concentration, ppb							
Location	**Al**	**Cr**	**Fe**	**Ni**	**Cu**	**Zn**	**Cd**	**Pb**
Fire dept	13210	52	24589	31	100	2514	17	75
Police station	5693	21	11103	14	39	873	6	39
Railway station	4611	33	9382	19	35	461	1	41
IFS	3307	25	36052	13	13	152	1	8

MPhil/M.Sc. Students: Mr. Prasanna Kumarathilaka, Mr. Indika Herath, Ms. Sonia Mayakaduwa, Mr. Yohan Jayawardhana, Mr. Tharanga Bandara, Ms. Lakshika Weerasundara, Ms. Waruni Geethika Kumari, Mr. Subhashana Wijebahu, Ms. Udari Siriwardhane

Key publications

1) Vithanage M,*Mayakaduwa SS, Herath I, Ok YS, Mohan D (2015). Kinetics, thermodynamics and mechanistic studies of carbofuran removal using biochars from tea waste and rice husks. Chemosphere. DOI: http://dx.doi.org/10.1016/j

2) Vithanage M,* Rajapaksha AU, Bootharaju MS, & Pradeep T (2014). Surface complexation of fluoride at the activated nano-gibbsite water interface. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 462, 124-1301.

3) Rajapaksha AU, Vithanage M,* Ok YS, Oze C (2013). Cr(VI) formation related to Cr(III)-muscovite and birnessite interactions in ultramafic environment. Environmental Science and Technology 47:9722-9729.

From left: Mr. Indika Herath, Ms. Lakshika Weerasundara, Mr. Yohan Jayawardhana, Ms. Sonia Mayakaduwa, Dr. Meththika Vithanage, Mr. Tharanga Bandara and Mr. Prasanna Kumarathilaka

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Condensed Matter Physics & Solid State Chemistry

Condensed Matter Physics deals with the synthesis and characterization of technologically important novel solid state and quasi-solid state materials. Under theCondensed Matter Physics projectof the NIFS we focus on developing novel materials and devices for energy generation and utilization. Synthesizing novel solid polymer and quasi-solid polymer electrolytes and suitable cathode materials for Mg^{++} ion rechargeable batteries, fabricating and characterizing electrochromic display devices with novel intercalation materials, optimization of the cadmium sulfide layer for efficiency enhancement in thin film p-n junction CdS/CdTe solar cells, fabrication of low cost water filters from electro spun polymer nanofibres for removing bacteria and arsenic from drinking water are some of the sub-projects completed under the Condensed Matter Physics project during 2014-2015.

Rutile (TiO_2) is an important low cost mineral available in Sri Lanka. One of the important research findings from our work is the possibility of using a purified grade of TiO_2 as a multifunctional material. This material can be used as a cathode material for low cost, rechargeable magnesium ion (Mg^{++}) batteries, which has a great potential to replace the expensive lithium ion rechargeable batteries in the future. The possibility to use TiO_2 in Electrochromic Display Devices (ECDs) is another important research finding from our work.

Under our sub-project on electro spunnanofibres, we have used polymer nanofibresprepared by electro spinningsuccessfully to fabricate an antimicrobial water filter. These nanofibres, when functionalized with TiO_2, have the ability to remove Arsenic from contaminated drinking water quite effectively (Figure 1).

B.Sc. M.S., Ph.D. (Indiana, USA), D.Sc. (Wayamba, Sri Lanka). Recipient of the "Vidhya Nidhi" National Award (2004), Committee of Vice Chancellors & Directors (CVCD) Award (2010), the SLAAS General Research Committee (GRC) Award (2015) for research excellence and Presidential Award for research publications(2015). Professor Emeritus, University of Peradeniya (2015)

The world currently relies heavily on fossil fuels, such as oil (petrol, diesel, kerosene etc), coal and natural gas for its energy needs. Fossil fuels create massive pollution in the environment. They are non-renewable. In contrast, the many types of renewable energy resources, such as solar energy and wind energy are more eco-friendly and constantly replenished and will never run out. Sunlight, can be used for generating electricity using solar cells and solar panels.

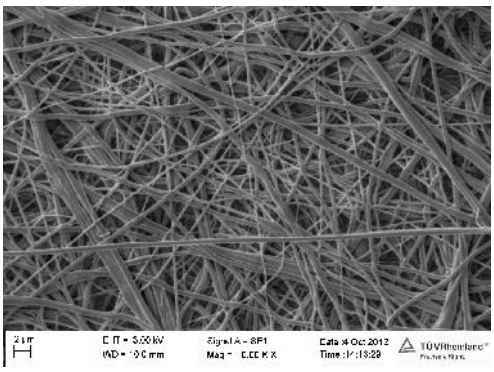

Figure 1: FESEM micrographs of an electrospun Cellulose Acetate polymer nanofibre membrane used to fabricate the antimicrobial water filter

At present, commercial solar panels are made from thin film silicon solar cells which are quite expensive to be used by the consumer. A low cost solar cell technology, currently undergoing extensive research is the dye-sensitized solar cell (DSSC) technology, which was invented by Michael Gratzel and Brian O'Regan in 1991. A typical DSSC consist of a wide band semiconductor such as TiO2, sensitized with a dye, a redox electrolyte and a Pt counter electrode (Figure 2).

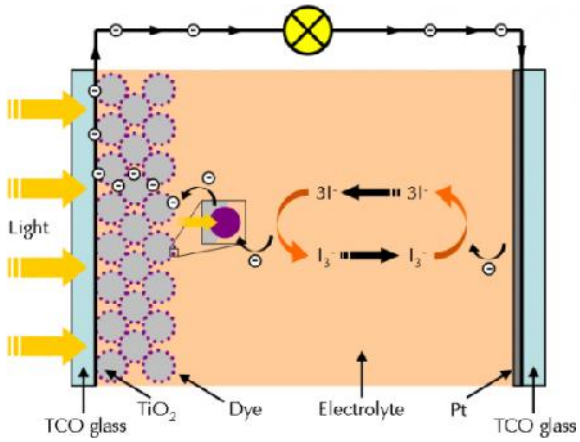

Figure 2: Schematic diagram of a dye sensitized solar cell

Conventionally used solution electrolyte-based dye-sensitized solar cells (DSSCs) can have efficiencies as high as 11 %, or even greater, but they often suffer from potential leakage and problems associated with electrode corrosion.

Even though the conversion efficiency of dye-sensitized PV cells is lower than that of some other thin-film solar cells such as silicon solar cells, their price to performance ratio is sufficient to make them an important player in the solar market, particularly in building-integrated photovoltaic (BIPV) applications.

Most of the present research on DSSCs worldwide is focused on enhancing the efficiency by improving spectral absorbance by making structural modifications in the photoanode, replacing the liquid electrolyte with solid state or quasi solid state (gel) electrolytes and improving the electron transport within the photoanode and the electrolyte.

Under the Solid State Chemistry project of the NIFS, during 2013-2015 period we have focused our research efforts on enhancing the efficiency of dye sensitized solar cells by several different approaches. Traditionally, in a typical DSSC with iodide/tri-iodide redox couple, the electrolyte is made with a single cationic iodide salt, such as potassium iodide (KI), or lithium iodide (LiI) or tetrapropylammonium iodide (Pr_4NI). One of the important research findings in this context from our recent work at NIFS is the enhanced efficiency when the electrolyte contains a mixture of two iodide salts, one with a small size cation such as KI and other with a bulky cation, such as Pr_4NI. This **"***mixed cation effect***"** has been observed in DSSCs with different binary iodide salt mixtures and it is well established now (Figure 3).

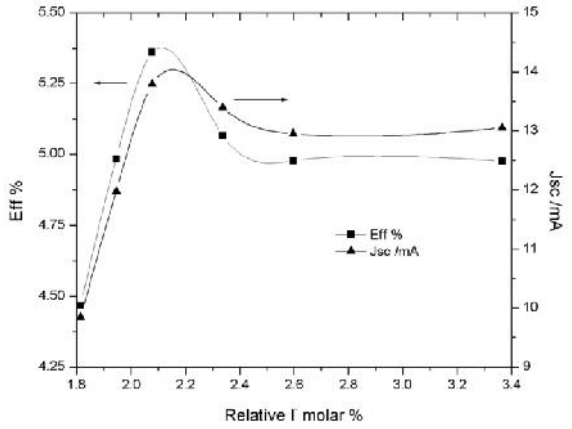

Figure 3. Variation of efficiency and current desnity with iodide ion molar ratio in the DSSC with PAN: EC:PC:KI+Pr_4NI, I_2 gel polymer electrolyte.

In one of our projects, we have been successful in designing fabricating an innovative type of three layer composite photo anode structure consisting of an electrospun TiO_2 nanofibre layer sandwiched between two TiO_2 nanoparticle layers. This three layer TiO_2 NP/NF/NP composite photoanode has been used successfully to enhance the efficiency of DSSCs by improved light harvesting. The increase in light harvesting is believed to be due to scattering of light within the composite photoanode structure (See figure below). The combined use of the TiO_2 three layer composite photoanode and the mixed cation iodide salt containing electrolyte has increased the solar cell efficiency from 5.38 % to 8.80% and represents an impressive overall efficiency enhancement by 64% compared to a corresponding DSSC made with TiO_2 nanoparticle (NP) photoanode and an electrolyte with

the single iodide salt Pr_4NI. A paper has been submitted for publication in an indexed journal (Figure 4).

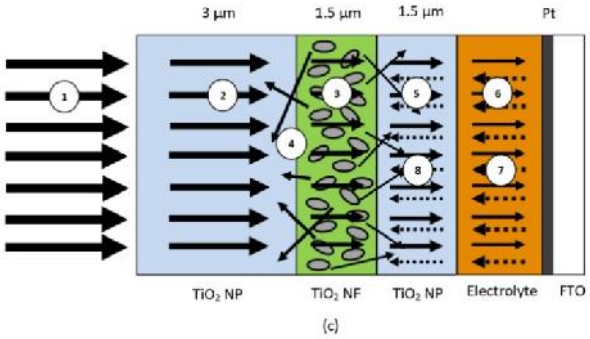

Figure 4. Schematic diagram of the TiO_2 NP/NF/NP three layer photoanode showing the enhanced light harvesting by multiple scattering effect.

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M.Sc. Students: A.A. Hasitha Jayanthirathne, D. Alakakoon

Key publications:

1) Dissanayake, MAKL, Thotawatthage CA, Senadeera, GKR, TMWJ Bandara, Jayasundera WJMJSR, MellanderB.-E . (2012). Efficiency enhancement by mixed cation effect in dye-sensitized solar cells with PAN based gel polymer electrolyte. J Photochemistry & Photobiology: A Chemistry, 246, 29–35.

2) Dissanayake, MAKL, Divarathnea, HKDWMNR, Thotawatthage CA, Dissanayake, CB, Senadeera, GKR, Bandara, BMR. (2014). Dye-sensitized solar cells based on electro spunpolyacrylonitrile(PAN) nanofibre membrane gel electrolyte. Electrochimica Acta 130 (2014) 76–81.

3) Dissanayake, MAKL, J. M. K. W. Kumari, G. K. R. Senadeera, C. A. Thotawatthage (2015). Efficiency enhancement in plasmonic dye-sensitized solar cells with TiO2photoanodes incorporating gold and silver nanoparticles. Journal of Applied Electrochemistry, 1-12, (DOI 10.1007/s10800-015-0886-03).

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Nanotechnology/Physics of Materials

The emerging fields of Nanotechnology and Physics of Materials are mainly responsible for most of the present technological advances in Advanced Materials. Already nanotechnology has created many new materials/devices for a vast range of applications. However, being in a developing country but rich with minerals resources, which can paly a major role in advanced/nano-materials based industry, we seriously mind these factors inherent to our country when adapting orcontributing to those scientific/technological advances.

Sri Lanka is well known for possessing a variety of economically useful minerals and related materials. However, higher value addition to these important natural resources has almost been lacking, due to dearth of advanced scientific research conducting in the country along this line. In the light of this, our project emphasizes on performing target oriented fundamental and advanced scientific investigations leading to develop Sri Lankan minerals and related materials for nano-technological and advanced industrial applications. Apart from that, we also involved with the exploration of low-cost but performance enhance novel advance semiconducting materials with special attention on energy conversion and storage applications. Going alone this line, within these first three years, we initiated and conducted target oriented fundamental and advanced research on three different areas:

Natural vein graphite; for the direct use in Li-ion rechargeable batteries, synthesis of graphite based nano-materials, structural modification to enhance ion intercalation for upcoming Na-ion, Mg-ion and their hybrid rechargeable batteries.

Advanced transition metal oxide semiconducting materials; synthesized by developing novel low-cost nano-technological methods and doping with cheaper additives, for electrode applications in fuel cells and rechargeable batteries.

Minerals and related materials for efficient water purification; by identifying novel candidate materials and developing the identified materials into more effective structures through structural modification, surface area enhancement, compositing, nano-particle formation etc

Athula Wijayasinghe obtained his LIC (Eng.) and Ph.D. in Materials Science from KTH (Royal Institute of Technology) in Sweden. Before joined the NIFS in 2013, he served in the Department of Materials Engineering in KTH, Electrochemical Materials Project in IFS and the Materials Technology program in Uva-Wellassa University

Nanotechnology/ Physics of Materials Project of NIFS commenced its work in January 2013. At present, the following three sub-projects, which emphasize on the basic and fundamental scientific aspects on advanced synthetic materials and advanced materials derived from Sri Lankan minerals are carried out under this project.

Investigation of ion intercalation in advanced materials derived from Sri Lankan graphite *(aiming for energy storage/nano-material applications)*

Primarily, investigations on deriving advanced materials out of Sri Lankan natural graphite are carried out under this sub project. Many specialized markets such as rechargeable batteries and nano-materials command premium prices for natural graphite.

Sri Lanka is the only commercial producer of vein graphite, which is the rarest and most valuable form of graphite. But it requires thorough upgrading of our graphite, carried out through comprehensive purification and modifications.

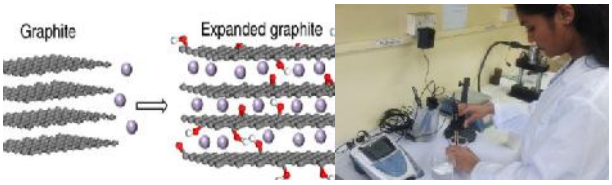
Collection of vein graphite from underground mines

Our project has so far invented several different purification methods resulting over 99.9% purity on all four different structural varieties of Sri Lankan natural vein graphite. These ultra-pure graphite varieties are further modified aiming to different advanced technological applications.

Under that, investigations are carried out on modification of graphite surface to be more electrochemically active, for the use in rechargeable Li-ion battery (LIB) electrodes. Accordingly, our recently developed needle platy vein graphite anode shows a reversible capacity of 378 $mAhg^{-1}$, which is even higher than the theoretically expected capacity of 372 $mAhg^{-1}$.

