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SRI LANKA

ANNUAL REVIEW 2016

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ISBN No: 2478-0782

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Vision

To be a world renowned center of excellence for research in fundamental studies

Mission

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

Message from the Director

It is a great pleasure to make this note on the occasion of the 2016 Annual Research Review. Institute of Fundamental Studies was established in 1981 and the name was changed to National Institute of Fundamental Studies (NIFS) Sri Lanka in 2014. NIFS is the only national institute which, by its Act, has the main objective as to engage 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.

Annual Research Review 2016 of NIFS is held to review the progress of its scientific research carried out in the year 2016. The Institute had 05 Senior Research Professors, 02 Research Professor, 03 Associate Research Professors, 02 Senior Research Fellows and 02 Research Fellows. Eighty four (84) postgraduate research students conducted their research under these scientists. Scientists at NIFS have published 86 research papers in referred journals including 61 in SCI/ SCI expanded journals, and 108 conference papers/ abstracts in the year 2016 along with two patents (one International and one National). Eleven (11) research assistants obtained their postgraduate degrees (05 Ph.D.s and 06 M.Phil.s). In addition, several M.Sc. students (12) and undergraduates (14) completed their research projects at NIFS in 2016. Several prestigious research awards including the CVCD Research Excellence Award and the NSF/TWAS Young Scientist Award were received by NIFS staff. We spent more than 70 million LKR from our 2016 budget for the purchase of major equipment such as XRD, GC, HPLC, LC-MS, Thermal Evaporator, ICPOES and multi-mode microplate reader. Science Education and Dissemination Unit (SEDU) concluded another excellent year by organizing inspiring programmes for the scientific community, school children and teachers, and the general public. In 2016, 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. I should also thank the technical, administrative, accounts, maintenance and other staff of NIFS for their invaluable support given to make a successful progress in 2016.

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BSc, MSc (Perad), PhD (Lond), FRES (Lond), FNAS (Sri Lanka)
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Slender Loris at Pollonnaruwa
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Research Units

Energy & Advanced Materials

- Condensed Matter Physics & Solid State Chemistry
- Nanotechnology & Advanced Materials
- Energy & Advanced Material Chemistry
- Material Processing & Device Fabrication

Theoretical Physics & Computational Studies

- Quantum Physics and Applied Electronics

Natural Products& Food Chemistry

- Natural Products
- Nutritional Biochemistry

Soil Microbiology & Carbon Sequestration

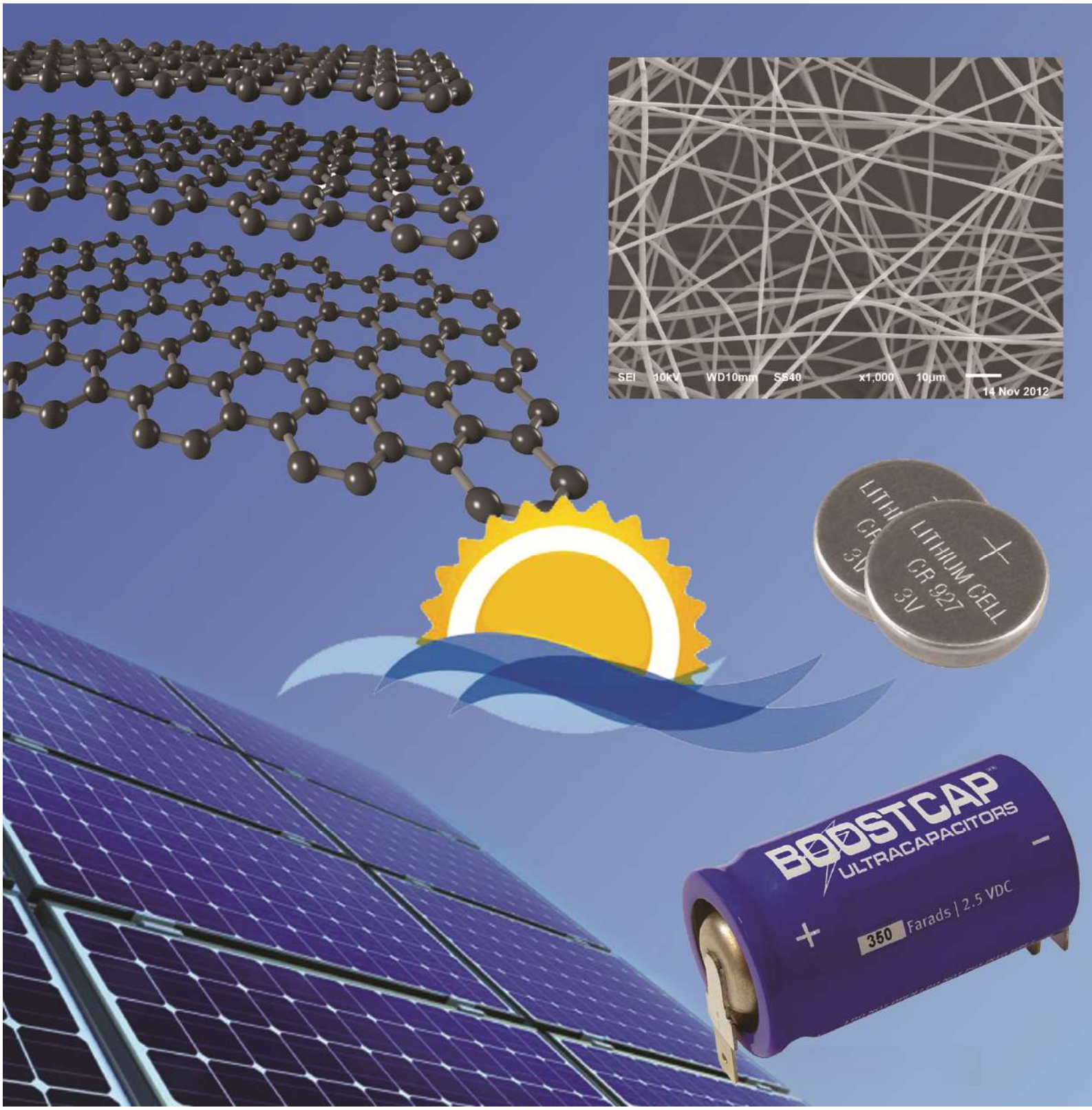
- Microbial Biotechnology
- Bioenergy & Soil Ecosystems

Earth, Environment & Biodiversity

- Natural Resources & Renewable Energy
- Chemical &Environmental Modeling
- Ecology &Environmental Biology
- Plant & Environmental Science
- Plant Taxonomy & Conservation
- Primate Biology

Molecular Biology & Biotechnology

- Cell Biology
- Medical Entomology


SEI 10kV WD10mm SS40 x1,000 10µm 14 Nov 2012
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Energy & Advanced Materials

Energy and Advanced Materials project unit *at the National Institute of Fundamental Studies cover several ambitious projects dealing with technologically important novel materials and devices. These are being investigated under four broad themes: Condensed Matter Physics and Solid State Chemistry project mainly deals with synthesis and characterization of novel polymeric electrolytes for dye sensitized solar cells, rechargeable batteries and electrochromic display devices. Nanotechnology and Advanced Materials project covers target oriented fundamental and advanced investigations leading to develop Sri Lankan minerals and related materials for nano-technological and advanced materials based applications. Energy and Advanced Materials Chemistry project focuses on chemistry and physics of novel materials for the conversion of solar energy into chemical and electrical energies. Material Processing and Device Fabrication project involves experimentation and basic studies in Materials Processing and Device Fabrication with emphasis on graphite, graphite based devices and carbon supercapacitors.*

- Condensed Matter Physics & Solid State Chemistry
- Nanotechnology & Advanced Materials
- Energy & Advanced Material Chemistry
- Material Processing & Device Fabrication

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Condensed Matter Physics & Solid State Chemistry

Condensed Matter Physics and Solid State Chemistry projects at NIFS currently focus on several ambitious technologically important sub-projects; These are, efficiency enhancement in dye sensitized solar cells by (a) nanostructural modifications to the TiO_2 and SnO_2 photoanodes and (b) development of novel solid and quasi-solid polymer electrolytes incorporating the "mixed cation effect", fabrication of quantum dot-sensitized solar cells, optimization of growth conditions of CdS and CdTe layers in CdS/CdTe thin film solar cells, development of novel Mg^{++} ion batteries, TiO_2 based electrochromic devices (ECDs) and synthesis and characterization of functionalized polymer nanofibre water filters for bacteria and Arsenic removal from drinking water.

Among the major research findings from our group over the last three years (2014-2016) are: (a) the "*mixed cation effect*" where by using a binary iodide mixture, containing a small size cation (such as Li^+, K^+) and a large size cation (such as Pr_4NI) in the redox electrolyte, the solar cell efficiency could be enhanced by 20-25% , (b) By having a three-layer composite photoanode made by a TiO_2 nanofibre layer sandwiched in between two normal TiO_2 nano particle layers the solar cell efficiency could be enhanced by more than 30%.

The group has also established the unique properties of TiO_2 as a technologically important, muli-functional material which can be used in dye sensitized solar cells, electrochromic display devices, rechargeable Mg^{++} batteries and polymer nanofibre water filters.

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TiO_2 as a low cost, multifunctional material: TiO_2 is a technologically important, naturally occurring, low cost material used in energy, environmental, health and many other applications. We have demonstrated the possibility of using TiO_2 in several different types of applications. The efficiency of a silver nanoparticle incorporated TiO_2 dye sensitized solar cell increased by 27% evidently due to the plasmonic effect. In a dye sensitized solar cell when nanopowder TiO_2 photoanode was replaced by a composite 3 layer photoanode with configuration TiO_2 nanoparticle/TiO_2 nanofibre/TiO_2 nanoparticle, the cell efficiency enhanced by more than 30%. In an electrochromic device of configuration, FTO glass/TiO_2/Poly (methylmethacrylate) electrolyte/SnO_2/FTO glass, an impressive reversible colour change was observed (Figures 1 & 2).

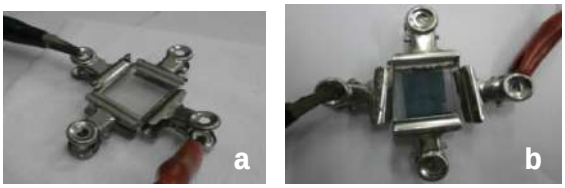

Figure 1. The two different states of the Electrochromic (EC) device: (a) as prepared (bleached state at 0 V) and (b) fully coloured state (at 4.0 V).

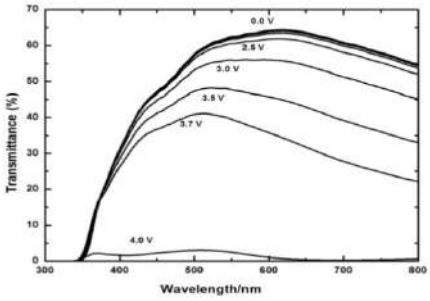

Figure 2. Optical transmittance spectra of ECD with configuration FTO glass/TiO_2/polymer electrolyte (PMMA) /SnO_2/FTO glass at various voltages.

A novel Mg^{++} ion rechargeable battery fabricated with a TiO_2 cathode exhibited an impressive discharge capacity of 220 $mAhg^{-1}$ showing that Mg^{++} ions can be reversibly intercalated in to the TiO_2 structure. An electrospun nanofibre membrane prepared from a biodegradable polymer and functionalized with TiO_2 nano powder was capable of removing arsenic (As) from drinking water efficiently.

Dye sensitized solar cells fabricated with electrospun polymer nanofiber based electrolyte: In this project, completed in 2016, the electrospun PAN nanofiber membranes were prepared using the NABOND electro spinning system. The solution used to produce nanofibers was prepared from a solution of PAN in DMF. In order to vary the thickness of the nanofiber membrane, the electrospinning time was altered (Figure 3).

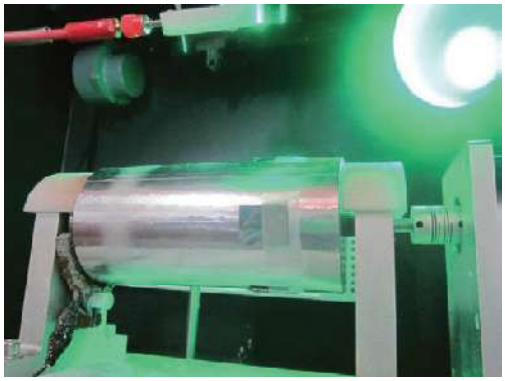

Figure 3. The electrospinning equipment used for the fabrication of PAN nanofiber membranes.

The liquid electrolyte with tetrapropyl ammonium iodide (Pr_4NI), propylene carbonate (PC) and iodine was used to swell the PAN nanofiber mat to obtain a gel electrolyte. The *I-V* characteristics of DSSCs fabricated with this nanofiber membrane gel electrolyte having the configuration FTO/TiO_2/dye/PAN NF: Pr_4NI: PC:I_2/Pt/FTO measured under the illumination of 1000 mW cm^{-2} simulated sunlight showed an efficiency of 5.5 %. The efficiencies of DSSCs with nanofiber membrane gel electrolytes showed dependence on the electrospinning time (corresponding to the membrane thickness) as shown in figure 4.

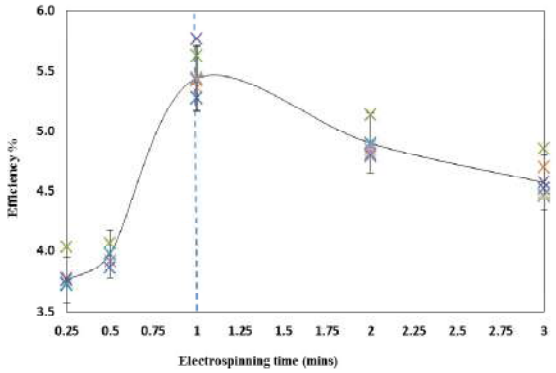

Figure 4. Variation of efficiency of nanofiber gel electrolyte based DSSCs with electrospinning time for PAN nanofiber membrane.

The efficiency of the DSSC with optimized nanofiber membrane based gel electrolyte is very close to the efficiency of the liquid electrolyte based DSSC. The use of nanofiber membrane based gel electrolyte can be one of the best alternatives to overcome many of the drawbacks associated with liquid electrolyte based DSSCs.

A novel, polymer free, fumed silica incorporated gel electrolyte for dye sensitized solar cells: A novel, polymer-free, quasi-solid state (gel), electrolyte has

been prepared using fumed silica as the gelling agent. The electrolyte consists of tetrapropyl ammonium iodide (Pr_4NI) and potassium iodide (KI) as the binary iodide salt mixture and iodine dissolved in ethylene carbonate (EC) and propylene carbonate (PC) co-solvent. Dye sensitized solar cells fabricated with this gel electrolyte and Ruthenium dye (N719) sensitized TiO_2 photoanode exhibited a short circuit photocurrent density of 13.7 mA cm^{-2}, an open circuit photovoltage of 702.2 mV, a fill factor of 62.5 %, and an overall efficiency of 6.03 % under simulated sunlight of 100 mW cm^{-2}.