Raw graphite, Graphite electrode, LIB with our electrodes

Under a more advanced fundamental investigation, our ultra-purified graphite varieties are subjected to structural modification through expanding the lattice inter-planer space. Here, it is mainly concerned with the enhancement of ion intercalation/de-intercalation mechanisms of the expanded graphite. The preliminary aim of this work is to structurally modify our graphite suitable for upcoming Na-ion and Mg-ion batteries.



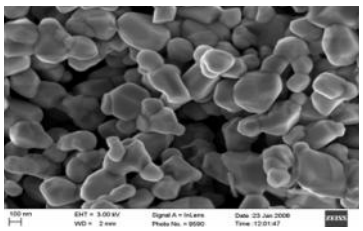
Inter planer expansion of vein graphite

Our recent investigations revealed a strong dependence of the degree of expansion on vein graphite variety and the oxidant used.

Study of mechanism and effect of dopants in advanced transition metal semiconductors *(aiming for energy storage/ conversion applications)*

This sub-project mainly emphasizes on developing advanced semiconducting materials through novel nano-material synthesis methods. For that, we have developed the low-cost wet chemical Glycine Nitrate Combustion (GNC) method to precisely control the size of the resulting powder particles into nano-scale. This finding is based on an investigation conducted to understand the effect of the composition of precursor on crystal growth.

G:N Ratio	0.2	0.4	0.6	0.8	1.0
Particle Size (nm)	78	68	64	62	58



Synthesis of nano particles by controlling Glycine:Nitrate (G:N) ratio in GNC process

Furthermore, fundamental and advanced scientific investigations are carried out to study the effect of dopents on enhancing electrical and electrochemical property in some important advanced semiconducting transition metal oxide systems.

The developed materials, which show promising characteristics are subjected to electrochemical studies through electrode fabrication and assembling into standard rechargeable cells.

Transition metal oxide systems developed with additives for the electrode application in novel rechargeable batteries

$Li(Ni_{1/3}Mn_{1/3}Co_{(1/3-x}M_x)O_2$, [M = Al, Fe, Mg, Ba, Na, Cu, Zn] for Li-ion battery cathodes

$NaNi_{0.4}Mn_{0.4}Co_{0.2}M_xO_6$ [M = Li, Mg, Ba, Ag, Al, Cu, Fe, Ti ..] for Na-ion battery cathodes

$Mg_{1-x}M_xO_2$, [M = Mn, Co ..] for Mg-ion battery cathodes

$MTiO_3$ [M = Mg, Na ..] for Na and Mg ion battery anodes

$Li(Ni_{1/3}Mn_{1/3}Co_{1/3})O_2$ cathode material shows a reversible capacity of 188 $mAhg^{-1}$, which is much higher compared to 127 $mAhg^{-1}$ of the expensive $LiCoO_2$ used in commercial Li-ion rechargeable batteries. Further investigations are carried out with the other developed

material systems intending for the novel Na-ion and Mg-ion rechargeable batteries.

Assembling and testing of batteries with our developed materials

Structural development of minerals and related materials *(aiming for efficient water purification)*

Though variety of potential local minerals have already being identified for water purification, conversion of these important research findings to practical use of efficient water purification is lacking in our country. A main reason behind this is the unsuitability to use our minerals directly as of the raw form in water filters

In addressing this, we recently initiated a fundamental materials scientific but targeted research project on developing these already identified potential materials into more effective structures for water purification, through structural modification, surface area enhancement, compositing, nano-particle formation etc.

Testing of our developed materials for water purification

M.Sc./M.Phil Students: S. Hewathilake, N. Karunarathna, N. Rathnayake, K. Heshan, T. Senevirathna, T. Pathirana, N. Rupasena

Key publications

1) Samarasingha P, Wijayasinghe A, Behm M, Dissanayake L, Lindbergh G, *Development of cathode materials for lithium ion rechargeable batteries based on the system* $Li(Ni_{1/3}Mn_{1/3}Co_{(1/3-x)}M_x)O_2$, *(M = Mg, Fe, Al and x = 0.00 to 0.33),* Solid State Ionics, 268 (2014) 226.

2) Rathnayake N, Hewathilake S, Wijayasinghe A, Pitawala A, Balasooriya N, *Development of expanded graphite from Sri Lankan natural vein graphite by chemical oxidation*, Proceedings, 2nd International conference on Nanoscience and Nanotechnology (2015).

From Left: Mr. WG Jayasekara, Mr. RICN Karunarathne, Dr. HWMAC Wijayasinghe, Mr. HPTS Hewathilake, Mr. GDK Heshan, Ms. RMNM Rathnayake, Ms. TC Senavirathna

Geophysics in Action

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Photochemistry

Photochemistry project involves mainly in the field of renewable energy research and the project focused its research on development of new materials for photoconversion of solar energy into chemical and electrical energies. The Photochemistry project also involves investigation of low cost water and air purification methods for abatement of industrial pollutants by using sunlight.

Efficient water splitting with solar light is one of the most promising technologies for solar hydrogen production. However, this is one of the problems considered as unresolved problems in Physical Chemistry field. There are three fundamental requirements for efficient water splitting; (a) sunlight must absorbed efficiently by light harvesting materials, (b) photoexcited electron and holes must be separated in space to prevent recombination, (c) photoexcited charge must be energetically and kinetically able to perform a chemical transformation. In Photochemistry Group at IFS, we investigate all three aspects.

Conversion of solar energy into electrical energy: (solar cells). The fundamental requirements (a), (b), (c) mentioned above apply for solar cell field and hence we investigate all these factors in our research.

Remediation of contaminated water and air: Pollution of water and air by waste chemicals is a major concern and photochemistry group carries out advanced oxidation technologies for the remediation of these pollutants.

Sonolyis of water: The accepted mechanism of sonolyis of water is questionable and we do experiments to understand and clarify the mechanism.

Water quality and the prevalence in CKDu in Rajarate area: In this project, the quality of drinking water to the prevalence of CKDu in the region was investigated.

Jayasundera Bandara obtained his Ph.D. from Swiss Federal Institute of Technology in 1999 and joined the NIFS in the same year. He was a Postdoctoral researcher at the Tufts University, USA and a George Foster Humboldt Research Fellow

The solar cells currently available in the market based on silicon material are very expensive. As an alternative to Si solar cell, dye sensitized solar cells (DSSC) has been introduced and the key material of DSSC is the large band gap oxide semiconductor such as TiO_2, ZnO, and SnO_2 decorated with light absorber dye molecules. In typical conventional DSSCs, randomly oriented TiO_2 nanoparticles were utilized as the oxide semiconductor material for dye adsorption and as an electron transport medium. Due to random orientation of nanoparticles, the electrons which are injected from the exited state of the dye molecules (HOMO) to the conduction band of the TiO_2 are moving in a random pathway which may result in higher charge carrier recombination reducing performance of the solar cell. In order to facilitate direct electron transport within the electron conducting material, 1-D nanomaterials such as arrays of nanotubes and nanorods etc. can be as they provide short direct pathways. In Photochemistry group of NIFS synthesis different 1-D nanostructures such as 1-D- TiO_2, SnO_2, ZnO as shown in Figure 1.

Figure 1. SEM images of 1-D TiO_2, SnO_2 and ZnO

These 1-D structures exhibit superior solar cell performance and the table 1 shows the present solar cell efficiencies an future targets.

Table 1. Solar cell performance

electrode	efficiency	target
$TiCl_4$-treated TiO_2 NT	7.6% (L/E) 5.5% (S/E)	10%
TiO_2 NT/NP	8.0%	<10%
ZnO NR	3.9%	10%

In a similar direction, conversion of solar energy into chemical fuels such as hydrogen is highly encouraged and it is an important area of research. TiO_2 is the most widely used photocatalytic material. Though TiO_2 is a highly stable photocatalyst with appropriate energy positions for water splitting reaction, practical use of TiO_2 is limited as it absorbs mainly high energy photons in the UV region of thesolar spectrum.

However, successful methods have not been reported to use the IR region of the solar spectrum for photolysis of water. Advantage of such a system is that IR waves are available from the sunset to sunrise and the solar spectrum consists of 47% IR radiation. We have recently developed Ag_2O/TiO_2 photocatalystthat utilizes IR region and produce hydrogen from water and water/methanol mixture. This is the first report on purely IR based photocatalyst and a possible photocatalytic mechanism is proposed as shown in Figure 2.

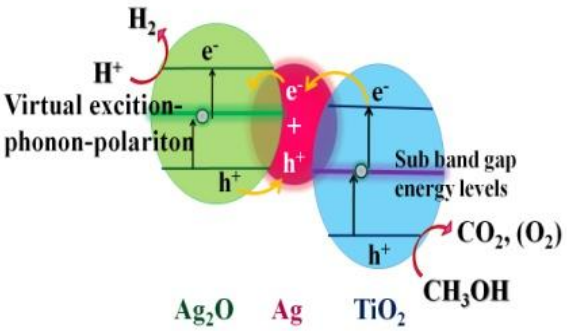

Figure 2. Schematic proposed photocatalytic process of $Ag_2O/Ag/TiO_2$ photocatalyst.

For the observed infrared photocatalytic activity of Ag_2O/TiO_2photocatalyst, a Plasmon assisted photocatalytic activity and/or a sub-band gap phonon-assisted multi-photon excitation mechanism are proposed. In the proposed ONF-phonon assisted process, the ONF generated at the nanostructures could excite the coherent phonons in the nanostructures forming virtual excition-phonon-polariton as shown in Fig. 2. These quasi particles can excite the electrons to the phonon level and successively to the CB. This type of multi-step excitation process is possible even the incident photon energy is lower than the band gap energy. Hence, the IR initiated catalytic activity of Ag_2O/TiO_2 photocatalyst could be mainly assigned to sub-band gap filling as it involves a multi-photon process as well as trapping and de-trapping of electrons and holes created by IR photon excitation.. However, we cannot totally exclude the surface Plasmon initiated reaction mechanism and hence further experiments are needed to distinguish the proposed reaction mechanisms.

Development of effective and inexpensive oil-water separation techniques for the cleaning of the oil polluted water is of highly demanding task as industrial oily wastewater is a worldwide problem. For the purpose of effective oil/water separation, a novel kind of superhydrophilic (underwater superoleophobic) filter is fabricated with naturally and hydrothermally treated mica particles. The double layered membranefilter consists of a stainless steel mesh on which a layer of hydrothermally treated mica particles are electrodeposited and the second layer of natural mica layer is sprayed on the first hydrothermally deposited mica layer.

The double layered membrane filter consists of a layer of electrodeposited hydrothermally treated mica particles and a second layer of spray deposited natural mica layer on on a stainless steel mesh. The mica coated membrane shows superamphiphilic and superhydrophilic/ superoleophobic (contact angle>159°) characteristic inand underwater respectively. The membrane can separate range of oil-water mixtures with oil/water separation efficiency of ~98-99%. Surface adhesion properties of mica is enhanced by the hydrothermal treatment of mica and the higher roughness of the mica layer is maintained by the natural mica.

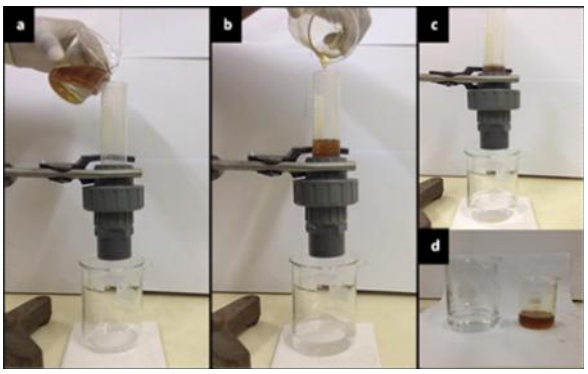

Figure 3. water/oil seperation process (a) complete setup for the separation (mesh fixed inside the union) (b,c) oil/water separation process (d) separated oil and water (right side - oil, left side - water).

A research project on chronic kidney disease of unknown etiology (CKDu) was commenced recently. The histopathological results clearly demonstrated that the mice fed with drinking water containing WHO recommended levels of Cd, F along with hardness, leading to early lesions similar to those of CKD. The toxicity effect of Cd-F, Cd-hardness, F-hardness or Cd alone on kidney is less pronounced than that of Cd,-F,-hardness combinationsuggesting a synergic effect among Cd,-F-hardness. Our investigation suggests existing of a synergic effect especially among Cd, F and hardness of water which could lead to kidney damage.

Ph.D. Students: A. Manjceevan, A. Anapayan, H.M.S. Wasana

M.Sc./M.Phil Students: K.M.S.D.B. Kulatunge, K.U.B. Gunatilka, K.C.I. Buddika, D.S. Dharmagunawordena, K.N.L..D. Silva, R.M.P. Wanigasekara, K.G.S.P.B. Samarakoon, A.M.B. Kulathunge, R.D. Senevirathne

Key publications

1) Wasana HMS, Aluthpatabendi D, Kularatne WMTD, Wijekoon P, Weerasooriya R, Bandara J, (2016). Drinking water quality and chronic kidney disease of unknown etiology (CKDu): synergic effects of fluoride, cadmium and hardness of water, *Environmental Geochemistry and Health*, 38, 157-168

2) Bandara J, Willinger K, Thelakkat M (2011). Multichromophore light harvesting in hybrid solar cells**,***Phys. Chem. Chem. Phys*., 13, 12906-11.

3) Gannoruwa A, Krishnan N, Ileperuma OA, Bandara J (2014). Infra-red active photocatalysis for water splitting, Inter. J. Hyd. Energ., 39, 15411-15415

From Left: Ms. DS Dharmagunawardane, Mr. KCI Buddika, Mr. A Manjceewan, Mr. KMSB Kulathunge, Mr. KUB Gunathilake, Mr, A Anapayan, Mr. KNLD Silva

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Renewable Energy, Natural Resources & Cleaner Environment

Sri Lanka, as a developing country, faces many challenges on its way to the future. Discovering, evaluating and development of the natural resources including renewable energy sources, efficient use of existing sources as well as maintaining of cleaner environment are some of the foremost challenges Sri Lanka faces. Our research projects are aiming to find ingenious solutions to some of those issues through basic and advanced research.

A project on geothermal resources of Sri Lanka aims to evaluate the geothermal resources with a view to utilise them for national development. As the first phase of the project, a comprehensive geophysical survey was conducted in the areas of known geothermal resources.

Geophysics can also be used in finding and evaluating of mineral resources. Although the general techniques are known, it is essential to develop a methodology to suit the specific conditions in each situation. A project to estimate the subsurface contents and exact boundaries of an economic mineral deposit was completed successfully with the financial support of the NSF. Geochemical and geological information can also be used in this context.

Thermoelectricity project was initiated with the objective to introduce this new area of research to Sri Lanka. Thermoelectric generators use “Seebeck Effect” to convert heat energy directly into electrical energy. One of the greatest and unique advantages of thermoelectricity is the ability to increase the overall efficiency of an existing system by ‘scavenging’ waste heat. Other advantages include the ability to operate with any source of heat and at any temperature range.

Electrochemical water purification is useful in cleaning the industrial effluents, especially organic contaminants. Development and optimisation of suitable anodes play a major role in this research. Anode stability, electrical consumption and efficiency are important factors to be considered.

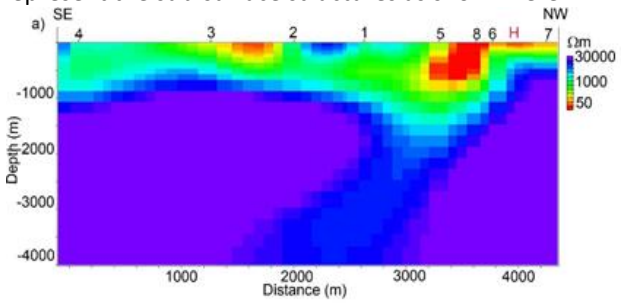
Deepal Subasinghe earned Ph.D. from University of Reading, England in 1999. He worked as a Senior Lecturer in Physics at the Open University of Sri Lanka from 2000-2003. He was a Postdoctoral researcher at the RMIT University, Australia from 2003 to 2009. He joined the NIFS in late 2009.

Geothermal Resource Mapping: World energy experts have long realized the importance of finding alternative and renewable energy sources to replace the non-renewable energy, especially fossil fuel. Dependence on fossil fuel for energy requirements makes us vulnerable to external pressures and we spend a huge amount of foreign exchange. Therefore, it is important to develop our own energy sources and reduce our dependence on imported fossil fuel.

As a pioneering project, the National Institute of Fundamental Studies (NIFS) initiated a project on mapping geothermal resources in Sri Lanka, in 2009. Sri Lanka, although not located on a highly active geothermal region, still has geothermal resources which may have a potential of generating electricity and contributing to the energy needs of the country.

As the first phase of the project, NIFS, in collaboration with few other institutes, conducted the first ever comprehensive geophysical survey. In this survey, passive and active geophysical techniques were employed to investigate the near-surface as well as deep structures of the earth. One of the non-invasive, passive geophysical techniques used in the survey was Magneto-Telluric (MT) technique. Time-Domain Electromagnetic (TDEM) is an active technique used in the survey. Without the need for drilling, above two techniques can provide information on geological structures, heat sources and water resources hidden under several meters to several hundred kilometers of the earth, if necessary. Since the MT equipments are very expensive, we requested the support of British group that brought the equipments on loan with experts on geophysics. The British experts offered their time, equipment and expertise free of charge, as a goodwill gesture.

We processed the data to produce resistivity profiles that represent the sub-surface structures as shown here.

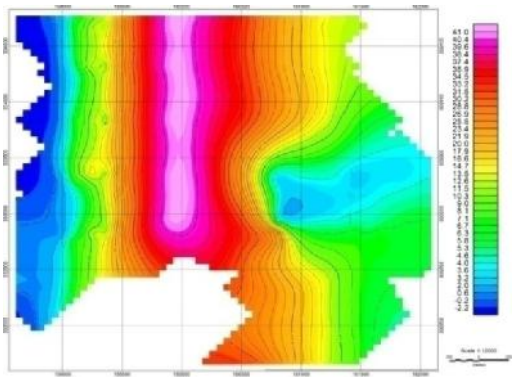


Resistivity profile across Kapurella thermal spring area.

Further investigations on geothermal resources of Sri Lanka are continued with geological, geophysical and geochemical tools available.

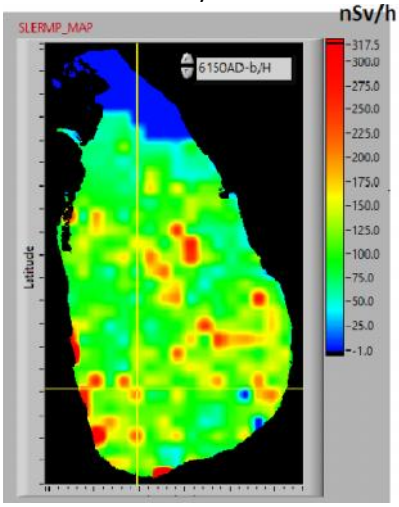
Estimating the extent of Eppawala Phosphate deposit: One of the major mineral resources in Sri Lanka is the phosphate ore at Eppawala. Although the mining and exploitation are done, no attempt has been made to estimate the extent of the deposit or determine the boundaries since the initial estimates made using bore holes, several decades ago.

In this project, modern geophysical techniques are employed to demarcate the phosphate body from the surrounding country rocks. Differences in magnetic signatures of the phosphate ore and the surrounding country rocks are the key to differentiate the two. Systematic mapping of the magnetic anormalies helped us to identify the boundaries of the phosphate ore. Our work also revealed that the phosphate deposit extends to areas much further than the areas known before. This project is funded by the National Science Foundation.



Magnetic anomaly map showing the boundaries of phosphate deposit at Eppawala.

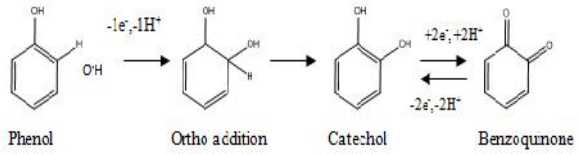
Radon Mapping Project: Radon is the single-most contributor to the natural radiation we are exposed to on earth. Level of radon changes due to many factors. For the first time in Sri Lanka radon monitoring programme was initiated in collaboration with the Atomic Energy Authority of Sri Lanka. With passive and active methods, natural radiation levels of are monitored and mapped around the country.



Natural background radiation levels in Sri Lanka

Electrochemical purification of waste water: This project which has now been successfully completed,focussed on developing suitable anode material to use in electrochemical purification of water. Phenol was selected as the model organic pollutant to be tested. Several combinations of potential electrode materials

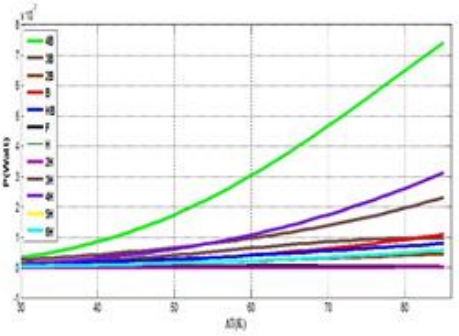
were tested and optimised. Electrodes made with $Ti/IrO_2–Sb_2O_3$ found to be the best in overall efficiency, cost, durability and stability. Reaction mechanisms were studied and the following mechanism is proposed for phenol oxidation.



Thermoelectricity Research: Although new to Sri Lanka, research on thermoelectricity is a fast growing area globally, mainly due to its ability to increase the energy efficiency of existing systems and to generate electricity from any source of heat, regardless of the temperature range. Some other advantages of thermoelectric generators (TEGs) are the scalability (from a large plant to nano-scale module), reliability and durability due to no moving parts. TEGs can scavenge heat energy and convert it to useful electric energy using thermoelectric effect, known as the *Seebeck* effect.

At NIFS, some low-cost TEGs are designed and tested using industrial grade components while new material are developed to increase the "figure of merit", which has direct connection to the overall output.

TEGs made using commercially available materials



Power output of different material compositions

M.Sc./M.Phil Students: D.R. Charles, K.V.P.B. Kobbekaduwa, P.B. Jayathilake (completed MPhil in 2015), S.A. Samaranayake
Ph.D. Students: T.B. Nimalsiri (completed MPhil in 2015)

Key publications

1) Nimalsiri TB, Suriyaarachchi NB, Hobbs B, Fonseka M., Manzella A, Dharmagunawardena HA, Subasinghe ND (2015). Structure of a low-enthalpy geothermal system inferred from magnetotellurics — A case study from Sri Lanka. *Journal of Applied Geophysics*, 117, 104–110.
2) Jayathilaka PB, Pathiraja GC, Bandara A, Subasinghe ND, Nanayakkara N (2015). Electrochemical oxidation of phenol on Steel/IrO2-Sb2O3 electrodes: a mechanisms study, *Canadian Journal of chemistry.* 93, 536-541.
3) Chandrajith R, Barth JAC, Subasinghe ND, Merten D, Dissanayake CB (2013). Geochemical and isotope characterization of geothermal spring waters in Sri Lanka: Evidence for a steeper than expected geothermal gradients. *Journal of Hydrology*. 476, (7) 360-369.

From left: S. Opatha, DR Charles, TB Nimalsiri, KVPB Kobbekaduwa, Prof. ND Subasinghe, PB Jayathilake, SA Samaranayake

Asiri Nanayakkara

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Single Bubble Sonoluminescence

Single-Bubble Sonoluminescence (SBSL) is observed when a single gas bubble, which is acoustically levitated in a liquid, undergoes nonlinear oscillations in synchrony with the applied sound field and emits sub-nanosecond flashes of light at the point of maximum implosion. As the bubble collapses, vibrational energy gets concentrated by at least a factor of 4x1011 to produce flashes of light in the UV range. These flashes of ultraviolet light have durations much shorter than a nanosecond. At the latter stages of the collapse, both the temperature and the pressure inside the bubble reach extreme values such as 20,000K and 3,500 atm respectively. Also the bubble wall reaches acceleration over 1011 g near the maximum implosion. SBSL is observed by only with the bubbles having ambient radii between 1 µm to 10 µm and during the collapse radii of these bubbles come down to 0.1 µm to 1µm.

The details of physical conditions and chemical processes in the bubble at the last stage of the bubble collapse have not been understood completely. The mechanism of the phenomenon of sonoluminescence is still unknown.

We investigate the physical conditions at the last stage of the bubble collapse in SBSL as well as the mechanism of light emission using theoretical and computational techniques as well as experimental methods.

Asiri Nanayakkara obtained his PhD from Iowa State University (USA) and has been a postdoctoral researcher at University of Bristol (UK), Ames laboratory(USA). He has also worked as a computational Scientist at CRAY Research inc. (USA) before joining NIFS.

We experimentally investigated the temperature dependence of intensity of single-bubble sonoluminescence (SBSL) in 85 wt %. sulfuric acid. It was found that the intensity increases as temperature increases from 15 °C and 25 °C, confirming what has been predicted by A. Moshaii et al. theoretically. This behavior, however, is completely opposite to what has been observed for water. Above 25 °C, the behavior of intensity of SBSL in sulfuric acid is found to be independent of the liquid temperature.

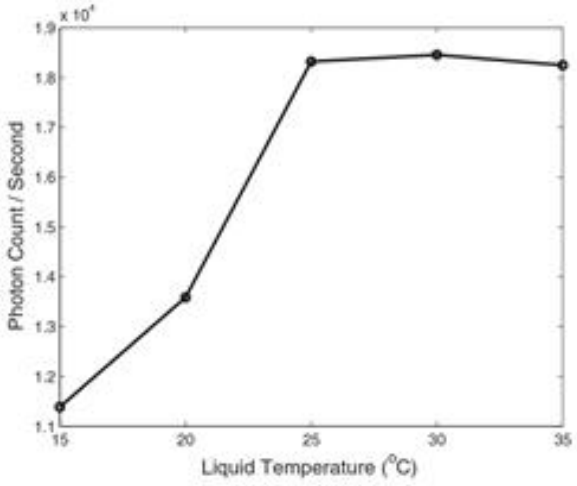

Figure 1. Number of photons detected per second by the PMT for five different temperatures.

Moreover, it was observed that as the temperature increases, contribution to total intensity from the UV portion of the spectrum increases while contribution from the visible portion decreases, indicating higher bubble temperatures at higher liquid temperatures.

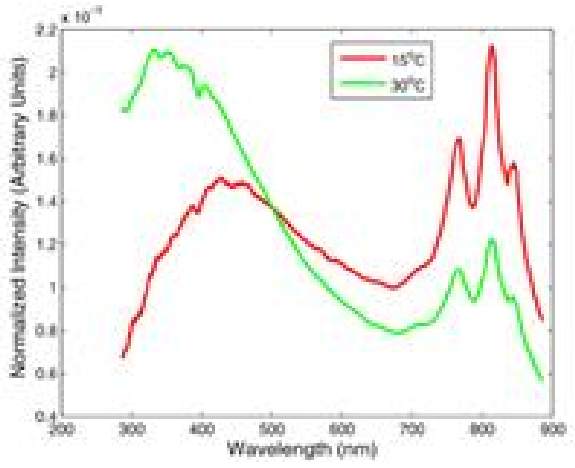

Figure 2. SBSL spectra of 85 wt % sulfuric for 15 °C and 30 °C. Ar emission lines are most prominent in 15 °C. Nevertheless, Ar emission lines are observed at all five temperatures: 15, 20, 25, 30, and 35 °C.

Results of this experiment further indicate that the intensity threshold at each temperature is not determined by the shape or the positional stability conditions as expected, but by the driving pressure at which the transition from SBSL to multibubble sonoluminescence (MBSL) takes place.

Reaction paths and barrier heights are useful in determining what reactions and reaction paths are favorable during the bubble collapse. This information will be valuable in determining chemical processes which are taking place inside the bubble at the collapse. In this project we use accurate electronic structure methods to construct potential energy surfaces and to calculate reaction paths and barrier heights of radical reaction which are relevant to SBSL. Reaction rates and mechanisms involving radicals SO and NO are studied using ab initio electronic structure methods (using GAUSSIAN 09) and transition-state theory calculations (using POLYRATE 2010) for the temperature range 200 K-2000 K.

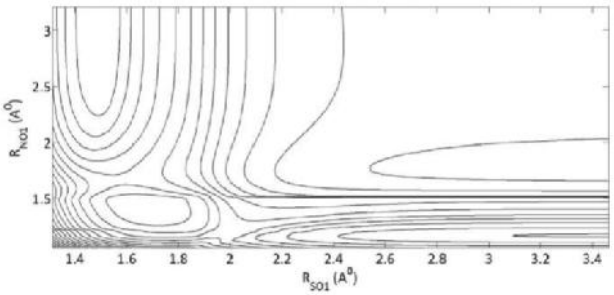

Figure 3. A potential energy contour plot for SO+NO-> S + NO_2 reaction. R_{NO1} and R_{SO1} are bond lengths of NO and SO respectively.

The rates calculated with variational transition state theory show that for the temperature range 200K - 2000 K, three parameter Arrhenius equation produces the most accurate reaction rates.

MPhil students: Mr. Prabhath Herath, Mr. Manoj Wijesingha, Ms. Vibodha Bandara

Key publications

1) Bandara V, Herath P, Nanayakkara A (2015). *"Temperature dependence of single-bubble sonoluminescence threshold in sulfuric acid: An experimental study"* Physical Review E 91, 063015

2) Wijesingha M, Nanayakkara A (2015). *"Determination of reaction mechanisms and rates involving SO and NO radicals"* Journal of Molecular Structure 1102: 275

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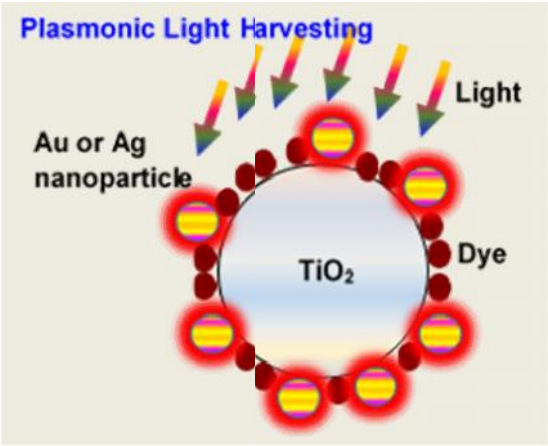
Condensed Matter Physics & Solid State Chemistry

Dr.Rohan Senadeerais a co- investigator of Condensed Matter Physics and Solid State Chemistry group of the NIFS in which, focuses its research activities on developing novel materials and devices for energy generation and utilization.