Research Students

Ph.D.- Mr. C.A. Thotawatthage

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Mr. A.M.J.S. Weerasinghe
Mr. T. Jaseetharan

M.Sc.- **Ms.** R.A. Jayarathna

Key publications:

Dissanayake, M.A.K.L., Divarathna, H.K.D.W.M.N., Dissanayakea, C.B., Senadeera, G.K.R., Ekanayake, P.M.P.C., Thotawattage, C.A. (2016). An innovative TiO_2 nanoparticle/nanofibre/nanoparticle, three layer composite photoanode for efficiency enhancement in dye-sensitized solar cells, *Journal of Photochemistry and Photobiology A: Chemistry*, 322, 110-118.

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Sarangika, H.N.M., Dissanayake, M.A.K.L., Senadeera, G.K.R., Rathnayake, R.R.D.V., Pitawala, H.M.J.C. (2016). Polyethylene oxide and ionic liquid-based solid polymer electrolyte for rechargeable magnesium batteries, *Ionics,* doi:10.1007/s11581-016-1870-3.

From Left: Ms. RA Jayarathna, Ms. JMKW Kumari, Mr. CA Thotawatthage, Dr. GKR Senadeera, Prof. MAKL Dissanayake, Mr. AMJS Weerasinghe, Mr. T Jaseetharan, Ms. Hiruni Jayasekara

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Nanotechnology & Advanced Materials

Nanotechnology and Advanced Materials could easily be attributed to most of the recent technological advancement and inventions. Minerals are playing a vital role as the most appropriate starting materials for the preparation of modern advanced/nano-materials based products. Sri Lanka possesses a variety of economically useful minerals but they are mostly exported as cheap raw materials, because, proper value addition, before exporting these important material resources, is still not in place in Sri Lanka. A main reason for this situation is the dearth of advanced scientific research conducted in the country, targeting higher value addition to our mineral resources.

Therefore, when adapting or contributing to the scientific/technological advances in Nanotechnology and Advanced Materials areas, we should seriously mind these factors inherent to our country. Hence, our project at the NIFS strongly emphasizes on performing target oriented fundamental and advanced scientific investigations leading to develop Sri Lankan minerals and related materials for nano-technological and advanced materials based applications.

This project also involves the exploration of performance enhanced advanced semiconducting materials with special attention on energy related applications. Under this, a number of target oriented fundamental and advanced research investigations are performed in order to develop novel transition metal based semiconductors. This is carried out, while introducing/developing modern nano-technological techniques/processes for the preparation and property enhancement of these advanced materials.

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This project commenced its work in January 2013. At present, the following four sub-projects, which emphasize the basic and fundamental scientific aspects on advanced synthetic materials and advanced materials derived from Sri Lankan minerals, are carried out under this project.

Development of Sri Lankan natural graphite for rechargeable battery applications: Sri Lanka is the only commercial producer of vein graphite, which is the rarest and most valuable form of graphite. However, the purity and the performance of our natural graphite should be comprehensively enhanced in order to use for advanced technological applications. In addressing this, our project so far has successfully developed/invented a number of low-cost purification techniques, such as acid leaching, alkali roasting and acid digestion, which can enhance the purity of vein graphite up to 99.99 % purity. Further this ultra-purity natural graphite is subjected to appropriate surface modification processes such as alkali roasting, mild oxidation and simultaneous digestion, which have been recently developed/invented by our research group.

Figure 1: Assembling of rechargeable batteries

Accordingly, our best developed graphite anode electrode for the rechargeable lithium ion battery shows an excellent Columbic efficiency of over 99.9 % with interestingly very low irreversible capacity. It's stable reversible capacity of 378 $mAhg^{-1}$ is even higher than the theoretically expected capacity (372 $mAhg^{-1}$). Further investigations are now successfully carried out on structural modification of our natural graphite for the intercalation of bigger ions, aiming to be used for upcoming Na-ion, Mg-ion and the related hybrid rechargeable batteries.

So far, most of the advanced characterization, specially the cell testing of our developed materials had to be performed in overseas laboratories under numerous difficulties. However, with the acquiring of a dedicated constant environment chamber, a battery tester, crimping machine and other homemade accessories during 2016, a small scale but fully functional battery testing facility has been established now at NIFS.

Synthesis of graphene and graphite based composites using Sri Lankan graphite: Graphene has emerged as a most promising nano-material because of its exceptional properties and suitability for a wide range of applications. Presently, graphene is derived from expensive synthetic graphite. The purity and cost of graphite source, efficiency and easiness of conversion determine the quality and the price of graphene.

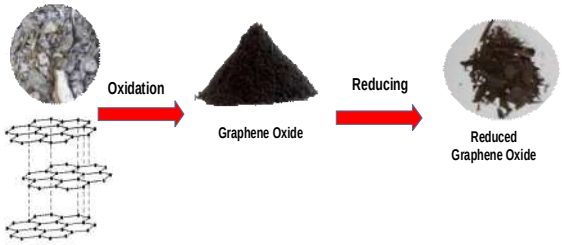

Figure 2: Synthesis of grapheme from Sri Lankan natural graphite

Our investigations on conversion of ultra- purified Sri Lankan vein graphite into graphene through chemical oxidation/exfoliation has revealed important findings on effect of the structural variety on properties and the yield. The needle platy graphite (NPG) variety showed the best performance by resulting Individual sheets with a layer thickness of around 1.2 nm, corresponding to a single layer of graphene. In another study, Polyaniline (PANI)/graphite composites were synthesized using purified vein graphite. This composite material shows good hydrophobic ability and prevents corrosion on metal surfaces. It also shows high thermal stabiity with resistance to heat up to 700 ^{0}C.

Development of materials for efficient water purification using local minerals and materials:

Figure 3: Studying for water purification

Sri Lanka possess a variety of cheaper materials capable for use in water purification. However, considerable efforts have not been put forward for using them in efficient water filtration. In addressing this, our project at NIFS is involved with developing them through property enhancement and forming into effective structures. Property enhancement is carried out through purification of materials followed by morphological and structural modifications. Presently, a number of local minerals such as clays and sands together with bio materials are under investigation. The ultimate aim of this project is the designing of low-cost water filters with our developed materials to improve the quality of drinking water.

Novel transition metal oxide semiconductors for energy conversion applications: This involves developing advanced semiconducting materials through novel nano-material synthesis techniques. For this, the low-cost wet chemical Glycine Nitrate Combustion (GNC) method was developed to precisely control the size of the resulting powder particles into nano-scale. Currently, investigations are being carried out on Na and Mg ion based transition metaloxide systems, doped with cheaper metal additives, intended for novel Na-ion and Mg-ion rechargeable batteries.

Chief Technical Officer Mr. W.G. Jyasekara

Research Students

Ph. D. Gayani Amaraweera (Completed)

M. Phil. Ms. Nimali Rathnayake
Ms. Sasanka Hewathilake
Mr. Niroshan Karunarathna
Mr. Heshan Kamalajith
Ms. Thilani Senevirathna
Ms. Niruba Kanagaratnam

M. Sc. Mr. Thushan Pathirana (Completed)
Mr. ilan Rupasana
Ms. Anushka Sajeevani

Key Publications

Rathnayake, R.M.N.M., Wijayasinghe, H.W.M.A.C., Pitawala, H.M.T.G.A., Yoshimura, M., Huang, H-H. (2017). Synthesis of grapheme oxide and reduced grapheme oxide by needle platy natural vein graphite**,** Applied Surface Science,393,309-315.

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Samarasingha, P., Wijayasinghe, A., Behm, M., Dissanayake, L., Lindbergh, G. (2014). 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, 268,226-330.

From Left: Ms. Thilani Seneviratne, Ms. Niruba Kanagaratnam, Mr. Heshan Kamalajith, Mr. Niroshan Karunarathna, Dr. HWMAC Wijayasinghe, Mr. WG Jayasekara, Dr. Gayani Amaraweera

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Energy & Advanced Material Chemistry

The main objective of the Energy & Advanced Material Chemistry project is to carry out research on renewable energy. Research is mainly focused on chemistry and physics of new materials for the conversion of solar energy into chemical and electrical energies. Several research projects such as; Extending and adapting current photovoltaic technology mainly dye-sensitized, Q-dot and polymer solar cells to generate electricity directly from solar radiation; Constructing artificial chemical devices mimicking photosynthesis to collect, direct, and apply solar radiation, for example to split water, convert atmospheric carbon dioxide and thus produce various forms of environmentally clean fuels; Chemical, Electrochemical and Photochemical methods for the purification of air and water are the main research topics of the project. Additionally, the project also involves investigation of low cost water and air purification methods for abatement of industrial pollutants by using sunlight. In the research topics of conversion of solar energy into either electrical or chemical energy mentioned, the fundamental requirements are; sunlight must be absorbed efficiently by light harvesting materials; photoexcited electron and holes must be separated in space to prevent recombination; photoexcited charge must be energetically and kinetically able to perform a chemical transformation. Hence we investigate all these factors in our research.

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Conversion of solar energy into electrical energy: Dye-sensitized solar cells (DSC) have been introduced as a low-cost alternative to currently available expensive Si solar cell in the market. DSCs are fabricated with large band gap oxide semiconductors such as TiO_2, ZnO, and SnO_2 decorated with light absorber dye molecules. The foremost problem in DSC is the rapid charge recombination problem and research is being carried out by Energy & Material Chemistry group to minimize the charge recombination by introducing 1-D materials in the fabrication of photoanode of DSC. During recent pass, the group synthesized different 1-D nanostructures such as 1-D-TiO_2, SnO_2, ZnO, $SrTiO_3$, $BaTiO_3$ and successfully demonstrated that these 1-D materials in fabrication of DSC.

In addition, Q-dot sensitized solar cells have been investigated to optimize and utilization of wide-spectrum solar energy. Three different complementary Q-dots were deposited on TiO_2 nanoparticles in order to absorb UV, Visible as well as IR and near IR light as shown in Figure 1.

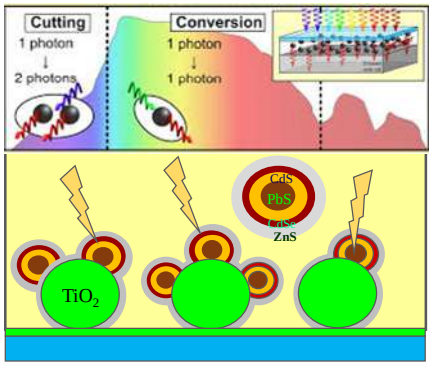


Figure 1. Schematic image of three complementary Q-dot sensitization of solar cells to harvest wider-spectrum

Conversion of solar energy into chemical energy: Hydrogen is considered as the future energy source and production of hydrogen using solar energy is one of the main goals of the Group. 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 the field of Physical Chemistry and the Group actively carries out research to tackle this problem.

In photocatalysis, TiO_2 is the most widely used 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 the solar 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 sunset to sunrise and the solar spectrum consists of 47% IR radiation. We have recently developed Ag_2O/TiO_2 photocatalyst that utilizes the IR region and produces 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.

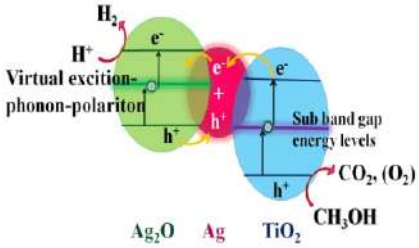


Figure 2. Schematic proposed photocatalytic process of $Ag_2O/Ag/TiO_2$ photocatalyst.

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 as shown in Fig. 2. 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.

While we continue to investigate ONF phonon assisted process for water splitting, a novel air stable reduced Titanium dioxides such as Ti^{3+}, Ti^{2+} states have been synthesized and tested for water splitting reaction to produce hydrogen.

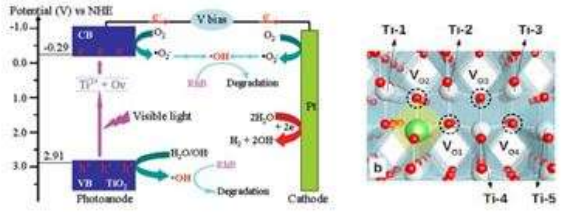


Figure 2.Energy diagram of TiO_2 and reduced Tistates and the schematic image of reduced TiO_2 states having Ti^{1+}, Ti^{2+} and Ti^{3+} states in TiO_2 lattice.

Considering the electrochemical redox potentials of these reduced $Ti^{3+}$and Ti^{2+} states, these Ti states can be utilized for the conversion of atmospheric carbon dioxide and thus produce various forms of environmentally clean fuels. Initial investigation shows that CO_2 can be converted to C2-C3 molecules while N_2 can be converted to NH_3 by reduced $Ti^{3+}$and Ti^{2+} states by room temperature reactions. These catalytic system will be further developed to construct artificial chemical devices mimicking photosynthesis to collect solar radiation and to produce various forms of environmentally clean fuels by conversion of carbon dioxide and water.

Photochemical methods for the purification of air and water: Under this project, IR radiation active

photocatalyt was developed for the degradation of airborne pollutants. In this investigation, $Ag_2O/Ag/TiO_2$ catalyst was synthesized and successfully applied for the degradation of gaseous phenol under IR irradiation. As the photodegradation described in this report involves low energy IR photons under ambient indoor conditions, the catalytic system can be applied for the degradation of common airborne pollutants found in indoors as shown in Figure 3.

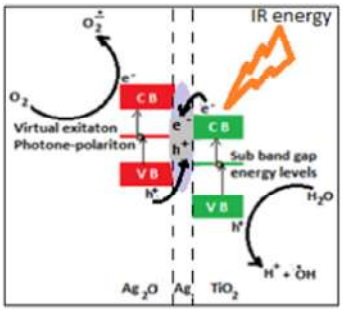


Figure 3. Schematic diagram of proposed photocatalytic process of $Ag_2O/Ag/TiO_2$ catalyst.

Water purification research: we investigated the TiO_2 nanofibers coated stainless steel mesh as a novel underwater superoleophobic membrane for the effective separation of contaminated oil-water mixtures (Figure 4a). The membrane was fabricated by spray deposition of hydrothermally synthesized TiO_2 nanofibers on stainless steel mesh. The fabricated membrane exhibits superhydrophilicity and superoleophobicity properties in air and underwater respectively, allowing the separation of oil water efficiently (Figure 4b). Randomly deposited TiO_2 nanofibers on mesh exhibit rough surface property and hence superhydrophilic nature. Water oil separation efficiencies of ~90 and ~99% were achieved with this filter for less viscous and highly viscous oil respectively.

Additionally, the TiO_2 nanofibers coated mesh can degrade immiscible organic molecules due to photocatalytic activity of TiO_2 nanofibers under UV light.

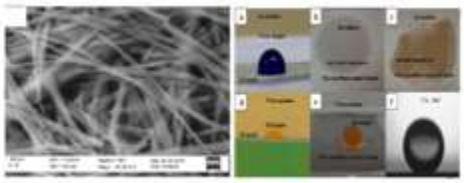


Figure 4.TiO_2 nanofibers and wetting properties of TiO_2 coated membrane

Research Students

Ph.D.- Mr. A. Manjceevan
Mr. A. Anapayan
Mr. U.B. Gunathilake

M.Phil.- Mr. K.M.S.D.B. Kulatunge

M.Sc.- Mr. K.C.I. Buddika,
Ms. D.S. Dharmagunawardena,
Mr. K.N.L. de Silva
Mr. A.M.B. Kulathunge,
Mr. R.D. Senevirathne

Key publications

Wasana, HMS., Perera, GDRK., Gunawardena, P de S., Fernando, PS., Bandara, J. (2017). WHO water quality standards Vs Synergic effect(s) of fluoride, heavy metals and hardness in drinking water on kidney tissues, *Scientific Reports*, 7,42516.