In one of the NIFS sub-projects carried out by the group, the use of gold (Au) and silver (Ag) nanoparticles (NP) incorporated into the TiO_2 photoanode has shown enhancement of the photocurrent of the DSSC by the surface plasmon resonance effect. The best conversion efficiency of the reference DSSC without Au and Ag NPs in TiO_2 was 5.12 % under the illumination of 100 mW cm^{-2} (AM 1.5). The efficiencies of plasmonic DSSCs after incorporating Au NPs and Ag NPs into TiO_2 were 6.23 % and 6.51% respectively. This represents an efficiency enhancement by about 21.6 % with Au NPs and 27 % with Ag NPs compared to the reference DSSC with pristine TiO_2 photoanode. The observed efficiency enhancement has been attributed to increased short circuit current density by enhanced light harvesting by the photo anode caused by the localized surface Plasmon resonance effect of the metal nanoparticles and faster electron transport within the TiO_2 photoanode as evidenced by the reduced electron life times which improves the electron collection efficiency.

In another sub-project, dye sensitized solar cells fabricated with nitrogen doped (N-doped) TiO_2 electrodes have been studied. A high conversion efficiency of 8.00% was achieved by the dye sensitized solar cells based on the N-doped TiO_2 electrodes while DSSCs with the undopedTiO_2 electrode had an efficiency of 4.22%. The enhancement in the photocurrent density of the N-doped DSSCs was 49% compared with undoped DSSCs. The significant enhanced efficiency of the devices was found to be related to the dye uptakes in N-doped TiO_2 electrodes and the efficient electron transport due to reduced charge transfer resistance.

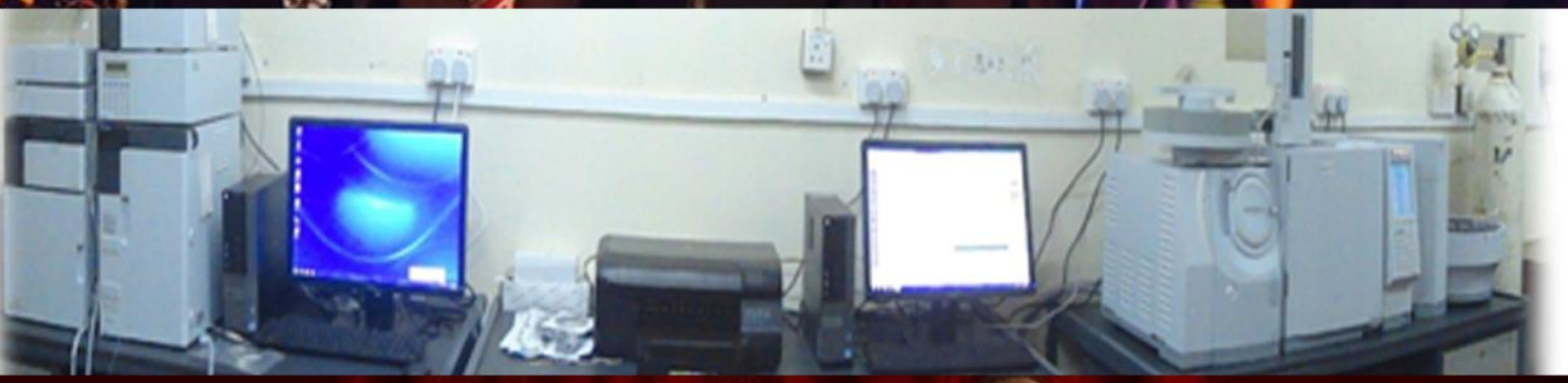
Senior Lecturer in Physics, The Open University of Sri Lanka; Served the NIFS as Associate Research Professor, prior to joining the OUSL in 2010; Postdoctoral Research Fellow, Tokyo Institute of Technology (1997/98) and Osaka University (2002/2003), Japan; Postdoctoral Research Fellow, New University of Lisbon, Portugal (2008).

Serpentine soil, Ussangoda

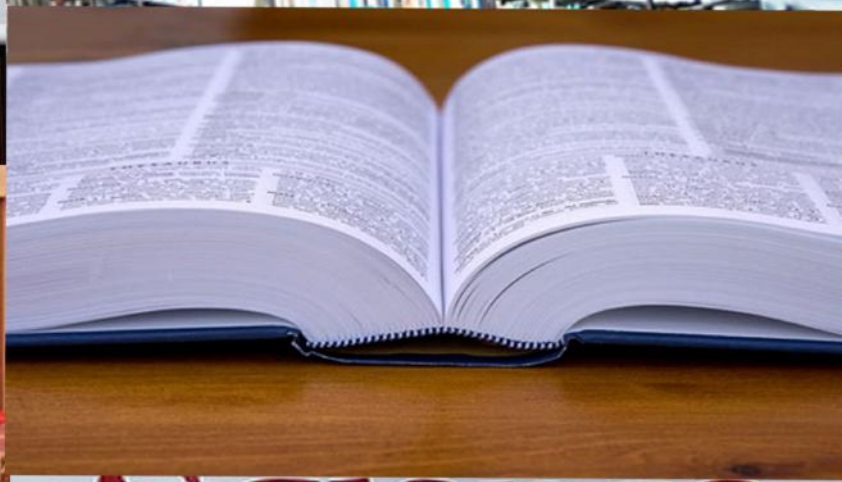
Academic Activities

Publications in Journals
Book chapters
Intellectual Properties
Publications in Conference Proceedings
Awards and Recognitions
Grants Received
Degrees
Equipment Development
Other Publications
Grants Received
Degrees
Post Graduate Students
Equipment Developments
Other publications

President's Awards for Scientific Publication



NIFS Scientist receives the 2015 SLAAS General Research Council Award



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Science Dissemination at Dambulla Aboretum

Intellectual Properties

Title: Detection of *rpo*B, *inh*A and *kat*G sequences of *Mycobacterium tuberculosis* complex

PI: Dr. Dhammika Magana-Arachchi

Country: Sri Lanka

Patent Number: 17423

This invention relates to in vitro diagnostic detection of pathogenic bacteria, and specifically relates to an multiplex assay and diagnostic kits comprising oligonucleotides to detect nucleic acid sequences associated with either wild type, multidrug and mono drug resistance (resistance to either rifampin or to isoniazid or both) of Mycobacterium tuberculosis complex isolates by using in vitro nucleic acid amplification of the rpoB, inhA and katG gene and detection of amplified products.

Title: Method for removal of antibiotics in water using steam activated biochar derived from burcucumber (*Sicyos angulatus* L.)

PI: Prof. Yong Sik Ok

Team: Dr. Meththika Vithanage, Dr. A. Rajapaksha, Mr. JE Lim

Country: Korea

Patent Number: 10-1536937

This invention relates to developing biochar from invasive plant species present in Korea to remediate antibiotics contaminated water. Different biochars produced at different temperatures by the burcucumber plant were successful in remediating sulfonamides from water.

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Rizliya V, Jayathilake C, **Liyanage R**. Analysis of Antioxidant and α-amylase inhibitory activity of ten commonly consumed Arurvedic plants available in local market in Sri Lanka, Sri Lanka Association for the Advancement of Science (SLAAS), Annual congress, 2015.

Samaranayake SA, de Silva SN, Dahanayake U, Wijewardane HO, **Subasinghe ND**. Feasibility of Finding Geothermal Sources in Sri Lanka with Reference to the Hot Spring Series and the Dolerite Dykes. Proceedings of the World Geothermal Congress April, 2015 Melbourne, Australia.

Samarasinghe SPRR, Alakolanga AGAW, Wickramaarachchi WART, **Kumar NS, Jayasinghe L.** In vitro antifungal activity of selected medicinal plants extracts against selected postharvest pathogens in fruits and vegetables. Annual Sessions, Uva-wellassa University, Jan. 2015.

Sayanthooran S, **Magana-Arachchi DN,** Gunarathne L, Abeysekera T. Gene Expression Profiles of Peripheral Blood to Understand Pathophysiology of Chronic Kidney Disease of Unknown Aetiology. 2nd International Conference on Advances in Medical Sciences (ICAMS), Kuala Lumpur, Malaysia; 04/2015. Pg 22. (Published in Research Updates in Medical Science Journal E-ISSN 2289-2141.

Sayanthooran S, **Magana-Arachchi DN**, Sooriyapathirana SDSS, Gunarathne L, Abeysekera T. Kidney Injury and Repair Related Gene Expression in Blood of Chronic Kidney Disease Patients with Unknown Aetiology. Postgraduate Institute of Science Research Congress 2015, Sri Lanka, Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka; 10/2015, p. 94.

Senanayake DMN, Igalavithana AD, **Seneviratne G**. (2015) The potential of biofilmed biofertilizers to reduce chemical fertilizer use in vegetable cultivation of Sri Lanka. Proceedings of the 1st International Symposium on Environmental Management and Planning, Water's Edge, Battaramulla, Sri Lanka, 23-24 February 2015.

Somarathna RMUM, Hewathilake HPTS, Rohitha LPS, Balasooriya NWB, **Wijayasinghe HWMAC**. Purity enhancement of natural flake graphite in Sri Lanka, Proceedings, 31st Technical Session of Geological Society of Sri Lanka, 2015, 27.

Sritharan T, **Kumar NS, Jayasinghe L**, Araya H, Fujimoto Y. Isocoumarins and dihydroisocoumarins from an endophytic fungus isolated from the fruits of *Averrho acarambola.*Proceedings of the Peradeniya Univ. International Research Sessions, Sri Lanka (iPURSE), 19, 359.

Sritharan T, **Kumar NS, Jayasinghe L**. Bioactive secondary metabolite from an endophyte isolated from *Carica papaya* fruits, *PGIS Annual Congress* – 10th Oct. 2015.

Thanabalasingam D, **Kumar NS, Jayasinghe L**. Phenazine derivatives from fungal endophytes *Nigrospoaoryzae* isolated from *Cocciniagrandis* leaves, *PGIS Annual Congress* – 10th Oct. 2015.

Wanigatunge RP, **Kulasooriya SA, Magana-Arachchi DN**. Removal of cyanobacterial cells and microcystin in water using extracts of *Moringa oleifera* seeds. Fourth International Symposium on Water Quality and Human Health: Challenges Ahead. Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka. P.28. 08/2015.

Wasana HMS, **Bandara J**. Chronic co-exposure effect of environmental toxins in drinking water for the epidemics of chronic kidney disease of unknown etiology (CKDu); toxic synergy effect of heavy metals, F and hardness, Postgraduate Institute of Science Research Congress, Sri Lanka, Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka; 10/2015

Watawana MI, Jayawardena N, Gunawardhana CB, **Waisundara VY**. Value-addition & therapeutic enhancement of king coconut water (*Cocos nucifera var. Aurantiaca*) by fermentation with Kombucha 'tea fungus'. 5 – 6 Nov 2015, University of Peradeniya International Research Sessions (iPURSE), Peradeniya, Sri Lanka.

Watawana MI, Jaywardena N, Ranasinghe SJ, **Waisundara VY**. Evaluation of the effect of three starter cultures on the antioxidant activity & phenolic content of Kombucha beverage. 23 Oct 2015, Annual Sessions of the Sri Lanka Society of Microbiology, Oak Ray Regency, Kandy, Sri Lanka.

Watawana MI, **Waisundara VY**. Enhancement of polyphenols, antioxidant & starch hydrolase inhibitory activities of ten edible plants by Kombucha (tea fungus) fermentation. 14 – 18 May 2015, 12th Asian Congress of Nutrition, Yokohama, Japan.

Watawana MI, **Waisundara VY**. Evaluation of the antioxidant activity, polyphenol contents and starch hydrolase inhibitory activities of fermented coffee. 24 – 26 June 2015, 14th ASEAN Food Conference, SMX Convention Center, Mall of Asia, Pasay City, Philippines.

Wathukarage A, Deepika T, **Iqbal MCM**. Phytoremediation potential of water lettuce (*Pistia stratiotes*) to remove crystal violet dye in aqueous solution, In 20th International Forestry and Environment Symposium-University of Sri Jayewardenpura, Nugegoda, 16th - 17th October 2015.

Wathukarage A, **Iqbal MCM**, Priyantha HMDN, **Vithanage M**. Decolourization of crystal violet synthetic dye from aqueous solution by woody biochar, In Peradeniya University International Research Sessions, University of Peradeniya, 5th - 6th November 2015.

Weerasekera D, **Magana-Arachchi DN**, Madegedara D, Dissanayake N, Thevanesam V. Major circulating Mycobacterium tuberculosis strains and their genetic diversity in three population groups in the Central Province, Sri Lanka -2nd International Conference on Advances in Medical Sciences (ICAMS), Kuala Lumpur, Malaysia; 04/2015. Pg 39. (Published in Research Updates in Medical Sciences Journal. E-ISSN:2289-2141)

Weerasinghe AMJ, **Dissanayake MAKL**, **Senadeera GKR**, Senevirathne VA, Thotawatthage CA, Kumari JMKW. Dye sensitized solar cells fabricated with polymer free quasi solid state (gel) electrolyte; Conference: Ruhuna International science and Technology Conference, University of Ruhuna Sri Lanka (2015)

Weerasundara L, **Vithanage M**, Ziyath AM, Goonetilleke A. Heavy metals in atmospheric deposition in Kandy City; Implications for urban water resources, 6th International Conference on Structural Engineering and Construction Management 2015, Kandy, Sri Lanka, 11-14 December 2015.

Wijepala P, **Seneviratne G**, Madawala HMSP, Jayasuriya KMGG. Effect of microbial exudates on breaking dormancy of soil microbial seed bank. International Postgraduate Research Conference 2015, University of Kelaniya, Kelaniya, Sri Lanka. 12/2015.

Wijesingha M, **Nanayakkara A**, Weerasuriya R. Postgraduate Institute of Science Research Congress, Sri Lanka, Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka; 10/2015.

Wijesinghe WMKEH, Awanthi WT, Dissanayake DMREA, **Iqbal MCM**. Biosorption of Pb(II) using Trigonosporaobtusiloba. Symposium Abstracts, 4th International Symposium on Water Quality and Human Health: Challenges Ahead, Sri Lanka, 2015, p 29.


Lichen and Moss Sampling for Atmospheric Pollution Monitoring

Awards & Recognitions

Dr. DN Magana-Arachchi delivered an invited speech at the MMDR-5 5th International Symposium-cum-Training Course on Molecular Medicine and Drug Research, International Centre for Chemical and Biological Sciences, University of Karachi, Pakistan, 11-16, January, 2015.

Dr. GKR Senadeera received a position to serve as a member of the Editorial Board of the Journal of Solar Energy Research Updates, Awanti Publishers (2015)

Dr. GKR Senadeera received Presidential Award for his scientific publications in the year 2013, on 18th November 2015.

Dr. GKR Senadeera received University Research Award for 2014, The Open University of Sri Lanka on 19th November, 2015.

Dr. Meththika Vithanage received a position to serve as a member of the Editorial Board of the Elsevier Journal of Groundwater for Sustainable Development (2015)

Dr. Meththika Vithanage received Presidential Award for his scientific publications in the year 2013, on 18th November 2015.

Dr. Meththika Vithanage served as a Member of the Board of Governors, Atomic Energy Authority (2015)

Dr. Meththika Vithanage was elected as a Steering committee member – Young Scientists Forum, National Science and Technology Commission, Sri Lanka (2015)

Dr. Viduranga Waisundara received an award for the outstanding contribution in reviewing by the Life Sciences journal, Elsevier B.V., Amsterdam, Netherlands

Dr. Viduranga Waisundara was invited as the quiz master of the Food Quiz Bowl Competition of the 14th ASEAN Food Conference from 24 – 26 June 2015 in Pasay City, Philippines

Dr. W Dittus delivered an invited speech on Lessons from Monkey behavior at Sri Lankan Veterinary Association, University of Peradeniya, 28th October, 2015.

Dr. W Dittus delivered an invited speech on Lessons in accounting and life from Monkeys at Sri Lanka Association for Charted Accountants, April, 2015.

Dr. W Dittus delivered was an invited speaker on critical habitats for the conservation of evolutionary significant units of biodiversity among Sri Lankan primates and other mammals at the National Symposium on Biogeography and Biodiversity Conservation in Sri Lanka in a Changing Climate, 12-13 November, 2015.

Dr. W Dittus received Presidential Award for his scientific publications in the year 2013, on 18th November 2015.

Dr. W Dittus was an invited speaker on History of Sri Lanka at Smithsonian Journeys, June, 2015.

Mr. Prasanna Kumarathilaka delivered an invited talk on E-Waste Management, TALENT soft 2015 program, Advance Technological Institute, Kandy, 04th October, 2015.

Ms. DK Weerasekera – Research Assistant attached to the NIFS Cell biology Project won the Best Poster Award at the 2nd International Conference on Advances in Medical Sciences; 14th-16th April 2015, Malaysia

Ms. Kalpani Wasana Kumari, Research Assistant attached to the NIFS Condensed Matter Physics and Solid State Chemistry Projects has won the Best Poster Award at the 5th International Conference on Functional Materials and Devices held in Johor Bahru, Malaysia from 4th to 6th August 2015.

Prof. J Bandara received a position to serve as a member of the Editorial Board of the Progress in Photovoltic (Wiley Science) and Journal of Solar Energy (Hindawi) (2015).

Prof. J Bandara was the recipient of Turkish Government Research Fellowship in 2015.

Prof. L Jayasinghe received Alexander von Humboldt Research Fellowship to conduct research work at Jacobs University of Bremen, Germany, September-November, 2015.

Prof. MAKL Dissanayake received a Presidential Award for his scientific publications in the year 2013, on 18th November 2015.

Prof. MAKL Dissanayake served as the Consultant for Physics subject revision for the Eastern University of Sri Lanka (2015). This was funded and administered by the Higher Education for the Twentieth Century (HETC) Project of the UGC.

Prof. MAKL Dissanayake was an Invited Speaker at the 5th International Conference on Functional Materials and Devices organized by University of Malaya, Kuala Lumpur and held in Johor Bahru, Malaysia from 4th to 6th August 2015. He delivered an invited presentation on "*TiO_2 as a multi functional material*"

Prof. MAKL Dissanayake was awarded the General Research Committee (GRC) Award of the Sri Lanka Association for the Advancement of Science (SLAAS) in 2015. This award has been instituted by SLAAS to recognize Sri Lankan Scientists who have carried out exceptionally high quality research/pioneering research in Sri Lanka over a period of time and the award is given for the total research contribution of a scientist rather than for his/her contribution to a single research project.

Prof. MCM Iqbal received Presidential Award for Scientific Publications in the year 2013, on 18th November 2015.

Prof. ND Subasinghe received Presidential Award for Scientific Publications in the year 2013, on 18th November 2015.

Prof. NS Kumar delivered an invited lecture on Indigenous medicinal plants of Sri Lanka: A cultural heritage for development at the International Symposium on Science and Technology for Culture, Cambodia, May 15-17, 2015.

Prof. SA Kulasooriya delivered a Key Note Speech at 4th Annual Conference and Scientific Sessions, Sri Lankan Soceity for Microbiology, Kandy, 23rd October, 2015.

Prof. SP Benjamin Dr. GKR Senadeera received Presidential Award for his scientific publications in the year 2013, on 18th November 2015.

Prof. SP Benjamin was invited as a Key Note Speaker of the 3rd Conference of the Asian Society of Arachnology, Amravati, India.

Grants Received

Research Grants

Dr. HWMAC Wijayasinghe (PI). NRC grant 15-007 Development of Sri Lankan graphite for rechargeable batteries, 2.4 million LKR (2015-2018)

Dr. Meththika Vithanage (Individual Grant). International Foundation for Science (IFS, Sweden) –W/5068-2 for the Hospital Wastewater monitoring research (2 years) 11195 USD=1,589,690 LKR (2015-2017)

Dr. Meththika Vithanage (PI). NRC Research grant for the Potential use of municipal solid waste derived biochar as a cover and permeable reactive barrier material for the remediation of volatile organic compounds in landfills– Grant number (NRC 15-24) 2,085,000 LKR (2015-2017)

Dr. RR Ratnayake (PI). Equipment grant by NSF for High Performance Liquid Chromatograph , 4.5 million LKR (2015-2016)

Dr. Suresh Benjamin (PI). NSF competitive research grant on Diversity of crab spiders of Sri Lanka based on morphology and DNA barcodes, 3,988,600 LKR (2015-2018)

Prof. L Jayasinghe (Collaborator). NSF grant on a comprehensive study on the anti-inflammatory and antimicrobial secondary metabolites in selected medicinal plants (2015-2018)

Prof. L. Jayasinghe (Collaborator) NSF grant on optimization of the processing parameters used in the traditional sesame oil production unit ('sekku') and in the screw-press oil expeller used in Sri Lanka (2015-2018)

Prof. MAKL Dissanayake (Co I). Grant from the Swedish Research Council for a collaborative research on dye sensitized solar cells, 12,000 USD=1,704,000 LKR (2015-2017)

Prof. MCM Iqbal and Dr. Meththika Vithanage (Co-I). NRC Reseach grant on historical trands in averages and extremes of rainfall, temperature and runoff data of Sri Lanka, 2 million LKR (2015-2017).

Prof. ND Subasinghe (PI). Grant from the NRC on Development of Thermoelectricity Devices, 3,283,750 LKR (2015-2018) Co-I Dr. HWMAC Wijayasinghe

Other Grants

Dr. CI Clayton received a travel grant to attend the 3rd Conference of Asian Society of Arachnology, Amravati, India. Nov 16-19, 2015.

Mr. CA Thotawatthage received a grant by the NSF OTPS and Swedish Research Council for a training at Chalmers University, Sweden from June to September, 2015.

Mr. Indika Herath received traveling and other expenses by the King Saud University to carry out research work from December, 2015 to February, 2016.

Mr. SMPR Kumarathilaka received traveling and other expenses by the King Saud University to carry out research work from December, 2015 to March, 2016.

Ms. HNM Sarangika received a grant by the NSF OTPS and University of Malaya for a training at Center of Ionics, University of Malaya, Malaysia from November to December, 2015.

Ms. Mindani I. Watawana received the ACN Travel Award to attend the 12th Asian Congress of Nutrition from 14 – 18 May 2015 in Yokohama, Japan.

Ms. UGSL Ranasinghe received a travel grant by National Science Foundation to attend the 3rd Conference of Asian Society of Arachnology, Amravati, India, Nov 16-19, 2015.

Ms. UGSL Ranasinghe received a travel grant to attend the 3rd Conference of Asian Society of Arachnology, Amravati, India. Nov 16-19, 2015.

Ms. UGSL Ranasinghe received partial bursary received to attend the 6th Student Conference on Conservation Science, Banglore, India.

Ms. SA Samaranayake received a training on Geothermal Systems at the United Nations University, Iceland for 7 months in 2015.

Ongoing Grants

Dr. HWMAC Wijayasinghe (Co I) received a grant for purification of Sri Lankan natural vein graphite for novel technological application by University Grant Commision for 2 years, 3,695,000 LKR (2014-2016).

Dr. Meththika Vithanage received a research grant for biochar for pesticide remediation, Ministry of Technology and Research, Sri Lanka, 5,000,000 LKR (2013-2016).

Dr. Meththika Vithanage received a research grant for the Quantitative assessment of potential human and ecosystem health risks imposed by atmospheric particulates in Kandy, Sri Lanka, by National Science Foundation, 3,900,000 LKR (2014-2016).

Dr. Meththika Vithanage received an equipment grant as a Core member of the JICA-JST grant for Solid Waste Management with University of Peradeniya, 37,000,000 LKR (2011-2016).

Dr. R Liyanage received a research grant for development of household food security models for poverty stricken areas of Sri Lanka by National Science Foundation for 3 years, 3,000,000 LKR (2013-2016).

Dr. RR Ratnayake received a grant for Government of Sri Lanka Presidential Scholarships for Foreign Students - 2013/14 by Ministry of higher education, 1,910,000 LKR (2013-2017).

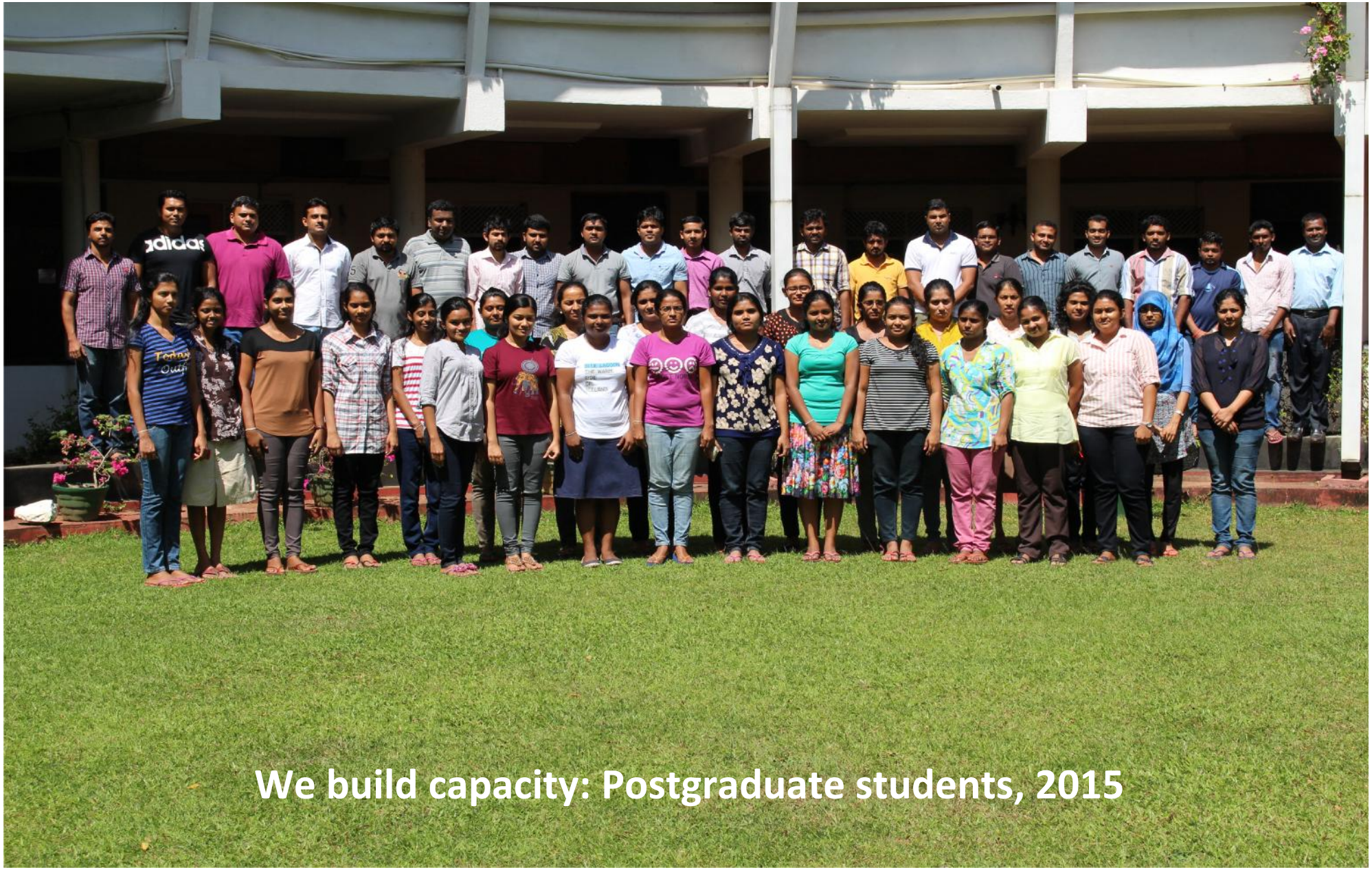
Dr. RR Ratnayake received a research grant for biofuel and other microbial products from cellulosic biomass by National Research Council for 3 years, 5,945,000 LKR (2012-2015).

Dr. VY Waisundara received a research grant for in-vitro array guided identification of functional food from Sri Lankan plant products by National Research Council for 3 years, 5,540,000 LKR (2014-2017).

Prof. J Bandara received a research grant on design of a biological and advanced oxidation technology reactor for oil water treatment by National Science Foundation for 3 years, 2,380,000 LKR (2014-2016).

Prof. MAKL Dissanayake received a research grant for optimization of Cds layer for efficiency enhancement in Cds/CdTe solar cells by National Science Foundation for 3 years, 2,800,000 LKR (2012-2015).

Prof. ND Subasinghe received a research grant for the estimation of subsurface extension of Eppawala apatite deposit and its parent rock using geophysical techniques by National Science Foundation for 3 years, 2,114,995 LKR (2012-2015).