Gannoruwa, A., Ariyasinghe, B., Bandara, J. (2016). The mechanism and material aspects of a novel Ag_2O/TiO_2 photocatalyst active in infrared radiation for water splitting,*Catal. Sci. Tech.*6 (2), 479-487.

Akilavasan, J., Wijeratne, K., Moutinho, H., Al-Jassim, M., Alamoud, ARM., Rajapaske, RMG., Bandara, J. (2013). Hydrothermally synthesized titania nanotubes as a promising electron transport medium in dye sensitized solar cells exhibiting a record efficiency of 7.6% for 1-D based devices, *Journal of Materials Chemistry A* 1 (17), 5377-5385.

From Left: Mr. KCI Buddika, Mr. KNL de Silva, Mr. UB Gunathilake, Prof. J Bandara, Mr. KMSDB Kulatunge, Mr. AMKL Abeykoon, Ms. DS Dharmagunawardena

G. R. A. Kumara B. Sc. (1993), Univ. of Peradeniya (UoP); M. Phil. (1997), University of Sri Jayawardanapura; Ph. D, (2001) Shizuoka University, Japan; Research Professor, NIFS (Jan 2017-todate) Visiting Professor, JSPS: Toyota Technological University, Japan, 2016; Postdoctoral Research Fellow: Department of Chemistry, UoP (2014-2015); Commissioned Scientist: Toyota Technological University, Japan, (2015); Senior Research Fellow: UoP, (2011-2014); Honorable Guest Professor: Research Institute of Electronics, Shizuoka University, Japan, (2009-todate); Senior Scientist: SPD Laboratory, Hamamatsu, Japan (2006-2010); Temporary Senior Lecturer: UoP (2009-2011); Postdoctoral Fellow: JSPS, Shizuoka University, Japan, (2004-2006); Postdoctoral Fellow: JST, Shizuoka University, Japan, (April – August 2004); Visiting Researcher: Shizuoka University, Japan, (April 2003- March 2004); Assistant Professor: Shizuoka University, Japan (2001-2003); **Awards and Fellowships:** Young Scientist Awards, TWAS-Italy & NARESA, Sri Lanka, (1996); MONBUSHO, Japanese Government Fellowship, (1999), Presidential Awards for scientific publications (1999, 2010,2011, 2012, 2016); JST Japanese Government Fellowship, (2004); JSPS Japanese Government Fellowship, (2004); NRC Merit Award, (2013); NSF SUSRED Awards,(2013, 2016); JSPS Japanese Government Visiting Professor Fellowship (2016). Seven patents (national & international); Research publications received over 4000 citations; *h*-index of 31.

Material Processing & Device Fabrication

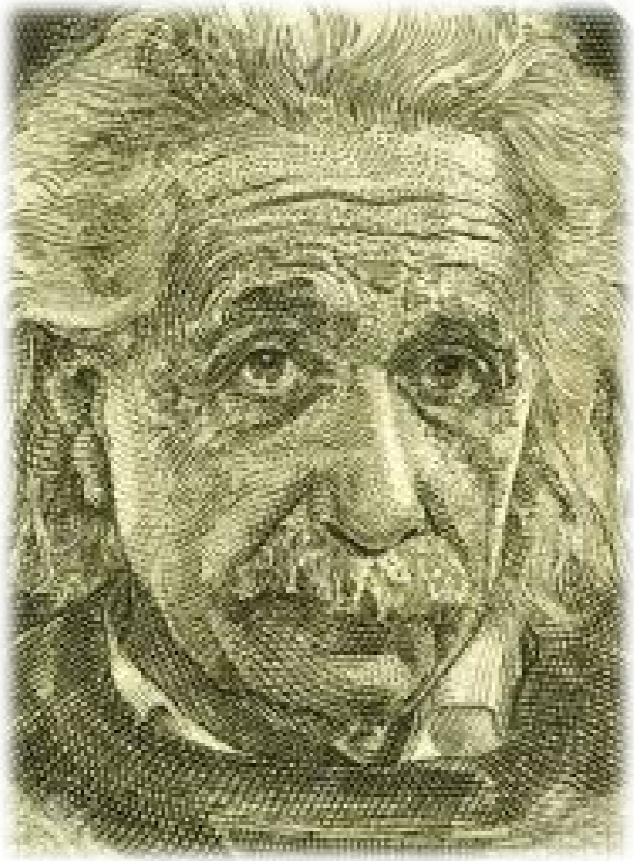
Material Processing & Device Fabrication project involves experimentation and basic studies in Material Processing and Device Fabrication with emphasis on graphite, graphite-based devices and carbon supercapacitors. Also investigations related to solar cells and other electronic devices based on new materials, primarily generated from local minerals.

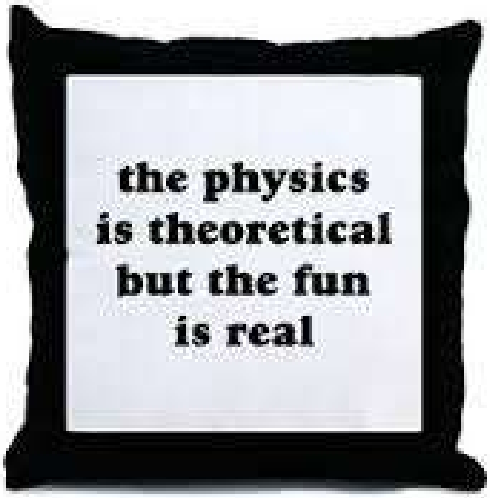
Work related to graphite will be the exfoliation of graphite and derivation into graphene plates, preparation of graphene thin films and their application in devices such as supercapacitors and solar cells. Furthermore, the project plans to conduct research in the area of extremely thin absorber solar cells and developing hole conducting materials to be used in these solar cell devices.

The project ideas stand at the forefront of current research in the areas of Materials Processing and Device Physics, related to Energy Conversion & Storage and Other Electronic Devices. The theme is nationally relevant and highly important. It is geared towards utilization of locally available materials with the aim of adding enormous values to local minerals and plant dyes. The outcomes of the research will help and improve the national economy through developing cutting edge local industries capable of manufacturing solar cells and other electronic devices.

Research Professor | grakumara2000@yahoo.com | grakumara@ifs.ac.lk

Morella Forest





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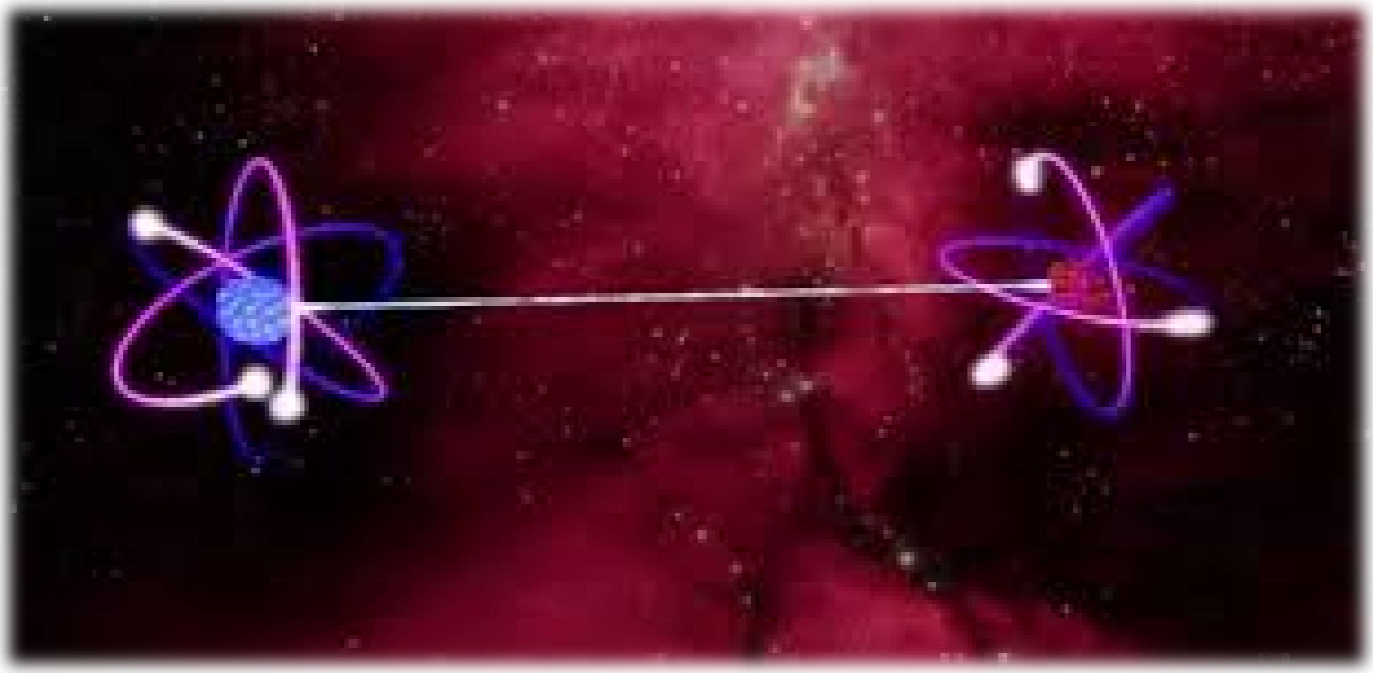

Theoretical Physics
&
Computational Studies

In Theoretical Physics and Computational Studies Research Unit at NIFS, we use the tools of theoretical and computational physics to address, explain and understand the physical world surrounding us. This research unit consists of projects under the areas of foundations of quantum mechanics and Single Bubble sonoluminescence (Mysteries of Energy Focusing Phenomena). Specifically the Quantum Physics Research Group is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

- Quantum Physics & Applied Electronics

Asiri Nanayakkara BSc in Mathematics (University of Colombo); MS in Physics (Ohio University USA); PhD in Physics (Iowa State University, USA). He has been a postdoctoral researcher at University of Bristol (UK), Ames laboratory (USA) and Supercomputer computations research institute (USA). He has also worked as a computational Scientist at CRAY Research inc. (USA) before joining NIFS. His research publications have received 72,559 citations (April 2016) and Google Scholar h-index of 55.

Quantum Physics & Applied Electronics

Quantum Mechanics:

Quantum mechanics, quantum field theory and relativity together form the theoretical foundations of modern physics. Even 100 years after its inception fundamental aspect of quantum mechanics is one of the most dynamic areas of current physics research. In particular, fundamental research on Quantum Non-locality, Quantum Entanglement and Quantum to Classical Transition is not only very important in understanding the true nature of the quantum reality but also their existence has practical consequences, enabling much stronger forms of information processing, communication and quantum computing. Quantum Physics research Group at NIFS which was initiated in January 2016 is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

Applied Electronics:

Brain–Computer Interface (BCI), sometimes called a direct neural interface is a direct technological interface between a brain and a computer. BCI systems are especially invaluable for patients who suffer from severe motor impairments. Using BCI systems they could communicate with the outside world via computer voice in their native languages (in Sinhala, Tamil or English) and / or control equipment such as wheel chairs and televisions. The main interest of the BCI project at NIFS includes identification of new mental activities that can be utilized in BCI systems as well as designing and construction of low cost hardware and software for BCI to be used in Sri Lanka.

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One of the unique features of quantum systems is quantum non-locality due to entanglement. On the other hand the processes of quantum decoherence can provide clues about the mechanism of wave function collapse and quantum to classical transition. Quantum decoherence and entanglement can be investigated both theoretically as well as numerically by means of quantum random walks that are the quantum counterpart of classical random walks. Further quantum walks provide a testing ground for various aspects of decoherence, wave function collapse and quantum to classical transition.

Although single particle one dimensional quantum walk cannot exhibit entanglement within the coin degree of freedom or the position degree of freedom separately, the conditional shift in the evolution operator of a quantum walk generates entanglement between coin and position degrees of freedom. Many investigations have been carried out for generation and utilization of entanglement in multidimensional quantum random walks as well as multiparticle random walks. Even though multidimensional coin operators constructed by taking direct tensor products of one dimensional unitary operators usually preserves entanglement if the initial coin state is entangled, they do not generate entanglement if the initial coin state is a product state.

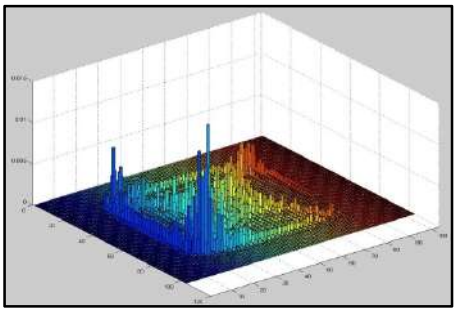


Figure 1: Probability distribution for ψ^+ state with no decoherence

In 2016, we discovered a non-local two particle coin which produces entangled particle states from non-entangle initial coin states. The entanglement was produced without any particle interactions or introducing higher dimensions as it has been achieved in the past by others. This new coin can also remove entanglement from maximally entangled initial coin states. The newly found quantum coin has unique features which have not been observed in any other two particle coins. As an example, when decoherence is introduced to one particle, the new coin made the wave function of the other particle undergo decoherence even though quantum walks based on 2-D Hadamard coins do not show similar behavior.

This new coin operator has the form C = $A_1 \otimes B_1 + A_2 \otimes B_2$, where operators A_1 and A_2 act on the wave function of the first particle while operators B_1 and B_2 act on the wave function of the second particle. When $A_1 = \begin{pmatrix} 1 & 0 \\ 1 & 0 \end{pmatrix}, A_2 = \begin{pmatrix} 0 & 1 \\ 0 & -1 \end{pmatrix}, B_1 = \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$ and $B_2 = \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix}$, the new coin operator C can be represented by a 4x4 matrix $C_s = \begin{pmatrix} 1 & 1 & -1 & 1 \\ 1 & -1 & 1 & 1 \\ 1 & 1 & 1 & -1 \\ 1 & -1 & -1 & -1 \end{pmatrix}$. Further we introduce decoherence through a retarder $R = e^{\frac{i\beta}{2}\sigma_z} = \begin{pmatrix} e^{\frac{i\beta}{2}} & 0 \\ 0 & e^{\frac{-i\beta}{2}} \end{pmatrix}$. The figures 1 and 2 show the evidence of decoherence in the wave function of the second particle when decoherence is applied to the first particle by the retarder.

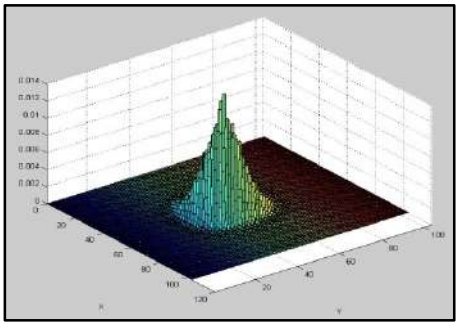


Figure 2: Probability distribution for ψ^+ state when phase retarder is applied to A_1 + A_2

As time progresses the coin $C_s$makes entanglement between particle states to increase even for initially unentangled coin states. Particle-particle entanglement and entanglement between coin states and position states are studied for a quantum walk in two dimensions. The Von Neumann entropy is used to quantify the entanglement. Figure 3 illustrates how the entanglement increases with time steps for an unentangled initial coin states. Manuscripts based on the outcome of this project in 2016 are in preparation.