We build capacity: Postgraduate students, 2015

Degrees Completed in 2015

- J Akilavasan, Ph.D., Different surface treatments of hydrothermally synthesied titania nanotubes for the improvement of the dye sensitized solar cells, University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. J Bandara** & Prof. RMG Rajapakse

- A Gannoruwa, M.Phil., Development of an IR active photocatalyst based on silver oxide and titanium dioxde nanocomposite, University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. J Bandara** & Prof. OA Ileperuma

- Anapayan, M.Sc., Synthesis and characterisation of Cu_2ZnSnS_4 thin films, University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. J. Bandara** & Prof. P. Samarasekara

- HMSKH Bandara, M.Phil, Isolation, structures and biological screening of metabolites from *Aspergillus niger* associated with *Musa* sp. University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. Lalith Jaysinghe** & **Prof. N Savitri Kumar**

- DS Jayaweera, M.Phil., Chemistry and Bioactivity of some edible seeds, University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. Lalith Jaysinghe** & Prof. BMR Bandara

- AAGW Alakolanga, M.Phil, Chemistry and Bioactivity studies of *Flacourtia inermis* and *Punica granatum.* University of Peradeniya, Sri Lanka, 2015.
  Supervisors: **Prof. N Savitri Kumar & Prof Lalith Jaysinghe**

- DK Weerasekara, M.Phil, Molecular Epidemiology studies of tuberculosis in three distinct population groups using optimized MIRU-VNTR typing system & spoligotyping. University of Peradeniya, Sri Lanka 2015.
  Supervisors: **Dr. DN Magana-Arachchi**

- MMSN Premathileke, Ph.D., Soil carbon sequestration in Eucalyptus grandis plantation forests of Sri Lanka along a chronosequence of forest age, University of Peradeniya, Sri Lanka, 2015.
- Supervisors: **Dr. RR Ratnayake & Prof. SA Kulasooriya**

- TB Nimalsiri, Mphil, Characterization of thermal springs in Sri Lanka: A combined geological, geophysical and geochemical approach, University of Peradeniya
  Supervisors: **Prof. ND Subasinghe**

- PB Jayathilake, M.Phil. (2015), Anodic oxidation of phenol in contaminated water on dimensionally stable anode. Post Graduate Institute of Science, University of Peradeniya.
  Supervisors: **Prof. ND Subasinghe**, Dr. N. Nanayakkara, A. Bandara

- Udari Siriwardana, M.Sc in Environmental Science (2015), Characterization of dissolved organic carbon in Gohagoda landfill leachate. Post Graduate Institute of Science, University of Peradeniya.
  Supervisors: **Dr. Meththika Vithanage**, Prof. BFA Basnayake

- Niroshan Karunarathna, M.Sc. in Physics of Materials (2015), Synthesis and characterization of PAN based gel polymer electrolytes (GPE) and anode/cathode materials for Na-ion batteries, Post Graduate Institute of Science, University of Peradeniya.
  Supervisors: **Prof. M.A.K.L. Dissanayake & Dr. A. Wijayasinghe**

- C Jayathilake, M.Sc. (2015), Determinants of total phenolic content and antioxidant activity of Tricosanthes cucumerina areal parts, University of Peradeniya
  Supervisors: **Dr. R Liyanage,** Dr. N Rajapaksha

Supervision of Postgraduate Students

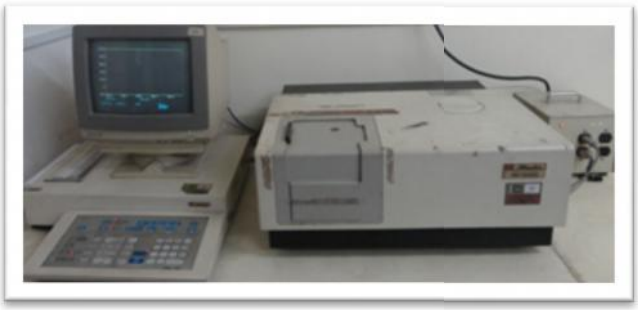
The postgraduate education is considered to be imperative as it provides the opportunities to build the research capabilities and enhance academic reputations whereas the postgraduate supervision is believed to be the cornerstone of an academic career. The success and quality of post graduate education largely depends on effective and efficient supervision of postgraduate students. In this process, the supervisor is designated to facilitate the research. As the expectation of high quality postgraduate supervision is increasing, the supervisory role is becoming more challenging. Due to the excellence in supervision, instruments and hard work most postgraduate students are now reaching high merit research with outstanding quality publications. Postgraduate supervision provides better support for improving research, maintain high caliber in ethics, inspirate, timely completion, retention rate, student satisfaction, research environment and administrative support services. The role of the supervisor plays a crucial role to the overall satisfaction, retention and completion of postgraduate research degrees.

Here, we provide an excellent facilities and supervision to conduct high caliber postgraduate research. This caters the image of NIFS to be so fascinating.

Equipment Facilities & Developments

Newport AAA solar simulator

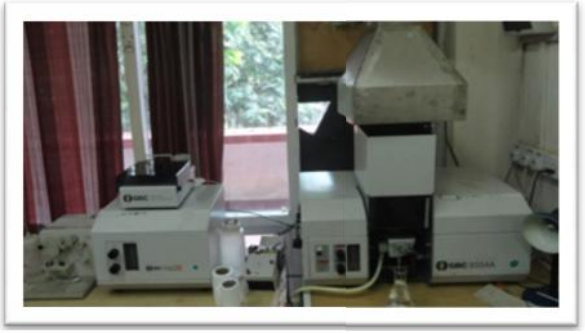
Gas Chromatoraph-Mass Spectroscopy



Spectrofluorometer

High Pertomance Liquid Chromatogrph

Gas Chromatograph

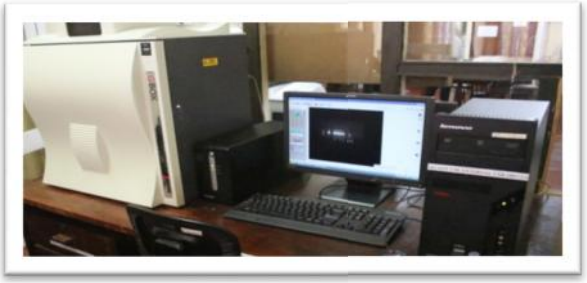


Atomic Absorption Spectrophotometer

Fuorier Transform Infra-Red Spectroscopy

TOC/TN Analyzer

Real Time PCR System



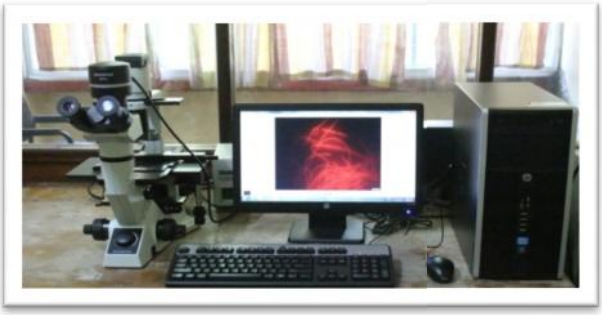
Gel Documentation System

Nabond nanofiber electrospinning unit

Bentham Photovoltaic Characterisation

Anaerobic work station

Ion Chromatography



Inverted microscope

Microwave Digestion System

Resisitivity Instrument

Glove box

Kjeldahl System

CO_2 Incubator

Other Publications

Newspaper articles

Bandara T, Vithanage M. *"Methane hydrate" mahasayura thula sangaunnu balashakthi prabhawaya.* (Methane hydrate - hided energy ore in the ocean) 27th May 2015. **Vidusara**.

Bandara T, Vithanage M. *Saagara sampath wanasana sthaai kaabanika sanyoga* (Ocean resource depletion agent - Stable organic compound) 11thFebruary 2015. **Vidusara**.

Benjamin S.P, Piyathilaka P," *Not quite an ant" – The discovery of the antlike jumping spiders of Sri Lanka*. 27th June 2015. **Sunday Observer**

Jayawardhana Y, Vithanage M. *Parisarayatath janajeewithayatath haniyaknowana lesa kasla bahara karanna GIS thaakshanaya* (GIS technology for sustainable practices of waste landfill selection) 13th March 2015. **Dawasa**.

Kulasooriya S.A, Piyathilaka P, *Aswenna wedi karana jaiwa pohora menna* (Bio Fertilizers made in Sri Lanka which increases the yield in rhizobium crops). 16th August 2015. **Mawbima**.

Kulasooriya S.A, Piyathilaka P, *How to reduce chemical fertilizer – Way forward for sustainable Crop production*, 15th September 2015. **Daily Mirror**.

Kulasooriya S.A, Piyathilaka P, *Ranila boga wala aswenna wedi karana Sri Lankawe nishpaditha jaiwa pohora* (Bio Fertilizers made in Sri Lanka which increases the yield in rhizobium crops) 19th August 2015. **Vidusara**

Kumarathilaka P, Vithanage M. *Bemata sudusu diyabindak labeida?* (Will water suitable for drinking in future?) 06th October 2015. **Wijeya**.

Kumarathilaka P, Vithanage M. *Pirameedaya pilibanda puwathakin yali avilunu rathu grahayage jeewaya pilibanda kuthuhalaya* (Pyramid on Mars – is it proof of an ancient civilization?) 08th July, 2015. **Vidusara**.

M Vithanage, VY Waisundara. 22 March Establishing an R&D Culture in Sri Lanka. **Sunday Times** (Sri Lanka). 2015 (www.pressreader.com/sri-lanka/sunday-times-sri-lanka/20150322/284112089857402/TextView).

Nanayakkara A , Piyathilaka P, *Minis sithiwili magin upakarana palanaya kirima ape ratedith yatharthayak wana lakunu* (Controlling equipment by mind is not a dream to sri lanka). 28th Octomber 2015. **Vidusra**

ND Subasinghe. *Radon Wayuwa*. Nawayugaya Magazine, February, 2015.

Piyathilaka P, *Paasal vidya pareekshana walata upakari wana Vidu Nena Dasuna* ("Vidu Nena Dasuna" You tube channel helps to science experiments in the school) **Wijeya**

Piyathilaka P, *Vidu Nena Dasuna you tube nalikawen paasal vidya pareekshana sadaha udaw* ("Vidu Nena Dasuna" You tube channel helps to science experiments in the school) 24th June 2015. **Vidusara**

Seneviratne G, Piyathilaka P, *Sampradayika pohora wenuwata jaiwa patala jaiwa pohora* (Biofilm Biofertilizers instead of traditional chemical fertilizer) 15th July 2015. **Vidusara**

Tumpale I, Piyathilaka P, *Large scale fish deaths in Kandy Lake attributed to pollution*. 22nd June, 2015. **The Island**

Weerasundara L, Vithanage M. *"Laikana" – sobadahame apuuru sahajeewee sambandathawayaka prathipalaya*. (**"**Lichens" wonderful result of nature due to symbiosis connection) 4th March 2015.**Vidusara**.

Weerasundara L, Vithanage M. *Jeewaya jeewath krawana vaayugolaye thathu.* (Description of atmosphere related to living organisms) 17th March 2015. **Vijaya**.

Weerasundara L, Vithanage M. *Mahanuwara vaahana thadabadayata visandumak nathda?* (IS there any solution for Kandy traffic jam? 3rd May 2015. **Lankadeepa**.

Wickramasignhe S, Vithanage M. *Nano thakshanaye thawathpathikadak* (Another aspect of nano technology) 30th September 2015. **Vidusara**.

Wickramasignhe S, Vithanage M. *Nodanuwathwama apawanadsana electronika apadhrawaya* (Electronic waste – as unaware hazardous compound) 15th November 2015. **Lankadeepa**.

Wickramasignhe S, Vithanage M. *Thaakshanika lookaye vishmayajanaka nipayuma - "grafeen"* (Grafeen - stupendous invention in technological world) 1st July 2015.**Vidusara**.

Wijayasinhghe A, Piyathilaka P, *Sri Lankawa thula karyakshama saha mila adu Lithium Ion Battery nipadawime subawaadi balaporoththu* (New hope for Sri Lanka to manufacture efficient and low-cost local Li-Ion batteries). 30th December 2015. **Vidusara**


Sky Scrapers at Morella Forest

Organization

Board of Governors
Research Council
Director's Office
Administration
Science Education and Dissemination Unit
Consultative & Collaborative Division
Dambulla Arboretum
Internal Auditor
Accounts Division
Laboratory Stores
Technical Staff
Library

From Left: Dr. PSB Wanduragala, Mr. JMUP Jayamaha, Dr. WKBN Prame, Prof. HMD Namal Priyantha, Prof. Jayantha Wijeratne, Prof. Anura Wickramasinghe (Chairman, BoG/NIFS), Prof. SHPP Karunaratne, Prof. CP Deepal W Mathew, Prof. MAKL Dissanayake, Prof. NGJ Dias, Prof. ULB Jayasinghe

Board of Governors

Prof. Anura Wickramasinghe
Chairman, Board of Governors / NIFS (ex-officio)
Dean, Faculty of Science, University of Peradeniya

Prof. S.S.H.P. Karunaratne
Director (ex-officio)
National Institute of Fundamental Studies
Kandy

Prof. Mohan De. Silva (ex-officio)
ex-officio
Chairman
University Grants Commission

Dr. W.K.B.N. Prame
Director General
Geological Survey and Mines Bureau

Prof. C.P. Deepal W. Mathew
Department of Biochemistry and Molecular Biology
Faculty of Medicine, University of Colombo

Prof. Jayantha Wijeratne
Senior Professor (Zoology), Department of Zoology
University of Kelaniya

Prof. M.A.K.L. Dissanayake
Research Professor
National Institute of Fundamental Studies

Prof. Namal Priyantha
Director, Postgraduate Institute of Science
University of Peradeniya

Prof. N.G.J. Dias
Professor in Computer Sciences
Department of Statistics & Computer Sciences
University of Kelaniya

Prof. U.L.B. Jayasinghe
Research Professor
National Institute of Fundamental Studies

Dr. P.S.B. Wanduragala
Secretary to the Board
Secretary / National Institute of Fundamental Studies

Research Council

Prof. S.H.P.P. Karunaratne (Chairman)
Director
National Institute of Fundamental Studies

Dr. Ruwan Duminda Jayasinghe
Faculty of Dental Science
University of Peradeniya

Prof. Namal Priyantha
Director, Postgraduate Institute of Science
University of Peradeniya

Prof. Rohana Chandrajith
Department of Geology
University of Peradeniya

Prof. Rohan Senadeera
Department of Physics
Open University of Sri Lanka

Prof. D.K. Weerakoon
Department of Zoology
University of Colombo

Prof. M.A.K.L. Dissanayake
Institute of Fundamental Studies

Prof. U.L.B. Jayasinghe
National Institute of Fundamental Studies

Prof. A. Nanayakkara
National Institute of Fundamental Studies

Prof. J.M.S. Bandara
National Institute of Fundamental Studies

Prof. G. Seneviratne
National Institute of Fundamental Studies

Prof. S. P. Benjamin
National Institute of Fundamental Studies

Prof. M.C.M. Iqbal
National Institute of Fundamental Studies

Dr. D.N. Magana-Arachchi
National Institute of Fundamental Studies

Prof. N.D. Subasinghe
National Institute of Fundamental Studies

Dr. R. R. Rathnayake
National Institute of Fundamental Studies

Dr. M.S. Vithanage
National Institute of Fundamental Studies

Dr. H.W.M.A.C. Wijayasinghe
National Institute of Fundamental Studies

Mr. P.S.B. Wanduragala - Secretary to the Research Council
National Institute of Fundamental Studies

Director’s Office

From left: *Ms. Abesingha A.M.N.U, Ms. Senevirathne O.W.K, Ms. Jeewa Kasthuri M.D., Mr.Malwewa M.P.D.K, Ms.Kapilarathne S.M.A.K*

All the activities related to administrative work of the National Institute of Fundamental Studies is facilitated by the Director’s Office. The Director of the institute is the Chief Excutive Officer of the Institute. Prof. SHPP Karunaratne is the present Director of the NIFS. Personal Assistant to the Director is Ms. Jeewa Kasthuri and Ms. OWK Seneviratne is the Stenographer. Mr. MGDK Malwewa is the Office Aid. Two trainees, Ms. AMNU Abeysinghe and Ms. SMAK Kapilaratne are also working in the Director’s Office.