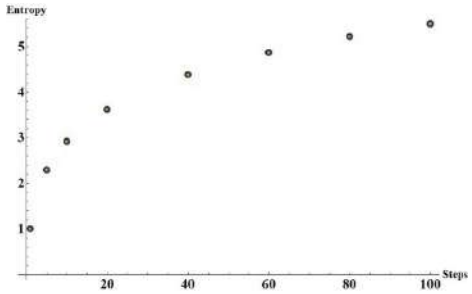


Figure 3: Entanglement increases with time steps for an unentangled initial coin states

In 2016, we have been mainly involved in designing and construction of a low cost portable BCI system which accepts EMG, EOG and EEG as inputs. The input signals can be collected from scalp, face or arm of a person. This BCI system consists of three hardware parts. A new type of electrode cap was designed and constructed to collect EEG signals from specific

locations of the scalp. The electrical signals (EEG, EMG or EOG) are amplified by an eight channel portable amplifier that was constructed using Texas Instruments ADS1299 IC (Figure 4). The electrical signals are processed by a lap top computer which is kept away from the subject.

Figure 4: EEG/EMG/EOG Amplifier circuit board constructed in our lab at NIFS

Bluetooth based data communication system was constructed for data transfer between the amplifier which is attached to the electrode cap and the lap top computer. Software for signal processing, feature vector construction and classifications were developed with MATHLAB computer language. Construction of this BCI system has been completed in 2016.

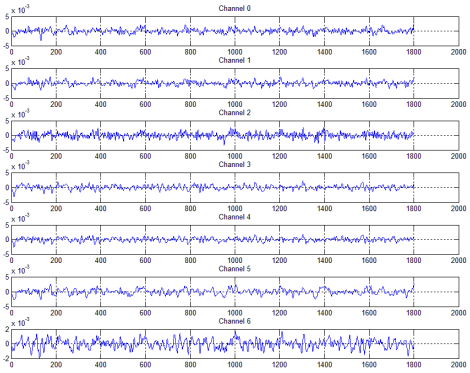


Figure 5: EEG signals recorded with newly constructed amplifier.

Research Students

M.Phil. - Mr. Vibhoda Bandara (BCI)
Mr. Mahesh N. Jayakody (Quantum Physics),
Mr. Randika Dodangodage (Quantum Physics)

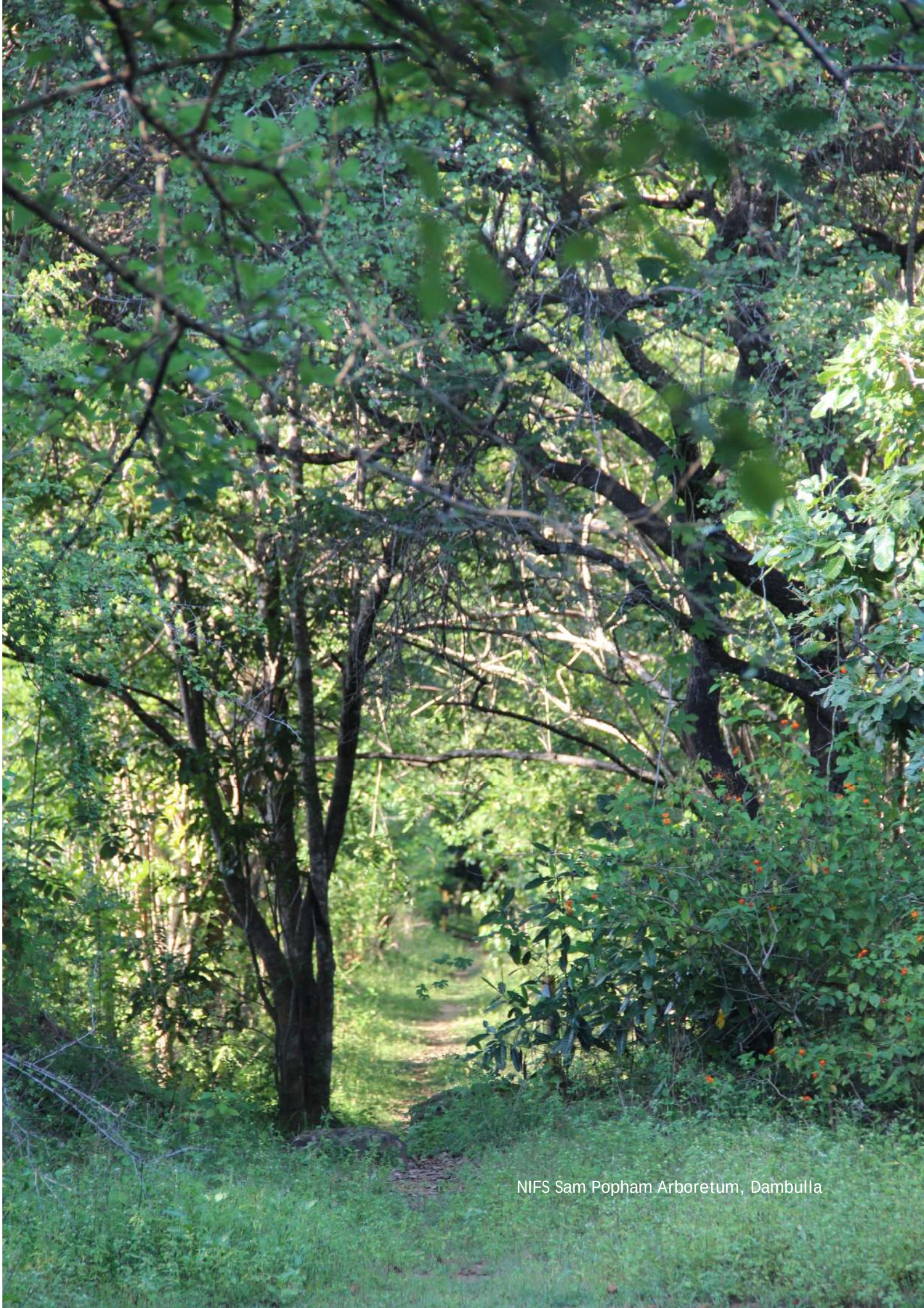
Key Publications

Nanayakkara, A., Mathanaranjan, T. (2012). Equivalent Hermitian Hamiltonians for some non-Hermitian Hamiltonians" *Physical Review A*, 86, 022106.

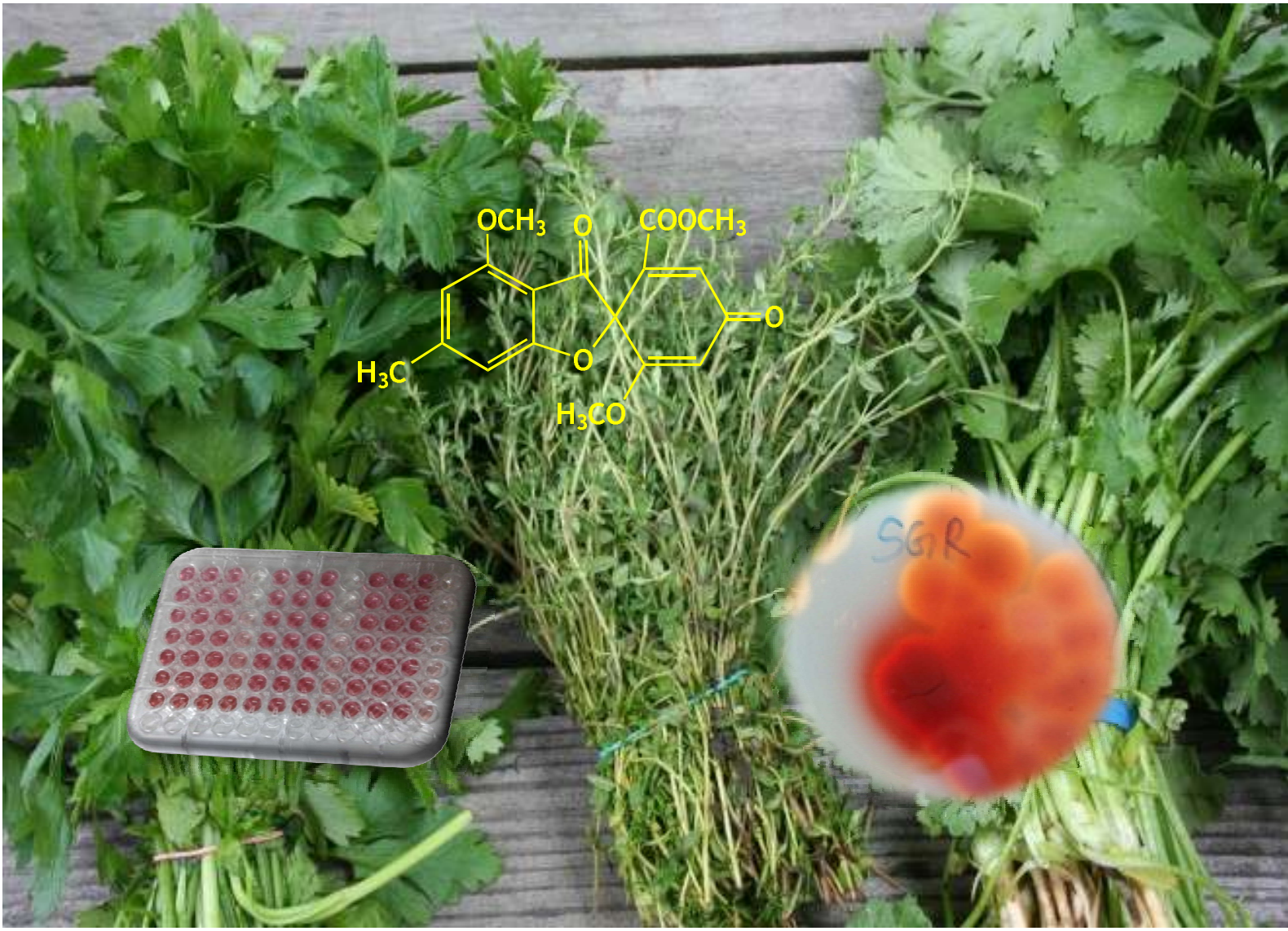
Nanayakkara, A. (2012) "Dynamical tunneling-like effects in 1D classicalsystems", *J. Phys. A: Mathematical and Theoretical* 45, 444025

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

From Left: Mr. Mahesh N. Jayakody, Mr. Randika Dodangodage, Prof. Asiri Nanayakkara, Mr. Vibhoda Bandara



NIFS Sam Popham Arboretum, Dambulla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Natural Products & Food Chemistry

Many types of plants, plant products (fruits and vegetables) and microorganisms such as fungi contain bioactive components which are of benefit to humans. These have been consumed as food and some have been used for medicinal purposes for centuries. The Natural Products and Food Chemistry unit of the NIFS has practical experience in the study of medicinal plants, natural products and functional food science. Studies are mainly focused on identifying natural products present in plant and fungal extracts, and in medicinal preparations. The preventive/therapeutic effects of these compounds are evaluated against chronic human diseases such as diabetes and cardiovascular diseases. Research work done in this unit involves the isolation and identification of biologically active compounds from natural sources, the development and validation of analytical methods, and the evaluation of their health and crop protection effects through in vitro and in vivo studies. The knowledge gained will eventually be used in the development of novel food products, food supplements and health foods with enhanced nutritional and functional properties. Fungal metabolites with useful bioactive properties will be cultured on a large scale for further studies and possible commercial applications.

- Natural Products
- Nutritional Biochemistry

Lalith Jayasinghe, Senior Research Professor, NIFS, Kandy; Ph.D., University of Peradeniya, 1992; B.Sc. (Chem Sp) Degree, University of Peradeniya; Diploma in Natural Products Chemistry by Tokyo Institute of Technology, Japan in 1994; Alexander von Humboldt Research Fellow at the University of Hohenheim, Stuttgart (1999/2000) and Jacobs University Bremen (2011 & 2015) Germany; the IPICS Research Fellowship in 1988 to University of Karachi, Pakistan; Kandiah Memorial Award, Institute of Chemistry Ceylon (1992); TWAS-NARESA Young Scientist Award in 1992; UNESCO & Mombusho Research Fellowship in 1993; Visiting Scientist at the Tokyo Institute of Technology in 2004; University of Mississippi, USA from 2004-2005 and the University of Milan, Italy, in 2006; Visiting Professor at the Tokyo Institute of Technology in 2009; Elected Fellow of the National Academy of Sciences of Sri Lanka 2012; Presidential awards for Scientific Publications (2002, 2003, 2004, 2006, 2007, 2008 & 2012) Research publications have received 978 citations (January 2017); h-index of 16; 67 Scientific Publications, 3 Book Chapters; 185 Communications to Learned Societies (Local and foreign); Research grants from NSF and NRC Sri Lanka.

Natural Products

Natural Products are compounds produced by plants, fungi and marine organism. 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 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 enzyme 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.

Senior Research Professor | ulbj2003@yahoo.com | http://nifs.ac.lk/?research-project=natural-products

Visiting Research Professors

N. Savitri Kumar, Ph.D, Univ. of London,1971: Emeritus Prof (UoP) (June 2009): Research Prof IFS, Kandy (August 2009–2015); Visiting Research Prof NIFS, Kandy (August 2015–to date); Invited Visitor, Rockefeller Foundation, Bellagio Center, Milan, Italy (2007 Sept-Oct): Visiting Prof, Univ. of South Pacific, Suva, Fiji, Feb-June 2006: Head**,** Dept. of ChemistryUoP, 2001– 2004: NSF Research Fellow (2005): Visiting Scientist, IACR, Rothamstead Experimental Station, UK (1998); Research Fellow, Dept of Chemistry, UBC, Vancouver, Canada (1986): Research Fellow, Univ. of Stockholm, Sweden 1985-1986; Postdoctoral Research Fellow, York Univ., Ontario, Canada (1977-78): Royal Society Commonwealth Bursary, UK 1977; Elected Fellow SL National Academy of Sciences 1991; Joint Awardee of the Sri Lanka President's Award for Scientific Achievements to the Natural Products Research Group led by Prof. MUS Sultanbawa at UoP (1985). Presidential awards for Research 1991, 1995, 1996, 1999, 2005, (awarded in 2010), 2008, 2009; Research publications have received 716 citations (Feb 2017); h-index of 15; Research grants from NSF Sri Lanka and NRC Sri Lanka at the IFS and UoP; International research awards; joint awardee of Asian-Swedish Research Partnership program,(1994- 2003) and Sida Bilateral Cooperation with Sri Lanka; IPICS, Uppsala, Sweden; TWAS Trieste, Italy and IFS, Stockholm.

Yoshinori Fujimoto, Ph.D, 1978; B.Sc. 1973, Chemistry, Tokyo Institute of Technology, Japan; Postdoctoral Researcher, School of Pharmacy, Univ. of Wisconsin-Madison, USA (May 1979–April 1982); Technical Staff of Education and Assistant Professor (May 1982–Feb 1990), Chem Dept, Tokyo Inst Tech; Associate Professor of the same (Mar 1990–Sep 1996); Professor (Oct 1996–Mar 2015), Department of Chemistry and Materials Science, and also Chem Dept; Retired as Emeritus Professor from Tokyo Inst Tech (Mar 2015); Visiting Research Professor, NIFS Kandy, Sri Lanka (May 2015– to date); Visiting Professor, School of Agriculture/Organization for the Strategic Coordination of Research and Intellectual Properties, Meiji University, Japan (Jun 2015–to date); Research publications received 5,520 citations (Jan 2017); h-index of 27; Published 272 research papers; Author of 14 book chapters and books, and 11 patent applications.