Administration Division

Secretary

Dr. P.S.B. Wanduragala
Secretary to the Board
Secretary / National Institute of Fundamental Studies

Division

From left, front: *Mr. Kumara AVAP, Mr. Dorakumbura DGK, Mr. Gunathilake AGST, Ms.Hettiarachchi TP, Ms. Weerasooriya RPM, Ms. Ilangakoon CLS, Ms. Ruwngalla NP, Ms. Ranasinghe C, Mr. Jayasinghe HADN, Mr. Somananda MAG.*
From left, back: *Mr. Gunasekara KBTB, Mr. Jayasekara DJMWP, Mr. Dissanayake DMDB, Mr. Gunawardene RSK, Mr. Gunathilaka DG, Mr. Dharmasena DG, Mr. Ariyawansha KM, Mr. Lal MA, Mr. Jayaweera ABGW, Mr. Aluthgedara AGJS*

Administration Division consists of the following sections:

- Maintenance
- Transport
- Reception
- Workshop

Duties and responsibilities entitled for the Administration Division

- Maintaining office procedures in Administration division
- Work related to recruitments
- Work related to contractual Services
- Arranging Tender Board and Supplies Committee meetings and keeping minutes of them
- Calling Tenders and quotations for goods and services – local purchases
- Preparing Administrative report annually
- Supervision of NIFS visitor's rooms
- Maintaining Leave records of NIFS Staff
- Call for registration of suppliers annually
- Work related to construction and renovations
- Checking Overtime, fuel orders and contractual payments
- Man the reception desk and preparation of reports when necessary
- Directing visitors to appropriate contacts
- Maintenance of the Building (Electrical, water, Sanitary etc.)
- Insurance coverage of NIFS staff
- Maintain NIFS vehicles
- Providing transport facilities for the NIFS staff

Science Education and Dissemination Unit

Objectives

Foster the exchange of technical and scientific information for the scientific community and to promote the public understanding of science

Team

Left row from the bottom: *Ms. Herath NN, Dr. Thilakarathne CTK, Mr. Bandara GCK, Ms. Samarakoon KIK*
Right row from the bottom: *Mr. Piyathilaka SDPGP, Mr. Ekanayake VM*

Vidu Nena Hawula/Open Science Circle in Electronic Media (OSCEM)

Vidu Nena Hawula Science Message Service, known as OSCEM (Open Science Circle in Electronic Media) with the aim of improving the science literacy and scientific temperament of Sri Lankans.

OSCEM provides a daily Science message service via text messages (sms), e-mails and social networks such as facebook and twitter, a Science Blog in Sinhala and also a question and answer section. In addition, it provides an open forum for the subscribers to discuss their problems related to science behind day-to-day activities. This free service is provided on all weekdays except on government holidays via text messages, e-mails and social networking websites. http://vidunenahawula.com

Vidu Nena Dasuna Youtube Channel-VND

The project – Vidu nena Dasuna Youtube Channel was launched with the aim of demonstrating science lessons and experiments to students in Sinhala and making science a simple and interesting subject for them. This project is being funded by the National Science Foundation since 2014 and currently consists of about 30short videos covering different lessons & experiments included in the G.C.E. Ordinary Level and Advanced Level Syllabuses as well as other experiments that can be done by students themselves. www.youtube.com/user/IFSVND

Sinhala Science Web Site: Vidu Man Petha

The website "Vidu Man Petha" was launched with the intention of providing a reliable source of scientific information in Sinhala. This website contains many scientific articles written by scientists, scientific games, interesting scientific experiments, a scientific glossary etc. Vidu Man Petha is the first ever Sinhala Science web site and has also won a juror's Special Merit award in the category of E-learning and Education at the e-Swabhimani National Best E-content award 2012 and is being continued successfully. http://www.vidumanpetha.com/


SOLAR ASIA – 2011
INTERNATIONAL CONFERENCE ON
SOLAR ENERGY MATERIALS, SOLAR CELLS
&
SOLAR ENERGY APPLICATIONS
28 - 30 July 2011
Jointly Organized by
Institute of Fundamental Studies & National Science Foundation


School Science Programme
CHOOL SCIENCE PROGRAM 2015
IENCE EDUCATION & DESSEMINATION UNIT - NIFS

MASS project (Mobile Apps for Science Students)

MASS is the first ever known Mobile Application project that develops mobile apps in Sinhala to make Sri Lankan students learn science in a novel and more exciting manner. The first App of this project "Periodic Elements" which is created in the form of an interesting educational game, not only makes it easy for the students to memorize the properties of the chemical elements that are included in their syllabuses, but also gives them the opportunity to learn chemistry as a new & unique adventure.
https://play.google.com/store/apps/developer?id=Science+Education+%26+Dissemination+Unit+-+NIFS

Inculcating Science towards an Innovative Future (ISTIF)

National Institute of Fundamental Studies (NIFS) in collaboration with the Department of Education Central Province under the sponsorship of the United Nations Educational, Scientific and Cultural Organization (UNESCO), initiated a project named "Inculcate Scientific Methodology and novel teaching techniques for the level of Junior Secondary Education in Sri Lanka" in August 2013.Phase I:1160 science teachers of the central province were trained in 2013, Phase II: To analyse the ability of using scientific methodology and the questioning mind of the students, examination was carried and answer scripts were corrected in 2015 and Phase III: The collected data will be analyzed using SPSS. The outcome of the project is expected to be published in electronic media including internet and the research journals in 2016.

School Science Programme (SSP)

The School Science Programme (SSP) is one of the most important annually conducted programme for the dissemination of science among the younger generation. The primary goal of the SSP is to expose young students to a few selected frontier areas of science and to provide an opportunity for them to interact directly with scientists actively engaged in research.One hundred and forty students from all over the country participated in the 42ndprogrammewhich was hold in year 2015.

In addition, Science camps, competitions, awareness programs, lab visits and exhibitions were organized to enhance the scientific literacy of the school community and the general public. To foster the exchange of technical and scientific information for the scientific community conferences, workshops, and different types of forums, seminars were organized jointly with the scientists of the institute. Training programmes were conducted for the undergraduate students on request by the Universities.

Recent Achievements:

Winner of National award in the category of e-learning and education at the e-Swabhimani National Best E-content Award 2014- *Open Science Circle in Electronic Media*

Juror's Special Merit award in the category of E-learning and Education at the e-Swabhimani National Best E-content award 2012- "Vidu man petha" *Sinhala Science Web Site (Vidumanpetha)*

Collaborative & Consultative Division

The Collaborative and Consultative Division (CCD) facilitates interactions of NIFS scientists and their projects with outside organizations. The principal objective is to take the findings of research studies beyond the institute so that their impacts are felt and utilized by the general public. During the year under review certain projects were completed, others are continuing and a few new projects were initiated and these are presented below:

a) Project completed:

Mass cultivation of *Spirulina platensis* (Gomont) Geitler in collaboration with Swayang Wattegedera
NIFS participants: Prof. S. A. Kulasooriya, A. M. H. A. K. Tennekoon (field assistant; Collaborator: Major General (Retired) W. J. T. K. Fernando
This project was successfully completed and the final report was submitted to the National Science Foundation that awarded a grant for its partial funding. Our collaborator received a Technology Award of Excellence together with the IFS as the collaborator at the NSF Awards 2015. According to General Fernando the technology has been transferred to the Agriculture Division of the Sri Lanka Army and they have now established large scale (5000 m^2) *Spirulina* outdoor cultivation ponds at Welikande.

b) Continuing projects:

Biofilm-Biofertilizers
NIFS participants: Prof. G. Seneviratne, Prof. S. A. Kulasooriya, Mr. E. M. H. G. S. Ekanayake (RA), Ms. P. Wijepala, Ms. S. Gunaratne
Collaborators: Mr. Saman Kumarasinghe (NBC) and Mr. Samuditha Kumarasinghe & Mr. Ananda Jayasekera (Lanka Biofertilizers PLC)
Extensive field testing of different crop specific biofilm-biofertilizers (BFBF) with plantation crops, cereals such as rice and maize, several vegetable crops, ornamental plants and fruits like strawberry are being conducted in collaboration with Lanka Biofertlizers (Pvt) Ltd, a subsidiary company of Nature's Beauty Creations PLC with which the 1st MoU was signed under the CCD.

Rhizobial Inoculants with food and forage legumes
NIFS participants: Prof. S. A. Kulasooriya, Mr. E. M. H. G. S. Ekanayake (RA), Mr. R. K. G. K. Kumara (Field Assistant), Ms. A. M. H. D. C. Abeyrathne (Lab Assistant)
Collaborators: Mr. H. M. A. C.Gunarathna, Mr. L. K. C. Prithiviraj, (Plenty Foods PLC), Mr. Sumith de Silva and Mr. Lakshman Dissanayae (Oasis Marketing PVT Limited), Ms. Niluka Gunathilleke, Research Officer, Department of Agriculture, Angunakolapelessa, Ms. N. H. Madhuka, S. Chitrapala, Research Officer, Department of Agriculture, Maha Illuppallema
Field testing of rhizobial inoculants with mung bean (*Vigna radiate* (L.) R. Wilczek*)* and ground nut (*Arachis hypogaea* L) are being carried out at Tissamaharama, Nugelayaya and Handungamuwa with outsource farmers of Plenty Foods PLC with the active participation of the field staff of the company. Field testing and demonstration trials of inoculating common bean or vegetable bean (*Phaseolus vulgaris* L.) were conducted in Balangoda, Maturata, Keppetipola and Hanguranketha. Further demonstration trials are in progress at Welimada and Balangoda areas with the active participation of staff from Oasis Marketing (Pvt) Limited. Field testing of rhizobial inoculation of the forage legume white clover (*Trifolium repens* L.) in collaboration with Ambewela Farm has given clear results to show that application of urea fertilizer to these cultivations can be replaced completely by inoculation. Studies are in progress to develop seed inoculating techniques that could be adopted to apply treated seeds to large field areas using 'seed spreaders' attached to farm machinery.
Detailed results are presented under the Rhizobium Inoculant Research and Production Project.

From Left to Right: Mr. Kumara RKGK., Mr. Ekanayake EMHGS, Prof. Kulasooriya SA, Ms. Aberathne AHMCD, Ms. Ekanayake EMNW, Ms.Thathsarani JAN

Collaboration with the South Eastern University of Sri Lanka on Purification of Sri Lankan natural vein graphite for novel technological applications
NIFS investigator: Dr. Athula Wijayasinghe
The Research Assistant Mr. P.T.S. Hewatilake recruited through the UGC grant registered for a M.Phil. Degree at the PGIS, University of Peradeniya. He underwent a short training program conducted by the University of Moratuwa on graphite mining a Kahatagaha mines.

Collaboration with the Sri Lanka Institute of Nanotechnology (SLINTEC) on the Development of Sri Lankan natural vein graphite for nano-technological applications
NIFS investigator: Dr. Athula Wijayasinghe
The project is continuing.

Collaboration with the Department of Geology, University of Peradeniya
The project is continuing successfully and a few publications and conference presentations were made.
NIFS investigator: Prof. N.D. Subasinghe

c) New projects
Collaboration with the Uwa Wellessa University (UWUSL) on the Development of next generation advanced materials for future applications including nano-technology
NIFS investigator: Dr. Athula Wijayasinghe
Material preparation on the development of electrolyte materials for Na-ion rechargeable batteries is in progress under the M.Sc. program of the NIFS Research Assitant. Preliminary work on the development of Sri Lankan montmorillonite for nano technological applications was initiated.

Collaboration with Rajini Farm, Piliyandala to introduce biofertilizers and minimize the application of chemical fertilizers and other agro-chemicals to their crops and move towards organic farming
NIFS investigator: Prof. S.A. Kulasooriya, Prof. G. Seneviratne
A memorandum of understanding was signed in December and a preliminary visit to the Farm was paid by a NIFS team. A field experimental design was prepared and instructions were given to lay out experimental treatment plots. Field trials will commence once the field plots are prepared.

IFS- Sam Popham Arboretum

When you travel from Dambula towards Anuradhapura on the A9 road and proceed about two and half kilometers along the Kandalama road you will encounter the IFS- Sam Popham Arboretum (IFS-SPA) on the right hand side. This unique site was owned by an Englishman, Mr. F. H. (Sam) Popham, who gifted it to NIFS (then IFS) in 1989 to carry out research and educational activities.

Mr. Popham was originally a Naval Officer who later became a Tea Planter. His last occupation was the administrator of the Revision of the Flora of Ceylon project funded by the Smithsonian Institution of Washington, DC. That project was based at the National Herbarium of Royal Botanic Gardens, Peradeniya.

Original site bought by Popham in 1963 was a seven and half acre-scrub jungle. Popham allowed the indigenous tree saplings in the site to emerge and establish by removing the 'weedy' shrubs around them. Consequently, the scrub jungle was turned into a dry zone woodland with a closed canopy.

After taking over the land in 1989, NIFS bought another 27 acres of adjoining scrubland to expand the arboretum. Popham's method of " assisted regeneration' was practiced to convert that land also into a dense woodland.

Currently, IFS-SPA is visited by many local and overseas researchers for educational purposes and ecological research. It is also a popular tourist destination owing to the presence of unique fauna such as Slender Loris, Pangolin and a rich vegetation consisting of over 200 species of trees.

Since 2005 the management of NIFS-SPA is carried out by Ruk Rakaganno (the Tree Society).

Internal Audit

The Internal Audit Division is functioning under the direct supervision and guidance of the Director.

From Left to Right: Ms. Jayasooriya SN, Gunasena, CO

The Division is responsible for independent and objective reviews and assessment of the Institute's activities, operations, financial systems and internal controlsadhering to Laws, Circulars, Financial Regulations and provisions of the Establishments Code and to make observations and recommendations to the Senior Management.