Nikolai Kuhnert, PhD. (1995) University of Würzburg; Postdoctoral Researcher University of Cambridge, University of Oxford; Lecturer and Senior Lecturer in Organic Chemistry, University of Surrey in 1998. Full Professor of Analytical and Organic Chemistry, Jacobs University Bremen (2006-todate).Visiting Professor Universities of Saarbrücken, Regensburg, Bremen, CSIC Rocasolano in Madrid, CEBAS in Murcia and KAUST. Research publications received 4,435 citations (January 2017); h-index of 33.

Nimal Adikaram, PhD. Queen's University of Belfast (1981); BSc Botany sp. University of Colombo (1975); Retired Senior Professor of Botany (2014); Professor Emeritus; Visiting Research professor, NIFS (2017-todate); Fellow (Elect), National Academy of Sciences of SL; Honorary Fellow, Indian Mycological Society. Head, Dept of Botany, UoP (1999-2000, 2002 – 2009); Chairman, Board of Study, PGIS (2003 – 2009); Editor-in Chief, Ceylon. J. Science (Bio. Sci.) (1998 –2007); TWAS Young Scientist Award in Biology (1988); King Baudouin Award, International Foundation for Science (IFS), Sweden (1990); General Research Council Award, SLAAS (1993); Silver Jubilee Award for research, IFS, Sweden (1997); NSF Merit Award for research in bioactive lichen substances (2004); CVCD award in 2012; Presidential Awards for Research (2003–2005, 2007-2009 & 2012); International Consultant in Postharvest Technology for Food & Agriculture Organization of the UN in Bangladesh (2003) & Plant Health for Asian Development Bank (ADB) in Cambodia in 2015. Published over 80 scientific articles, four books and five book chapters which earned 902 citations, h-index 17.

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

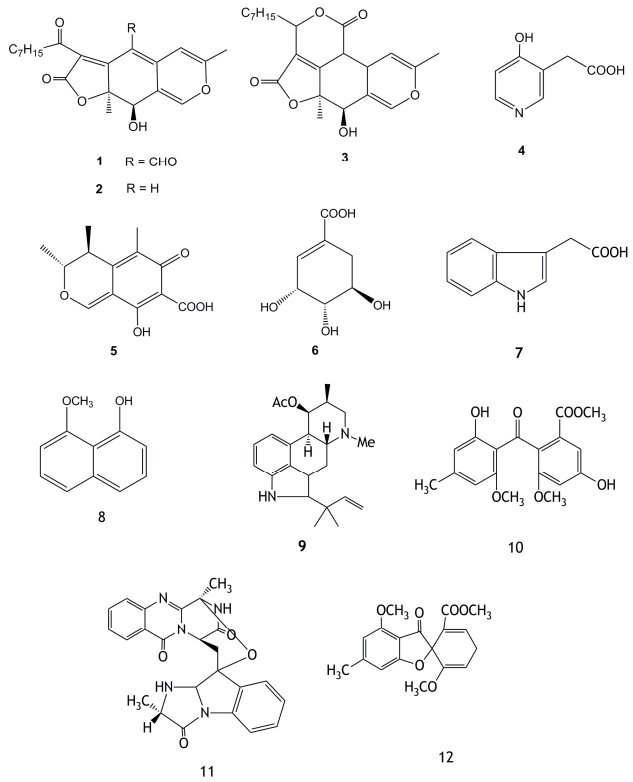
(1) Investigation of extracts from plant sources and,epiphytic and endophytic fungi, for use in agriculture and human health
(2) Chemistry and bioactivity of edible fruits
(3) Plant secondary metabolites and LC-MS profiling of bioactive extracts

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, immunosuppressants, 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*. Currently we are studying the chemistry and bioactivity of secondary metabolites produced by the endophytic fungi isolated from some medicinal plants. Several secondary metabolites with interesting structural features and some useful bioactivities have been isolated. Structures of some selected compounds are given below. Pithaloid B & D (**1** & **2**) and a new pithaloid with a lactone ring (**3**), demethoxycinnapine (**4**) {*Phialemonium curvatum* from *Manilkara zapota*}; speciferone A (**5**) {from *Artocarpus altilis*)} shikimic acid (**6**) {from *Flacourtia inermis*}; indole-3-acetic acid (**7**) {*Colletotrichum siamnase* from *Piper nigrum*}; 1-methoxy-8-naphthol (**8**) {*Daldinia eschscholtzii* from *Phyllanthus acidus*}; fumigaclavin C (**9**) monomethylsulochrin (**10**), fumaquinazoline C (**11**), and trypacidin (**12**) {*Aspergillus fumigatus* from *Solanum insanum*}.

Metabolites produced by the fungus *Monacrosporium ambrosium*.

The shot-hole borer beetle (SHB) *Xyleborus fornicatus* causes serious damage in the tea (*Camellia sinensis* var. *assamica*) plantations of Sri Lanka and South India. SHB is found in symbiotic association with the ambrosia fungus *M. ambrosium* (syn. *Fusarium ambrosium*) in galleries located within the pencil thick stems of tea bushes. *M. ambrosium* is known to be the sole food source of SHB beetles. Six pigmented naphthoquinones produced during spore germination in a laboratory culture broth of *M. ambrosium* were isolated and identified as dihydroanhydrojavanicin, anhydrojavanicin, javanicin, 5,8-dihydroxy-6-methyl-7-(2-oxopropyl)naphthalene-1,4-dione, anhydrofusarubin and solaniol. Extraction with chloroform of tea stems having red coloured galleries occupied by SHB beetles led to the detection of UV active compounds similar to the above naphthoquinones. Laboratory assays demonstrated that the combined ethyl acetate extracts (Extract A) of the fungal culture broth and mycelium inhibited the growth of endophytic fungi *Pestalotiopsis camelliae* and *Phoma multirostrata,* which were isolated from tea stems. By contrast, *M. ambrosium* did not inhibit the growth of *Bipolaris sorokiniana*, *Daldinia eschscholizii* and *Glomerlla magna,* also endophytic fungi, isolated from Sri Lankan medicinal plants. These results suggest that the naphthoquinones secreted by *M. ambrosium* during germination of spores possess fungal inhibitory activity to prevent other fungi residing in tea stems from invading SHB galleries. Thus, it is proposed that the fungal ectosymbiote of SHB provides not only the food and sterol necessary for the development of the beetle during its larval stages, but also serves as a producer of fungal inhibitors.



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. Currently we are in the process of profiling polyphenols in popular green herbs in Sri Lanka.

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 extracts that display antifungal activity could lead to the isolation and identification of environmentally friendly pesticides and antifungal agents.

Research Students

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Chief Technical Officer

Mr. D.S. Jayaweera

Key Publications

1. Padmathilake, KGE, Bandara, HMSKH, Qader, MM, Kumar, NS, Jayasinghe, L, Masubuti, H, Fujimoto, Y. (2017). Talarofuranone, a New Talaroconvolutin Analog from the Endophytic Fungus *Talaromyces purpurogenus* from *Pouteria campechiana* Seeds, *Natural Product Communications.* (*in press*)

2. Alakolanga, AGAW, Kumar, NS, Jayasinghe, L, Fujimoto, Y. (2015). Antioxidant property and α-amylase, α-glucosidae 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.

3. Gunawardena, DC, Jayasinghe, L, Fujimoto, Y. (2015). Phytotoxic Constituents from the fruits of *Averrhoa carambola*, *Chemistry of Natural Compounds*, **51**, 532-533.

From Left: Mr. MM Qader, Ms. S Sathya, Ms. D Premasiri, Ms. CL Kehelpannala, Prof. NS Kumar, Prof. L Jayasinghe, Prof. NKB Adikaram, Ms. D Thanabalasingam, Mr. DS Jayaweera, Ms. DMDM Dissanayake, Mr. GRN Rathnayake, Ms. VK Munasinghe, Ms. CB Gunawardhana

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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 including functional and nutritional properties of food, food safety, and functional food product development to improve health and well-being of people.

Functional and nutritional properties of food: Under this research theme, studies are carried out to assess the antioxidant, enzyme inhibition (α-amylase, α-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. At present, there are several ongoing studies on assessing the functional properties of some selected starches and macro algae in Sri Lanka.

Novel assay development: A novel assay was developed to determine α-amylase activity. α-Amylase is an enzyme responsible for hydrolysing α bonds such as in 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 residues and trace elements in milk powder available in market were analyzed.

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Substrate specificity of glucose oxidase (GOx) and clinical implications:

The use of enzymes in analytical reagent preparation has grown exponentially since the 1970s owing to the high specificity exhibited by these molecules towards the reaction they catalyse. The enzyme glucose oxidase (GOx) is one of the widely used enzymes clinically and industrially due to its high specificity towards D-glucose. However, our preliminary studies showed that GOx interacts with other sugars. Thus, the interaction of GOx with other sugars and sugar alcohols was studied and the Vmax, Km, Kcat, catalytic efficiency and the lowest detection limit for each sugar and sugar alcohol were calculated. The Km values of the sugars ranged from 2.23 ± 0.07 to 1580 ± 78 mM and glucose showed high affinity towards GOx followed by maltose and galactose. The lowest affinity was recorded in fructose while lactose, arabinose, rhamnose, mannitol, arabitol, ribitol and xylitol did not show any significant reaction with GOx. The lowest detection limit (LDL) for the sugars varied from 0.04 ± 0.001 to 445.55 ± 5.75 mM. Glucose showed high sensitivity towards GOx while the least was observed in fructose.

Samples	Km (mM)	LDL (mM)
Glucose	2.23 ± 0.07	0.04 ± 0.002
Maltose	25.4 ± 2.25	0.48 ± 0.03
Galactose	412.22 ± 12.5	5.2 ± 0.3
Sucrose	989.87 ± 64.7	19.96 ± 1.9
Xylose	790.9 ± 48.47	17.5 ± 0.8
Sorbitol	424.56 ± 29	40.8 ± 0.6
Fructose	1580± 78	445.5 ± 5.8

The glucose kit reagent used for blood glucose estimation mainly consists of GOx. The reaction taking place is,

$$\text{Glucose} + O_2 \xrightarrow{\text{GOx}} \text{gluconic acid} + H_2O_2$$

$$2H_2O_2 + \text{Phenol} + \text{4-Aminoantipyrine} \xrightarrow{\text{POD}} \text{Red quinone} + 4H_2O$$

GOx is widely used in diagnostic reagents due to its high specificity towards glucose. However, as can be seen, GOx shows significant interaction with other sugars as well. Although the sensitivity of galactose is roughly 128 times lower than glucose, the LDL for galactose is 5 mM which is below the cut-off value to be detected as hyperglycemic (>6 mmol/L). Thus, this fact should be considered when treating people suffering from galactosaemia where they can be misdiagnosed as having diabetes. In addition, maltose, galactose and xylose are found in biological preparations given intravenously. Patients given intravenous fluids containing these sugars can be misinterpreted as having elevated serum glucose levels and administration of insulin in these cases may lead to hypoglycemia and in severe cases can result in death.

A simple microplate-based method for the determination of α-amylase activity using the glucose assay kit (GOD method):

For the first time, a reliable, simple, rapid and high-throughput analytical method for the detection and quantification of α-amylase inhibitory activity using the glucose assay kit was developed based on our previous observation on interaction of GOx with maltose. The new method facilitates rapid screening of a large number of samples, reduces labour, time and reagents and is also suitable for kinetic studies. This method is based on the reaction of maltose with glucose oxidase (GOx) and the development of a red quinone. The test is done in microtitre plates with a total volume of 260 µL and an assay time of 40 min including the pre-incubation steps. In the present work, the developed GOD method was successfully used to determine the amylase inhibitory activity of acarbose, three phenolics and five natural herb extracts. The results demonstrate that the developed method is accurate, quantitative, precise and highly reproducible. The new method can be considered as a high-throughput technique as it allows the analysis of several samples at once and also it is most suitable for kinetic studies.

Comparative analysis of physicochemical, morphological and functional properties of starches available in Sri Lanka:

Starch is a major energy-providing carbohydrate in the human diet. Thus, starches from various plant species, have received extensive attention in food research. Starch contributes 50 to 70% of the energy in the human diet, providing a direct source of glucose. The glycemic response to excessive consumption of starch may be a factor in some diet-related illnesses. The present study was conducted to study the variability in physicochemical, morphological and functional properties of 16 starches available in Sri Lanka. The hydrolyzing rate of the starches against α-amylase and amyloglucosidase was determined by the GOD method. The granule morphology and the biochemical composition of starches were determined using Scanning Electron Microscopy (SEM) and CHN analyser respectively. The water absorption index (WAI), water solubility index (WSI) and water swelling capacity (WSC) of the starches were also determined. Hydrolyzing rates of the starches for amyloglucosidase and α-amylase ranged from 4.78±3.04 - 85.69±8.18 µM glucose/min and 2.10±1.25 - 174.37±9.96 µM

maltose/min respectively. The highest glucose and maltose releasing rates were observed respectively in Oats and Palmyra while the least rate was observed in Soy on both occasions. The median granule size of starch of tested flours ranged from 12.22 to 1457.20 μm^2. The largest granule size was found in Mandu followed by Kithul, Chickpea and Oats while White Basmati, White Raw Rice and Red Basmati had markedly smaller granule sizes.

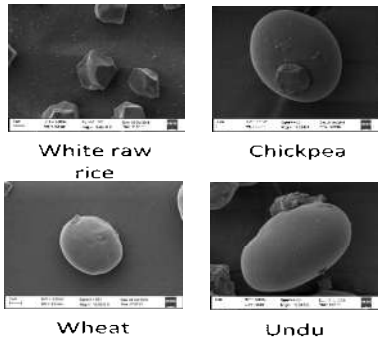

Figure 1: SEM images of starches

Research Students

M.Phil. -Ms. R. Visvanathan
Ms. G.T.R. Abeynayake

Undergraduate Trainee– Ms. R.J. Bangamuwage

Publications:

Visvanathan,R., Jayathilake, C., Liyanage, R. (2016). A simple microplate-based method for the determination of α-amyalse activity using the glucose assay kit (GOD method), *Food Chem.* 211,853–859.

Perera, O.S., Liyanage, R., Wettasinghe, P., Jayawardhana, B.C., Vidanaarchchi, J.K., Fernando, P., Sivakanesan, R. (2016). Cowpea incorporated diets modulate serum lipids and serum antioxidant activity in Wistar rats. J Narl Sci Found Sri. 44, 69-76.

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From Left: Ms. GTR Abeynayake, Dr. R Liyanage, Ms. R Visvanathan


Kurerkan
Kiffaul
White Basmati Rice
Palmirah
Chickpea
Flour


Biofilm-F
-RHIZIN
UREA REPLACEMENT

Soil Microbiology
&
Carbon Sequestration

In the evolution of the Earth, formation of the lithosphere preceded that of the biosphere and even today the existence of plants depends largely upon soil which provides the substrate for anchorage and most of their nutrients. Soil nutrient supply is sustained by cycling of water, carbon, nitrogen, sulfur etc and these processes are mediated by soil microorganisms. Studies carried out by this cluster are aimed at sustaining and improving soil fertility by manipulating the role of microorganisms in nitrogen fixation, carbon sequestration and enhancing root growth and nutrient uptake through the introduction of beneficial microbial communities in biofilm mode. Research work is also directed towards microbial generation of bio-energy to circumvent the use of environmentally damaging fossil fuels.

- Microbial Biotechnology
- Bioenergy & Soil Ecosystems

Gamini Seneviratne B. Sc. (1984), Ph.D, University of Peradeniya, Sri Lanka, (1993); Senior Research Professor, National Institute of Fundamental Studies; Postdoctoral Fellow, Katholieke Universiieit Leuven, Belgium (1994); Visiting Collaborative Research Fellow, University of Sydney, Australia (April-June 2007); Visiting Professor, University of Sydney, Australia (January-May 2009); Member, Soil Science Society of America/American Society of Agronomy; Member, American Society for Microbiology; Associate Editor, Agriculture, Ecosystems & Environment (Elsevier); Research publications have received 1082 citations (December 2016); Google Scholar h-index of 19; Elected Fellow of the National Academy of Sciences (2011 to date). **Awards:** Presidential Research Awards (1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006); Listed as a top researcher in Sri Lanka by the University Grant Commission (UGC), Sri Lanka & one of the most productive scientists in Sri Lanka in the Third World Academy of Sciences, Italy.

Microbial Biotechnology

The research program focuses investigations on the role of in-vitro developed microbial biofilms in agriculture, plantations and the environment. With the invention of development of microbial biofilms, fungal-bacterial biofilms (FBBs) in particular, 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, BFBFs are used in over 10,000 acres in the country with a chemical fertilizers (all NPK) usage cut down to 50% and also in organic agriculture. The target during 2017, is to expand the extent of land up to 100,000 acres. After field testing, BFBFs are also used now in tea cultivations in South India. Plans are underway to start testing them in rice cultivation in Vietnam and Cambodia.

Current studies are centered on agricultural, health and environmental benefits of the use of BFBFs, and also industrial applications of FBBs.

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Microorganisms are of greater importance in the production of industrial enzymes, such as amylase, cellulase, protease, lipase, etc. Amylases are one of the most important enzymes used in Biotechnology. These starch degrading amylolytic enzymes are vital in biotechnological applications in industries ranging from food, fermentation, textile, paper, pharmaceutical to sugar. Microbial enzymes are preferred to those from plants and animal sources, because they are cheaper to produce, and their enzyme contents are more predictable, controllable and reliable. Efficiency of microbial enzyme production depends on the nature of the culture media. The study was conducted with the objective of identifying the effect of the physical nature of culture media on microbial amylase production. A bacterial, a fungal sp. and a fungal-bacterial biofilm (FBB) were inoculated separately into two different culture media (solid and liquid). Control was maintained without any microbes. The study was laid in a Completely Randomized Design (CRD). A *Bacillus* sp. and a *Aspergillus* sp. were used for inoculation. Amylase enzyme assays were conducted at three stages *viz*: initial stage, after 2 and 4 weeks. Meanwhile, the attachments of the microbes were examined weekly to observe the biofilm formation. Data were analyzed by ANOVA and means were separated by *t*-test. Bacteria and FBB showed good biofilm formation. Bacterial biofilms significantly improved the amylase enzyme production in liquid medium, whereas in solid medium FBB showed the highest enzyme production. According to this study, microbial amylase enzyme production was observed to vary with the physical nature of the culture media. Thus, amylase enzyme production depends on the selection of culture medium according to industrial requirement. Further studies are required to understand the effects and potentials of the physical nature of culture media.

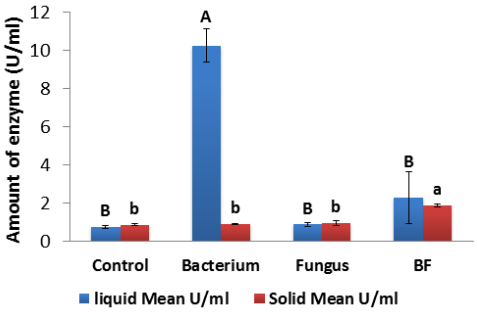

Figure 1. Amylase enzyme produced after 4 weeks in liquid or solid medium by the bacterium, fungus and BF- FBB.

Chronic kidney disease of unknown etiology (CKDu) has become a very serious health problem in some parts of Sri Lanka. The causative factors and etiology of this chronic kidney disease therefore is still considered uncertain or unknown. Now this disease is considered to be multifactorial origin. Causes of chronic kidney disease are suspected to be occupational and environmental. Paddy cultivation is one of the key economic sectors in the areas where the chronic kidney disease has been spread. Cadmium (Cd) contamination and high fluoride (F) level are suspected to be two key parameters responsible for the CKDu. Chemical fertilizers are one of the major sources that add heavy metals and fluoride into paddy soil. Biofertilizers are a good alternative to reduce chemical fertilizer application in rice fields. The study was conducted in a greenhouse in the National Institute of Fundamental Studies to evaluate the above CKDu parameters with the application of a biofilm biofertilizer (Biofilm – R) to rice. A leaching tube experiment was carried out in a Complete Randomized Design with four treatments and three replicates; full rate (100%) of chemical fertilizers (NPK), 50% of chemical fertilizers with Biofilm – R, Biofilm – R alone and initial soil alone as the control. Cadmium acetate was used to spike Cd in the soil. Leachate F level was determined using ion selective electrode, whereas Cd levels in soil, leachate and plant (in early vegetative growth) were determined by flame Atomic Absorption Spectrometer. Plant dry weight was measured. Data were analyzed using GLM procedure and means were separated by Duncan's multiple range test. Biofilm biofertilizer application showed decreasing trends of F and Cd levels in leachate and also Cd uptake by the plant. Further studies are necessary to evaluate these effects for a longer period.

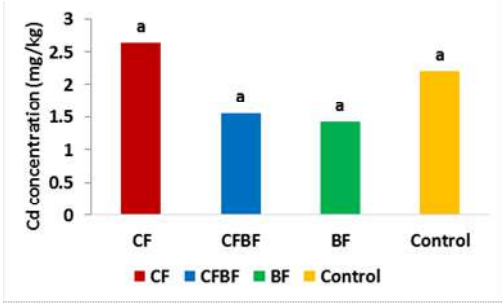

Figure 2. Plant Cd uptake in different treatments. CF- Chemical fertilizers (100%), CFBF- Chemical fertilizers (50%) + Biofilm-R, BF- Biofilm-R alone.

Soil microbiota are frequently influenced by the temporal and spatial activities, and that hampers functionality of the soil microbiome. Under hostile conditions, plant growth and productivity are lowered mostly in agroecosystems. The application of synthetic compounds to increase plant growth results in environmental issues and reduced sustainability of conventional agroecosystems. Recent studies have introduced microbial biofilms as biofertilizers, now known as Biofilm biofertilizers (BFBFs), to reinstate sustainability of degraded agroecosystems. A study was conducted to evaluate temporal changes of soil microbes and endophytes under lowland conditions using rice in a pot experiment, with treatments; 50% chemical fertilizers NPK (CF), 100% CF, Biofilm-R alone, 50% CF + Biofilm-R and the control with no

amendments. The experiment was arranged in a Completely Randomized Design with three replicates. Soil and endophytic microbial counts were enumerated for 12 weeks. Then, the plants were harvested, and shoot and root length, number of tillers and panicles per plant were recorded. Initial and final soil pH, nitrogen and carbon were also measured. Compared to the other treatments, 50% CF + Biofilm-R and Biofilm-R alone showed significantly increased soil microbial and endophytic counts ($p < 0.05$), and endophytic biofilm induction that contributes to healthy plant growth. Further, 50% CF + Biofilm-R showed the significantly highest fungal-bacterial ratio in the soil, reflecting restoration of microbiota.

Since this field of research is still in early stages, further studies are needed to identify its effects and potentials.

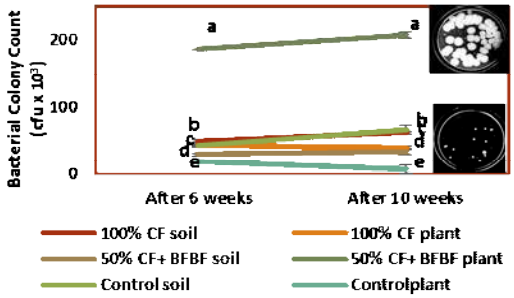

Figure 3.Soil and endophytic bacterial colony counts of rice in different treatments. Inset photos show plated endophytic bacterial colonies (large, due to biofilm induction) of 50% CF + Biofilm-R (top), and small endophytic colonies of 100% CF (bottom).

Research Students

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Key publications

Buddhika, U.V.A., Seneviratne, G**.,** Ekanayake, E.M.H.G.S., Senanayake, D.M.N., Igalavithane, A.D., Weeraratne, N., Jayasekara, A.P.D.A., Weerakoon, W.L., Indrajith, A., Gunaratne, H.M.A.C., Kumara, R.K.G.K., De Silva, M.S.D.L., Kennedy, I.R. (2016) Biofilmed biofertilizers application in agroecosystems. In: V.K. Gupta, D. Thangdurai, G. D. Sharma (eds.), Microbial Bioresources, CAB International, Wallingford, United Kingdom, 96-106.

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Seneviratne, G., Kulasooriya, S.A. (2013). Reinstating soil microbial diversity in agroecosystems: The need of the hour for sustainability and health. *Agric. Ecosyst. Environ.*, 164, 181-182.

From Left: Ms. P Wijepala, Ms. S Gunaratne, Mr. AK Pathirana, Prof. G Seneviratne, Ms. N Manjalee, Ms. RKC Karunaratne

Renuka Ratnayake, Senior Research Fellow at NIFS, obtained her B.Sc. (Sp) Botany (1992), M.Phil. (by research) (1997) and Ph.D.(2006) from the University of Peradeniya and joined the NIFS in 2009. She was a Postdoctoral researcher at the World Forestry Center, USA and Murdoch University, Australia. Dr. Ratnayake is a recipient of Endeavour Research Fellowship, Presidential Research Awards and SUSRED award for post graduate supervision. She has worked as a lecturer in the Faculty of Applied Sciences at the Rajarata University of Sri Lanka before joining the NIFS.

Bioenergy & Soil Ecosystems

Biofuel production and soil C sequestration are the main research areas investigated in this project with sub projects in each category. The project on soil C sequestration targets to study soil C sequestration potential, its dynamics and the method of improvement in different major vegetation types of Sri Lanka including natural and plantation forests, agricultural plantations, farm lands, home gardens and small holder cultivations etc. The studies conducted so far by our group were among the few studies reported so far on soil C sequestration in Sri Lanka. Up to now the project has achieved very good progress. Attempts have been made now to study C sequestration capacity of lowland paddy soils and to prepare a digital map showing the available C stocks in paddy soils of Sri Lanka.

The biofuel project aims to explore the microbial flora of Sri Lanka to isolate efficient degraders of cellulose, hemicellulose and lignin and study the effect of biofilms and/or co-cultures on degradation of cellulosic biomass. The present project also aims to study possible enhancement of enzyme production by formation of co-cultures or biofilms. The possibility of using cyanobacteria and other algal species, available in fresh water bodies of Sri Lanka, for biofuel production is also under investigation. Algae are rich in polyunsaturated fatty acids and hence enhance their potential as a source for biofuel. In addition, the investigations are also focused on other value added products and processes of cyanobacteria. The work conducted so far is the first study on biodiesel and other value added products from cyanobacteria isolated from fresh water bodies representing all climatic zones of Sri Lanka with their molecular characterization. The present study confirms a novel species of cyanobacteria *Cephalothirx komarekiana* for the first time in Sri Lanka.

Nitrate contamination of ground water is a worldwide problem. A significant increase in nitrate contamination in well water was detected recently in the Jaffna District. Therefore we have initiated a study in collaboration with the University of Jaffna on the possibility of using denitrifying bacteria for removal of nitrates from well water in the Jaffna District.

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

Spatially distributed estimates and mapping of soil organic carbon status are important requirements for understanding the role of soil in the global carbon cycle and also for assessing potential environmental responses to climatic changes. Forest soils play an important role due to the large area involved in regional and global scale. Knuckles Man and Biosphere Reserve is a tropical forest ecosystem situated in the South Asian Region. This study aimed at assessing and mapping the potential of soil carbon sequestration in different vegetation types of the Knuckles Forest Region (KFR) such as Montane Forests (MF), Sub Montane Forests (SMF), Moist Monsoon Forests (MMF), Open and Sparse Forests (OSF), Grasslands (GL) and Forest Plantations (FP) (Fig. b & c). Results indicated the highest SOC stock (72.63 t/ha) was within the 0-30 cm edaphic layer under the Montane Forest ecosystems followed by SMF ecosystems (66.17 t/ha) and the lowest in FP soils (43.03 t/ha).

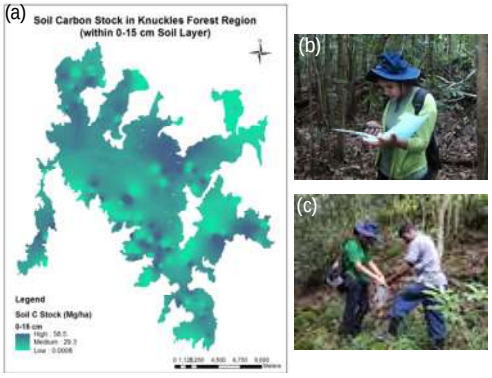

Figure 1. (a) Soil C stock map for Knuckles Forest, (b) (c) Soil sampling in Moist Monsoon and Sub Montane Forest soils

A map was prepared (Fig. 1a) using these data for future use in conservation and management activities of the Knuckles Forest and climate change mitigation programs in Sri Lanka.

Carbon stocks and carbon fractions in paddy fields of Polonnaruwa district of Sri Lanka

Paddy is the most important and widely grown food crop of Sri Lanka mainly in the Dry Zone. The main objective was to estimate carbon stocks and carbon fractions in paddy soils of Polonnaruwa; the second most paddy cultivated district in the Dry Zone. Samples were collected from two depths of 0-15 cm and 15-30 cm according to the proportion of 13 main paddy cultivation areas. The highest soil organic carbon stock (38.08 t/ha) was reported in Galamuna whereas the lowest carbon stock (9.34 t/ha) was in Dimbulagala for upper 0-15 cm soil depth. This study provides valuable baseline data on the capacity of carbon sequestration in paddy soils. This is a part of a large scale study to estimate and map soil C in paddy soils of Sri Lanka.

Extraction and characterization of humic substances from soils under different cropping systems of paddy in the dry zone of Sri Lanka

Humic substances play a dominant role in improving soil productivity. The objective was to extract, quantify and characterize soil humic substances in rice based farming systems (Rice-Rice, Rice-Soya, Rice-Onion and Rice-Tobacco) in the dry zone of Sri Lanka. Fourier Transformed Infrared (FTIR) spectra of extracted Humic acid and fulvic acid were used to indicate the presence of major structural elemental groups. This is a useful analysis for the farmers to improve fertilizer usage with relevant modification for their paddy cultivations.