When dealing with internal audit functions of the institution, special attention is paid for the below functions as mentioned in F.R. 133,

- Examine whether the internal inspection and administrative system implemented within institution to prevent frauds and malpractices are successful in its planning and implementation.
- Ascertain the accuracy of the accounting and other records and ensure that the accounting methods used are effective for the preparation of financial statement.
- Evaluating the quality of performance demonstrated by the staff in the performance of their duties and responsibilities.
- Verifying how far the assets belonging to institute have been protected from any kind of damages.
- Examine whether the provisions of the circulars issued from time to time by the Ministry in charge of the subject of public administration and the General Treasury, establishments code, financial regulations of the government and other supplementary instructions are properly followed
- Conducting special investigation wherever necessary.
- Following the guide lines and directions given from time to time by the Department of Management Audit, conducting the meetings of audit&management committee quarterly and taking follow up actions to verify the progress in the implementation of decisions taken at those meetings.

Accounts Division

<u>From Left to Right:</u> Mr. Weerasooriya BJ, Ms. Nissanka MK, Ms. Gamlath TP, Ms. Nishshanka LNMDSK, Ms. Samarakkody PSS, Ms. Rathnayake RMVP, Ms. PalliyaGuruge MP, Mr. Ariyaratne, MP, Mr. Perera MAP, Mr. Keshan MKD

This division consists of the Deputy Accountant (supervisor-in-charge), an Accounts Officer, three Senior Staff Assistant (Clerks, Book-Keeper), a Staff Assistant (Stores Keeper), three Management Assistants and an Office Machine Operator. The division provides support for finance and accounting services at the institute in the following areas:

- **Funding Sources:** Recording of cash received from the General Treasury and other external local and foreign sources.
- **Payroll:** Preparation of salaries based on personal information, taxes and other deductions and allowances.
- **Personal Provident Fund:** Maintenance of the contribution of Employees Provident Fund by keeping cards and records separately for individual employees, investing & monitoring fixed deposits and withholding tax.
- **Staff Loan:** Management of the EPF and concessionary loan schemes, and maintenance of relevant records.
- **Cash payments:** Payment of a wide variety of purchases, taxes;upkeep all supporting documents and files to assure the amount to be paid is correct and in compliance with relevant government rulesand regulations.
- **Budgeting:** Estimating the sources and expenditure for the period; this also serves a number of important purposes such as monitoring and controlling the finances of the institute.
- **Procurement &Inventory:** Keeping track of all purchases such as stationery, hardware & general items, and local inventory items.
- **Final Accounts Statement:** Preparation of comprehensive final accounts and statements in compliance with Sri Lanka public accounting Standard and accepted accounting principles.
- **Maintenance of Financial Records:** Ensure proper maintenance and updating of accounting records and preparation of financial reports upon request

Procurement & Laboratory Stores

Our Objectives

The Procurement and laboratory Stores is committed to providing the necessary resources to achieve the goals of the National Institute of Fundamental Studies.

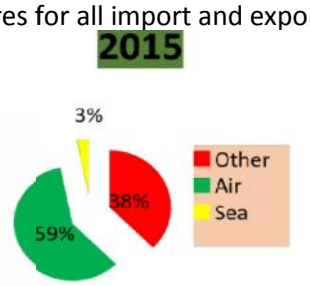
Our Team

From Left to Right: Ms. J. P. G. H. T. Jayalath (Trainee), Ms. E. M. G. W. D. Edirisooriya (Trainee), Ms. H. M. M. H. K. Herath (Trainee), Eng Ms. W. D. S. P. Perera (Laboratory Manager), Ms. D. M. K. L. Kumari (Senior Staff Technical Officer), Ms. G. W. R. P. Chandrakanthi (Senior Staff Assistant/Stenographer)

Our Services

- Foreign and local purchasing for all items including Laboratory Equipment, Chemical, Glassware and Consumables

- Handling chemical and Glassware Stores and implementing and monitoring the Bin card system
- Handling Customs procedures for all import and export items



- Maintains a record of assets owned by Institute. The system includes a complete description of the asset; Its acquisition date and cost, location, condition and other information.

Technical Staff

The mission of the Technical staff of the National Institute of Fundamental Studies is to support the research activities when analytical and technical expertise are needed.

The expertise of the Technical Staff is useful for the scientists to carry out the research. They guide the undergraduates and post graduates to operate the instruments for research.

The technical staff also support computer and system administration of the institute, and also handle orders and manage supplies of chemicals and glassware. Thus, they are key to achieving the objectives of the institute.

Further, they conduct sample analysis for other institutes. Some have research publications in referred journals and received several presidential awards.

The role of the Technical officer at IFS

- programming, operation and maintenance of servers, computers and network system of the entire institute
- The maintenance and operation of the PABX system and telephone network of the institute
- The maintenance and supervision of the electrical installation, switchgears, generator and the Central UPS system in the institute
- Maintaining the chemical, glassware store and inventory the institute
- Instrument, sample preparation and analysis
- Method and analytical technique development and maintenance, calibration and operation of all analytical equipment.
- Maintenance and operation of the automated attendance system for the whole staff
- Web designing, providing technical support to school science programs, conferences, seminars and workshops
- General maintenance of the analytical instrument range in the institute
- Field sample collection, preservation
- Ethics of laboratory discipline in line with GLP

Other miscellaneous services provided include participation in committees like Tender Board, supplies Committee, Instrument Committee, Salaries committee, Technical Evaluation Committees, Computer committee, Web committee, Interview panels and also has represented the Institute in various occasions.

The technical personnel have contributed in setting the specifications by evaluating the analytical requirement from various basic to high - end instrumentation by maintaining and living up to the standards of the institute.

N.P.Athukorala
D. Aluthpatabendhi
A.K. Pathirana
S.S.K.Skalasooriya
A.B. Herath
R.C.K. Karunarathna
R.S.M. Perera
M.D.K. Lakshmi Kumari
D.S. Jayaweera
S. Opatha
I .Thmpala
W.G. Jayasekara Banda
G.C.K.S. Bandara
V.M. Ekanayeke
R.B. Weerakoon
M.N.B. Kulathunga

Library

The NIFS library was established in 1985 with a small collection of books and journals donated by Prof. Cyril Ponnamperuma, well-wishers and the Asia Foundation. Since then it now has a modest collection of over 6669 books and about 120 Journal titles covering the life, physical and mathematical sciences as well as the philosophy and history of science the fundamental text books, monographs and edited volumes.

Objective

The Main objective of the library is to collect, compile, retrieve and disseminate information related to our research for the benefit of NIFS Research staff and other interested parties.

During the last year 84 new books were added to the collection, consisting of 58 purchased books, and 26 books received on complimentary basis. A large number of periodicals, newsletters, annual reports from local and foreign institutions were also received on a complimentary or an exchange basis, and the library subscribed to 14 journals related to our research

Library Services

NIFS Library provided services on reference and lending, document delivery, resource sharing, inter-library loan facility, photocopying facility, information alert services and sourcing web based electronic journals and articles. The Library also provides access to the OARE data base through subscriptions. This provides online access to scientific journals. Currently 40 such journals are available online through this scheme.

Digitization of institute publications

National Science Foundation undertook digitization of our institute's publications starting from 2013-12-21. The aim of the project was to establish an institutional e-repository and provide quick enhanced online access to institute publications. About 60,000 pages were electronically scanned to upload to server (http://ifs.nsf.ac.lk/).

Conferences and Seminar

- Institutional Repository of the NIFS: A Seminar with demonstration on the National Digitization was organized by the NIFS Library. Lectures were conducted by Mrs. Sunethra Perera, Head NSF Library and Resource Centre, on 03rd August ,2015.
- A workshop on Dewey Decimal Classification System was organized by the National Library and Documentation Center on 11th August 2015
- Progress review meeting of "National Digitization Project", National Science Foundation, was held on 22 September 2015

Other Activities

- A series of lectures on Improving reading habits in children and intorducton of library system was conducted at the following places
    - Palath Paalana Sathiya, A special lecture was delivered on education and library development day organized by Kandy Municipal Council, on 10th September, 2015
    - Janaraja Maha Vidyalaya, Katugastota, Kandy, on 15th October, 2015
    - Hillwood College, Kandy, 29th October, 2015

From Left to Right: Ms.Tilakarathne TCPK, Ms.Witharana RM, Ms. Sumanarathne HMTL

Looking at the Underground

Staff of the NIFS

Director : Prof. C.B.Dissanayakeupto 30.09.2015
Prof. S.H.P.P.Karunaratnew.e.f. 01.10.2015

Secretary : Dr. P.S.B.Wanduragala

Research Staff

Senior Research Professor

Prof. A.Nanayakkara

Research Professors

Prof. J.M.S.Bandara
Prof. U.L.B.Jayasinghe
Prof. P.R.G.Seneviratne
Prof. M.A.K.L.Dissanayake
Prof. N.S.Kumar up to 02.08.2015

Associate Research Professors

Prof. S.P.Benjamin
Prof. M.C.M.Iqbal
Prof. N.D.Subasinghe

Senior Research Fellow

Dr. D.N.MaganaArachchi
Dr. R.R.Ratnayake
Dr. M.S.Vithanage

Research Fellow

Dr. R.Liayanage
Dr. H.W.M.A.C.Wijayasinghe
Dr. V.Y.Waisundara

Visiting Research Professors

Prof. S.A.Kulasooriya
Prof. N.S.Kumar w.e.f. 03.08.2015

Visiting Associate Research Professor

Prof. G.K.R.Senadeera

Visiting Senior Scientist

Dr. W.P.J.Dittus

Research Assistants Gr.I

Mr. A.Manjceevan
Mr. C.A.Thotawattage
Mr. W.W.M.A.B.Medawatte
Mr. P.H.M.I.D.K.Herath
Mr. T.B.Nimalsiri
Ms. S.M.M.P.K.Seneviratne

Research Assistant Gr.II

Mr. E.M.H.G.S.Ekanayake
Mr. S.M.P.R.Kumarathilake
Mr. K.M.S.D.B.Kulatunga
Ms. C.L.Kehelpannala
Ms. R.P.S.K.Rajapaksha
Ms. U.G.S.L.Ranasinghe
Ms. T.P.Keerthiratne
Ms. J.M.K.W.Kumari
Mr. G.R.N.Ratnayake
Ms. D.Thanabalasingham
Mr. M.M.Qader
Ms. W.T.Awanthi
Ms. S.A.Samaranayake
Mr. K.P.V.B.Kobbekaduwa
Mr. A.M.J.S.Weerasinghe
Mr. R.I.C.N.Karunaratne
Ms. M.I.Watawana
Ms. N.N.Jayawardena
Ms. R.M.G.C.S.K.Jayathilake
Mr. D.M.V.Y.S.Bandara
Ms. P.C.Wijepala
Ms. R.Vishvanathan
Mr. K.N.L.De Silva
Ms. R.M.N.M.Ratnayake
Ms. D.M.D.M.Dissanayake
Ms. H.M.S.Wasana
Ms. E.G.C.K.Priyadarshika
Mr. D.M.T.U.Bandara
Ms. M.Kanesharatnam
Mr. S.Sayanthooran
Ms. H.K.S.N.S.Gunaratne
Mr. G.D.K.Heshan
Mr. M.Kathigamanathan
Ms. D.K.Weerasekara
Ms. R.M.A.S.Ratnayake
Ms. H.A.P.P.B.Jayathilake

Technical Staff

Chief Technical Officers

Mr. M.N.B.Kulathunga
Mr. W.M.R.B.Weerakoon
Ms. I.Tumpale
Mr. N.P.Athukorale
Mr. W.G.Jayasekara Banda
Mr. S.Opatha
Mr. H.M.A.B.Herath
Ms. S.S.K.Sakalasooriya
Mr. D.S.Jayaweera
Ms. R.K.C.Karunaratne
Mr. A.K.Pathirana
Ms. D.Aluthpatabendi
Ms. R.S.M.Perera

Director's Office

Ms. M.D.JeewaKasthuri	Personal Secretary to the Director
Ms. O.W.K.Seneviratne	Stenographer Gr.II
Mr. M.P.D.K.Malwewa	Office Aide

Internal Audit Division

Ms. W.S.N.F.Jayasuriya	Internal Audit Officer
Ms. C.O.Gunasena	Management Assistant Gr.III

Library

Ms. T.C.P.K.Tilakaratne	Assistant Librarian
Ms. R.M.Witharana	Library Assistant Gr.III

Science Dissemination Unit

Dr. C.T.K.Tilakaratne	Coordinator
Ms. K.I.K.Samarakoon	Stenographer Gr.II
Mr. V.M.Ekanayake	Technical Officer Gr.III
Mr. G.C.K.S.Bandara	Technical Officer Gr.III
Mr. S.D.P.G.P.Piyathilake	Communication & Media Officer
Ms. H.M.G.N.N.Herath	Management Assistant Gr.III

Colombo Office

Ms. M.C.Rajapakse	Coordinator cum Scientific Officer – on leave
Mr. A.D.Gunawardena	KaryalaKaryaSahayake/Driver

Accounts Division

Ms. P.S.S.Samarakkody	Deputy Accountant
Ms. L.N.M.D.S.K.Nishshanka	Accounts Officer
Ms. M.K.Nissanka	Senior Staff Assistant – Book Keeper
Ms. M.P.PalliyaGuruge	Senior Staff Assistant – Clerical

Ms. R.M.V.P.Ratnayake	Senior Staff Assistant – Clerical
Mr. G.Ariyaratne	Staff Assistant – Store Keeping
Ms. T.P.Gamalath	Management Assistant Gr.III
Mr. M.K.D.Keshan	Management Assistant Gr.III
Mr. B.J.Weerasooriya	Management Assistant Gr.III
Mr. M.A.P.Perera	Office Machine Operator

Procumbent & Lab Stores Division

Ms. W.D.S.P.Perera	Laboratory Manager
Ms. D.M.K.LakshmiKumari	Chief Technical Officer
Ms. G.W.R.P.Chandrakanthi	Senior Staff Assistant – Stenographer

Administration Division

Ms. R.P.M.Weerasooriya	Senior Staff Assistant –Clerical/ Actg.Administrative Officer
Ms. T.P.Hettiarachchi	Senior Staff Assistant – Stenographer
Ms. C.L.S.Illangakoon	Senior Staff Assistant – Stenographer
Ms. C.Ranasinghe	Staff Assistant –Stenographer
Mr. D.G.Gunathilake	Record Keeper Gr.I
Mr. A.G.S.T.Gunathilake	Management Assistant Gr.III
Mr. A.B.G.W.Jayaweera	Driver – Special Grade
Mr. M.A.G.Somananda	Driver – Special Grade
Mr. K.M.Ariyawansa	Driver - Special Grade
Mr. G.A.R.Basnayake	Driver - Special Grade
Mr. R.S.K.Gunawardena	Driver - Special Grade
Mr. K.G.T.B.Gunasekara	Driver Gr.I
Mr. H.A.D.N.Jayasinghe	Driver Gr.III
Mr. D.M.D.B.Dissanayake	DriverGr.III
Mr. D.J.M.W.P.Jayasekara	Machinist – Special Grade
Mr. A.V.A.P.Kumara	Machinist Gr.I
Mr. M.A.Lal	Laboratory Attendant – Special Grade
Mr. R.B.Hapukotuwa	Laboratory Attendant – Special Grade
Mr. G.D.Dharmasena	Electrician Gr.II
Mr. D.G.K.Dorakumbura	Mason Gr.I