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

In the present study, water samples were collected from 38 freshwater bodies of Sri Lanka representing three climatic zones and a total of 74 uni-algal cultures were obtained. For the period of 2016 a total number of 31 efficient isolates were selected based on highest biomass, total pigments and lipid content and they were identified using molecular data. One novel species, *Cephalothrix komarekiana,* was identified for the first time in Sri Lanka. The present study reports the availability of *Alkalinema pantanalense*, *Geitlerinema sp.*, *Westiellopsis prolifica* which had rarely been reported in 1986 or thereafter from Sri Lanka. Sequence of identified isolates have been stored in GeneBank database as well.

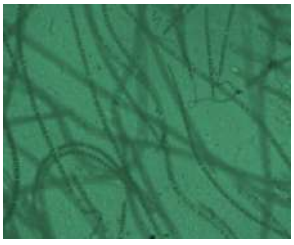

Figure 2*: Cephalothrix komarekiana (40x)*

Figure 3: Fatty acid analysis

Total lipid content in cyanobacteria in laboratory culture was recorded up to 31.9 ± 2.01% of dry biomass. The sun protection factor (SPF), anti oxidant, antipathogenic activity, protein content and total carbohydrate content were measured in remaining biomass of cyanobacteria for the purpose of adding a value to remaining residues.

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

Earlier studies showed that fungal-fungal co-culture of *Trichoderma reesei* and *Eupenicillium javanicum* produce a more efficient saccharifying enzyme mixture than in their monocultures. The effect of using three different plant materials, namely rice straw, banana pseudostem and palmyrah leaves, as the carbon source for hydrolytic enzyme production from

T. reesei, *E. javanicum* and their co-culture was studied. It was found that the use of these plant materials as the carbon sources resulted in a higher number of enzymes secreted and increased cellulase and xylanase activities, compared to the use of cellulose. Further, the enzymes produced using the plant materials caused higher percentage of saccharification of the same plant materials compared to the enzymes produced using cellulose. Further improvement of enzyme production may be achieved by using mutant strains of *T. reesei* and/or optimization.

Use of microbial cellulases in Biofuel production and other value added products and processes

Isolation procedures are being conducted to find efficient anaerobic and aerobic cellulose degrading bacteria and fungi from the environment. Anaerobic cellulose degrading bacteria have been isolated from termite gut. Experiments are continuing to study the efficiency of these strains on cellulose degradation. The use of cellulase enzymes extracted from microbial isolates in bio stone washing of denim is another aspect under investigation. The initiatives have been taken for this by formulating culture media to enhance the production of cellulases from potential microorganisms.

Figure 4: Sugar analysis using HPLC

Figure 5: Anaerobic microorganism isolation

Isolation of denitrifying Bacteria and their potential use in nitrate removal from well water of Jaffna district.

Nitrate contamination of ground water is becoming a serious problem in Jaffna. There has been little research reported on remediation of such pollution except few phytoremediation studies. The aims of the present study is to utilize denitrifying bacteria isolated locally from different sources such as paddy soils, waste water etc for nitrate nitrogen removal from well water of Jaffna.

Research Students

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	Ms. S.K. Jayasekara
	Ms. Abhiramy Thureirajah
	Ms. S. Jayalath

Key publications:

Ratnayake, R.R., Perera, B.M.A.C.A., Rajapaksha, R.P.S.K., Ekanayake, E.M.H.G.S., Gunaratne, H.M.A.C. (2017). Soil carbon sequestration and nutrient status of tropical rice based cropping systems: Rice-Rice, Rice-Soya, Rice-Onion and Rice-Tobacco in Sri Lanka. Catena, 150: 17–23.

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Hossain, M.F., Ratnayake, R.R., Meerajini, K., Kumara, K.L.W. (2016). Antioxidant properties of some selected cyanobacteria isolated from fresh water bodies of Sri Lanka. *Food Science & Nutrition.*

From Left: Mr. Md Fuad Hossain, Ms. T Abhiramy, Dr. RR Ratnayake, Ms. TK Bowange, Ms. SK Jayasekara, Ms. RPSK Rajapakse, Ms. HMBMK Herath, MS. MS Marasinghe

Earth, Environment & Biodiversity

Sri Lanka is blessed with a bounteous amount of biotic and abiotic natural resources. Discovering, evaluating, and development of the island's natural resources is the main focus of research in this unit. Origin of Sri Lankan rocks using their mineralogy and petrology is also studied. Improving efficiency of existing systems by energy scavenging and co-generation is an important step in conservation of energy. Research activities are focussed on thermoelectricity and maintaining a cleaner environment through efficient use of existing resources.

A team of scientists in this unit work on monitoring and modelling of atmospheric, terrestrial and aquatic systems that provide scientific support for restoration and management. Laboratory and field experiments are conducted on monitoring toxic metal release from atmospheric deposition, soil and water. Thus enable measurements of concentrations and reaction rates in environmental samples for key/emerging pollutants in the environment in order to assess their fate and transport to discover solutions to remediate those using different geo/bio/nano materials.

Investigating the degradation of our forests and their restoration through natural regeneration, particularly in the dry zone of Sri Lanka, is another line of research in this unit. Biogeography, factors affecting biodiversity, such as invasive alien plants, and conservation status of flora of Sri Lanka are also studied.

Understanding how ecosystems are modified by the loss of biodiversity is the focus of another group of scientists. These studies are based on plants and animals in terrestrial and aquatic ecosystems with a special focus on the Western Ghats – Sri Lanka biodiversity hotspot. Taxonomic and ecological studies conducted range from arthropods such as spiders and scorpions to primates and higher plants.

- Natural Resources & Renewable Energy
- Chemical & Environmental Modeling
- Ecology & Environmental Biology
- Plant & Environmental Sciences
- Plant Taxonomy & Conservation
- Primate Biology

N. Deepal Subasinghe, B.Sc. (UoP), M.Phil. (UoP), PhD (Reading, UK); Associate Research Professor, NIFS; Senior Lecturer in Physics, the Open University of Sri Lanka (2000-2003) and established geology and geophysics courses at OUSL. He was a Postdoctoral researcher at the RMIT University, Australia from 2003 to 2009. He was worked as a visiting lecturer at University of Kelaniya, University of Peradeniya, Macquarie University, Australia and Geoscience Teaching Unit, University of Reading, England, during his career. He has also worked for exploration giants such as BHP Billiton (Australia) and British Petroleum (UK). **Merit Awards:** ODCSS (Overseas Develop. Corporation Schol. Scheme) – Australia; Faculty merit scholarship -Faculty of Science, University of Reading, UK; Overseas Research Students (ORS) Scholarship (CVCP), UK; Australian Research Council (ARC) fellowship, RMIT University; Presidents Awards for scientific publication (from 2013-todate); President Elect - Geological Society of Sri Lanka (GSSL), Member of British Sedimentological Research Group (BSRG) 1995-1999; British Parachute Association, American Physical Society. Life member of the Geol Soc. SL and SLAAS. Member of Energy Expert Group, Ministry of ST&R, Chief Editor, Journal of GSSL 2013-14.

Natural Resources & Renewable Energy

Natural Resources & Renewable Energy project deals with several projects focused on the fundamental aspects of science, with some possible applications towards national development.

The project on geothermal resources of Sri Lanka aims to evaluate the geothermal resources with a view to utilize them for national development. A combination of geophysical techniques was used in the evaluation of geothermal resources.

A joint project on Sri Lankan petrology is conducted with the University of Peradeniya (UoP). Mineralogy and petrology are some of the most fundamental aspects of geology. Deep understanding of them leads not only to discover new natural resources and to develop new economic aspects, but also to understand the origins of lithological complexes in Sri Lanka and thus improve the advanced knowledge of the subject.

Mapping the radiation levels throughout the country and establishing the baseline of the background radiation levels are useful to identify hazardous areas, find mineral resources, as well as to identify any radiation leak due to human activities. Firstever radon mapping is being conducted jointly with the Atomic Energy Board (AEB), Sri Lanka.

The pioneering research project on thermoelectricity was initiated with the objective to introduce this new area of research to Sri Lanka. Thermoelectric generators use "*Seebeck Effect*" to produce electricity directly from heat energy. Thermoelectricity also has the unique ability to increase the overall efficiency of an existing system by 'scavenging' and converting waste heat to electricity. Other advantages include the ability to operate with any heat source and any temperature range, durability, low-maintenance and scalability.

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Geothermal Resource Mapping Project: The need for alternative energy sources is increasing everyday while the fossil fuel resources are rapidly depleting. Dependence on fossil fuel for energy requirements makes us vulnerable to external pressures. Fossil fuel is the highest single most commodity we spend our foreign exchange on. Developing our own renewable energy sources will not only reduce our dependence on imported fossil fuel, it will also help to reduce pollution.

The National Institute of Fundamental Studies (NIFS) initiated a project on mapping geothermal resources in Sri Lanka, in 2009. Although not located on a highly active geothermal region, Sri Lanka 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 a few other institutes, conducted the first ever comprehensive geophysical survey on geothermal sources in Sri Lanka. 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 drilling, above two techniques can provide information on geological structures, heat sources and water resources hidden under several meters to several kilometers of the earth. Processed data is used to produce resistivity profiles that represent the sub-surface structures as shown here.

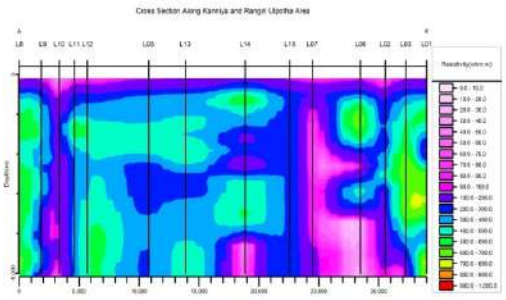

Figure 1. Resisitivity variations down to 5 km depth near Kinniya hotwater spring. Profile constructed using TDEM and MT data.

Radon Mapping Project: Radon is a naturally occurring gas, which is radioactive. It is generated by radioactive decay of uranium and thorium naturally found in rocks and minerals and responsible for delivering the largest dose of natural radiation we are exposed to on earth. While the mineral deposits with uranium and thorium produce more radon, level of radon in the atmosphere changes due to many factors. In health perspectives, it is important to monitor the indoor radon levels. Further, it is imperative to establish Sri Lanka's radiation baseline in order to monitor any radiation leak or nuclear accident, here or in a neighboring country.

In collaboration with the AEB, NIFS is conducting a radon monitoring programme in order to produce a radon map of the country. Passive and active methods are used in this exercise. Natural radiation levels of the country are shown in the following map.

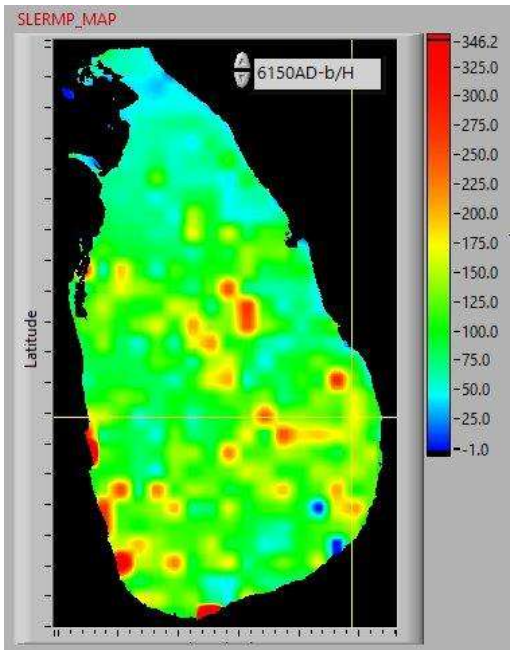

Figure 2. Natural radiation levels around the country as observed.

Mineralogy & Petrology Project: Mineralogy and petrology are some of the most fundamental aspects of geology. Fundamental understanding of them leads not only to discover and to develop new economic aspects, but also to improve advanced knowledge of the subject. Collaborative research activities between the NIFS and the UoP, has led to many high-quality publications and findings that will lead to national development through discovering new mineral resources and generating new knowledge.

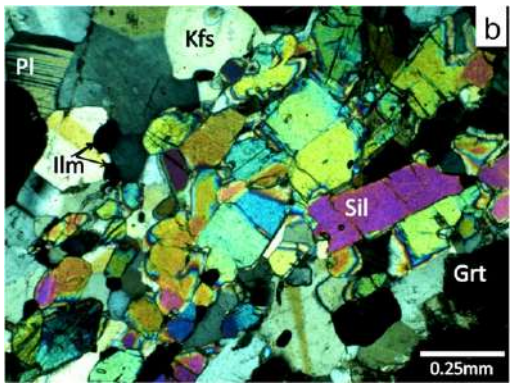

Figure 3. Photomicrographs showing the textural features present in the matrix of the quartz-under saturated domain in a selected Sri Lankan rock (from a joint publication).

Thermoelectricity Research: Research work on thermoelectricity (TE) at the NIFS is a pioneering study, since this area of reasearch was new to Sri Lanka. While TE can be considered as a source of renewable energy, the main advantage is its ability to improve the overall energy efficiency of existing systems by energy scavenging and co-generation. In thermoelectricity, heat is directly converted to electricity using thermoelectric effect, known as the *Seebeck* effect. Unlike other methods, TE can utilise heat energy from any source; including, solar energy, geothermal energy, waste heat from cooking, baking, factories, or from automibile engines. Some other advantages of thermoelectric generators (TEGs) are the scalability (from a large plant to nano-scale module), reliability and durability due to the absence of moving parts.

With a grant from NRC, new designs for TEGs are tested while new materials are developed to increase the "figure of merit", which has direct connection to the overall output.

Chief Technical Officer: Mr. S. Opatha

Research Students

Ph.D. - Mr. T.B.Nimalsiri
M.Phil. – Ms. S. A. Samaranayake
M.Sc. - Mr. K.P.V.B.Kobbekaduwa
Ms. S.S. Hettiarachchi (NRC: April- Aug 2016)

Key Publications

Subasinghe, N.D. (2016) Prerequisites for Science Technology and Innovation Policy Making in Sri Lanka *in* Tacheba, B., Shaeri, M. and Yousef, A.J.J. *(Eds) The Science Technology and Innovation Policy Making.* Daya Publishing House, New Delhi. 79-94.

Kobbekaduwa, K.P.V.B., Subasinghe, N.D. (2016) Modelling and Analysis of Thermoelectric Generation of Materials Using Matlab/Simulink. *International Journal of Energy and Power Engineering*. 5, 97-104.

Dharmapriya, P.L., Malaviarachchi, S.P.K., Galli, A., Su, B.X., Subasinghe, N.D., Dissanayake, C.B. (2015), Rare evidence for formation of garnet + corundum during isobaric cooling of UHT meta-pelites: New insights for retrograde P-T trajectory of the Highland Complex, Sri Lanka, *Lithos*, 220-223, 300-317.

From Left: Mr. S Opatha, Mr. TB Nimalsiri, Ms. SA Samaranayake, Prof. ND Subasinghe, Mr. KPVB Kobbekaduwa

MeththikaVithanageis a Senior Research Fellow at the National Institute of Fundamental Studies, Kandy and an Adjunct Associate Research Professor at the University of Southern Queensland, Australia. Her work has yielded important findings for successful application in the fields of agriculture, solid waste management, and environmental pollution remediation. She has received several awards from, American Geophysical Union as the Best Graduate Scientist, Presidential Awards for scientific publications, Awards for science popularization from National Science Foundation and Sri Lanka Association for Advancement of Science, and for post graduate supervision by the National Science Foundation, Sri Lanka. She is a Young Affiliate of the Third World Academy of Sciences considering her contribution to science as a young scientist. She has been selected as the TWAS-NSF Awardee for Chemical Sciences in 2016. Dr. Vithanage has contributed more than 70 journal articles and 15 book chapters.

Chemical &Environmental Modeling

Dr. Vithanage's research approach builds on enabling measurements of concentrations and reaction rates in environmental samples for key/emerging pollutants in the environment in order to assess their fate and transport to discover solutions to remediate those using different geo/bio/nano materials. She combines the field observations with laboratory studies of kinetics and thermodynamics that provide detailed chemical information, in order to test and parameterize and evaluate models. Dr. Vithanage is particularly interested in elucidating the mechanistic understanding of release/remediation of pollutants with contrasting physical and chemical properties that can be used to obtain insights into environmental partitioning, chemical persistence and ultimate accumulation in biota. To this end, her current research interests are focused on monitoring atmospheric deposition, landfill leachate, water and soil for pollutants, develop and enhance the properties of biochar, nano/geo substances and composites as material for environmental remediation.

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Perchlorate Research This project was started in 2014 and ended in 2016. 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, proposes potential mechanisms of interaction and investigates amendments for perchlorate neutralization. Overall, this study illustrated that perchlorate, even at low concentrations, can both accelerate metal release and increase the bioavailable metal fractions in soils. This implies that environmental remediation of perchlorate enriched sites must not only treat the direct hazard of perchlorate, but also the potential indirect hazard of related metal contamination. Further, the results showed that biochar could be utilized as an effective amendment to immobilize Ni and Mn in heavy metal and ClO_4^- contaminated soil.

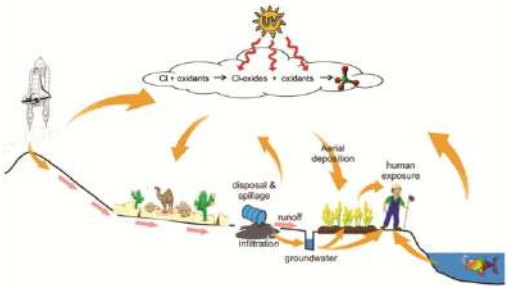

Figure 1. Geogenic perchlorate occurrences in the world

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 produced from waste materials are highly capable of removing heavy metals, metalloids as well as antibiotics and pesticides. Our recent attempts were focused further on pesticide removal and improving soil quality by immobilizing pollutants using biochars generated as a byproduct from the dendro power industry.

At the same time, we produced biochar from the organic portion of municipal solid waste (MSWBC), characterized and seek the potential for the removal of carcinogenic volatile organic compounds from MSW dumpsite in the landfill leachate. Further, we conducted pot, incubation, batch, column experiments, modeling and spectroscopic techniques. Simultaneously, we produced magnetized biochar and composite of nano zero valent iron and magnetized BC and tested for the capacity to remediate Cr(VI) in the aqueous media. That particular project supported Science Research Project competition of the National Science Foundation.

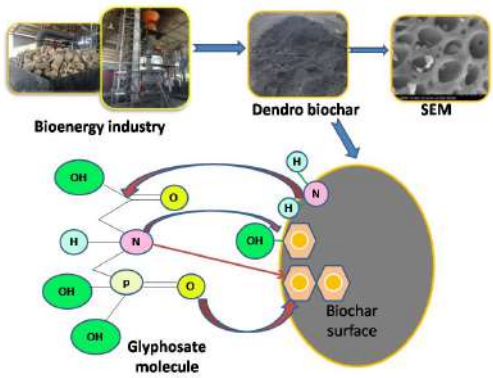

Figure 2. The removal of glyphosate using dendro power plant waste by-product biochar

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. Hence, the objectives of the study are to monitor heavy metals and hydrocarbons attached to particulate matter around Kandy. The metal loads in wet deposition showed higher concentrations than dry deposition. The metal concentrations among the different sampling sites significantly differ from each other depending on traffic conditions. Since industrial activities are not significant in Kandy City, traffic exerts a high influence on heavy metal loadings. We produced 2 book chapters from this research project during 2016.

Heavy metal stress may destruct many biochemical and physiological activities in bacteria, such as growth, development, enzyme and hormone production. Indole acetic acid (IAA) is one of the most important hormones in plants, which is secreted by both bacteria and plants. We assessed the effect of heavy metal stress on the growth of *Bradyrhizobiumjaponicum* and IAA production under heavy metal stress. It was revealed that the bacterial growth was reduced with the increase of heavy metal concentrations. However, it did not show any significant effect with some heavy metals in the considered range. The growth retardations observed in lettuce in the presence of Pb, Ni and Cu were in the orderNi>Cu>Pb. It was revealed that bacterial inoculation has reduced the heavy metal stress and increased the shoot and root lengths of lettuce seedlings. FTIR spectrum of the bacterial biomass showed that amine and nitro groups are responsible in

metal sorption process. According to our results, microorganisms are sensitive to heavy metal stress with a retardation of growth and IAA production, though it is able to enhance the growth of seedlings.

Constructed Wetlands were used to investigate the potential remedial measures for Reverse Osmosis (RO) rejected water through Constructed Wetlands (CW) with low cost materials in the media established in Chronic Kidney Disease of Unknown Aetiology (CKDu) endemic area in Sri Lanka. This study was supported by the collaborator and students from the Open University of Sri Lanka.

A pilot scale surface and subsurface water CWs were established at the Medawachchiya community based RO water supply unit. Locally available soil, calicut tile and biochar were used in proportions of 81, 16.5 and 2.5% (w/w) respectively as filter materials in the subsurface. Vertiver grass and Scirpusgrossus were selected for sub surface wetland while Water lettuce and Water hyacinth were chosen for free water surface CW.

This study indicated a potential of purifying aforesaid ions in water which is considerable in RO rejection. Therefore the invented bio-geo constructed wetland can be considered as a sustainable, economical and effective option for reducing high concentrations of CKDu sensitive parameters in RO rejected water before discharging into the inland waters.

Research Students

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Ms. LakshikaWeerasundara
Mr. YohanJayawardhana

Key publications:

Vithanage M,* Mayakaduwa SS, Herath I, Ok YS, Mohan D. (2016). Kinetics, thermodynamics and mechanistic studies of carbofuran removal using biochars from tea waste and rice husks. Chemosphere. 150:781-789

Herath I, Kumarathilaka P, Al-Wabel MI, Abduljabbar A, Ahmad M, Usman ARA, Vithanage M*. (2016). Mechanistic modeling of glyphosate interaction with rice husk derived engineered biochar. Microporous and Mesoporous Materials, 225:280-8

Kumarathilaka P, Oze C, Vithanage M.* (2016). Perchlorate mobilization of metals in serpentine soils. Applied Geochemistry. 74: 203-209

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

Ecology & 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 fundamental to 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 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 orchid groups of high conservation necessity. These findings are then shared through papers published in peer reviewed journals.

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

Dwarf hunting spiders or goblin spiders (Oonopidae) are an extremely diverse spider family with over 1655 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. 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 128 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 430 oonopid spiders of seven reported genera (*Aprusia, Brignolia, Camptoscaphiella, Ischnothyreus, Orchestina, Opopaea* and *Xestaspis*) and five new genera for the country. Three new species of the genus *Xestaspis* (*X. nuwaraeliya*, *X. padaviya* and *X. pophami*) and four new *Brignolia* species (*B. carlmulleri*, *B. ondaatjei*, *B. meemure*, *B. shyami*) were described during 2016.
In addition, Sri Lankan Oonopids are included for the first time in a worldwide molecular analysis.

Figure 1: *Xestaspis kandy*, female

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

The jumping spider (family Salticidae) contains more than 620 genera and about 5935 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 71 species placed in 51 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.
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*, *Phaeacius* have been recorded. To date, nearly 1015 specimens have been identified up to genus and/or species level.
During 2016, three new species each of *Habrocestum* and *Onomastus* (*H. hantaneensis*, *H. kodigalaensis*, *H. ohiyaensis*, *O. jamestaylori*, *O. corbetensis*, *O. maskeliya*) and *Bristowia gandhii* were described.

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. 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 one manuscripts that is 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 several new

species described. Our collection consists of 608 crab spiders belonging to 28 genera and most of them are identified up to species level. To date we have new records for Sri Lanka in the genera; *Platythomisus*, *Mastira*, *Massuria*, *Ozyptila*, *Strigoplus*, *Angaeus*, *Cebreninnus*, *Alcimochthes*. Several species of the genera *Peritraeus*, *Tmarus*, *Indoxysticus*, *Cebreninnus* and *Alcimochthes* are new to science and would be formally described in 2017.

Research Students

Post-doc- Dr. C. Indunil Clayton

Ph.D. - Ms. Nilani Kanesharatnam

M.Phil.- Ms. Sasanka Ranasinghe,
Ms. Ilesha Sandunika Ileperuma Arachchi

Key Publications

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

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

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. CI Clayton, Ms. IS Ileperuma Arachchi, Ms. S Ranasinghe, Ms. N Kanesharatnam

M.C.M. Iqbal graduated with a B.Sc (Agric.) from the University of Peradeniya in 1980 and joined the Eastern University of Sri Lanka as an Assistant Lecturer in Agriculture Biology and later served as a Senior Lecturer in Agronomy. He completed his Master's degree at the Swiss Federal Institute of Technology (ETH) in Zurich. He received a Freedom from Hunger Award from the Rotary International to read for his PhD from the University of Göttingen, Germany in 1990. He joined the IFS in 1996 and is now an Associate Research Professor. He has received Research Fellowships from the German Academic Exchange Service and the Erasmus –Mundus programme of the EU. He has received Presidential Research Awards (2000, 2002, 2003, 2004, 2007, 2013) and NRC Merit Award for Scientific Publication (2011). He was a council member of the Royal Asiatic Society of Sri Lanka and the Institute of Biology, and Chairman of the General Research Committee of the SLAAS.

Plant & Environmental Science

The Plant Biology project has three major areas of focus: (i) Environmental remediation of pollutants using plants and plant biomass, (ii) restoration of degraded dry forests in Sri Lanka, and (iii) flora growing on serpentine soil.

Environmental remediation is the removal of pollutants or contaminants from water and soil to ensure the protection of the environment and human health. Of the existing remediation technologies, bioremediation is cost effective, easy to operate and eco-friendly. Our research interests are focused on two biological methods: phytoremediation and biosorption. Phytoremediation is the removal of pollutants from water or soil by using live plants and biosorption is the removal of pollutants by using non-living biomass. Our major interests are the removal of textile dyes, heavy metals, phosphate and nitrate from water bodies. Forest degradation is a permanent and ongoing issue since forests are regarded as a freely available natural resource by subsistence farmers (*chena* cultivation) and for timber harvesting. In this context it is necessary to assist in the restoration of our dry forests. We assessed the degree of forest degradation by determining the distribution of tree species, their structure and the influence of communities living adjacent to forests to find viable solutions. Our studies on plants species living on the harsh environment of serpentine soils provides an insight into how plants adapt and their possible utilization for bioremediation of heavy metals. Plants are also a useful natural resource to remove pollutants from waterways such as heavy metals, dye effluents from small textile industries and excess fertiliser such as nitrates and phosphates that are leached away into water bodies. Besides absorption by aquatic plants we have studied the adsorption by plant biomass and also composites of these with other organic and inorganic material.

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Remediation of textiles dyes using biochar: Synthetic dyes are used in textile industries and their removal from effluents prior to their disposal is an emerging concern due to adverse effects on the environment and public health. Biochar derived from waste by-products are effective as biosorbents to remove dye contaminants. This study investigated the adsorption of a cationic dye, Crystal Violet (CV) and an anionic dye Congo Red (CR) from aqueous solutions on to biochar derived from *Lunumidella (Melia azedarach)* sawdust pyrolysed at 700 °C. The sawdust collected from saw mills was pyrolysed at a heating rate of 7 °C min^{-1}. The adsorption process was investigated through batch experiments by varying pH, adsorbent dose, initial dye concentration, and contact time. The sorbent dosage, initial dye concentration and contact time were set as 0.5 - 6.0 g L^{-1}, 5 - 200 mg L^{-1} and 5 min - 24 h, respectively. Edge experiments for CV and CR were conducted within the range of pH 3.0-9.0 and 5.0-10.0, respectively. The equilibrium data were analyzed by the Langmuir, Freundlich and Hill isotherm models while pseudo first order, pseudo second order and Elovich kinetic models were used to investigate the kinetic data.

The optimal contact times for CV and CR were 12 h and 8 h, respectively. The best pH for CV removal was pH 7.5 and for CR removal was pH 6.0. Freundlich model (r^2 = 0.9611) gave the best fit for CV sorption suggesting multilayer adsorption to heterogeneous sites of biochar. Hill model (r^2 = 0.9712) was best fitted for CR sorption which suggests the cooperative interactions between CR and biochar. Maximum adsorption capacity for CR (131.9 mg g^{-1}) was higher than for CV (81.7 mg g^{-1}) based on the Hill equation. The CV and CR sorption processes are highly pH dependent. In CV sorption, the biochar surface is negatively charged as the solution pH (7.5) >pH pzc (6.4) and tend to bind CV cations while in CR sorption the surface is positively charged as the solution pH (6.0) <pHpzc (6.4) and tend to bind CR anions through strong electrostatic attractions. Thus, Lunumidella sawdust biochar pyrolysed at 700 °C could be a sustainable solution to remove cationic and anionic dyes from waste effluent while compromising the solid waste management of sawdust.

Remediation of Phosphate and Nitrate: Nitrate and phosphate are major inorganic pollutants causing health and environmental problems. The major source of these pollutants entering the water system is excessive use of N- and P- fertilizers, addition of human and animal excreta and industrial waste. Besides health effects ("Blue baby syndrome", gastric cancer, kidney damage etc), excess nitrate and phosphate in water causes eutrophication causing algal blooms, and growth of planktons and aquatic plants. We are investigating biodegradable polymer-silicate composites using locally available silicate minerals (quartz, feldspar) and biopolymers (agar, alginate) cross linked with metal ions, to adsorb these pollutants. Phytoremediation using aquatic plants such as water lettuce (*Pistia stratiotes* L.) and Salvinia (*Salvinia molesta* D. Mitch) is also being investigated to remove phosphates and nitrates from water.

Remediation of heavy metals and textile dyes: Biosorption can be a cost effective alternative End-Pipe treatment method for SMEs for water treatment. We have identified potential plant material as biosorbents to treat textile dye and heavy metal contaminated waste water. Since the reuse of natural biosorbents is limited due to degradation and losses during the regeneration of the biosorbent, we are attempting to develop cost effective hybrid materials using biopolymer-mineral composites such as Chitosan:Kaolin and Alginate:Kaolin to remove heavy metals and textile dyes. Biomaterials are hard woody structures made out of biopolymers such as cellulose, hemicellulose and lignin. In biopolymer-mineral composites, the plant material is combined with a mineral supporting material. Functional groups present in these biopolymers readily form chemical or physical interactions with the pollutants present in the waste water. The suitability of the biopolymer will be decided by the type of interactions (cationic or anionic polymer). Interactions between the pollutant and the adsorbent depends on the external parameters of the environment: external pH of the system, duration of contact, shaking speed/rate of contact, pollutant concentration and amount of adsorbent. For some adsorbents stability will be determined by the external pH.

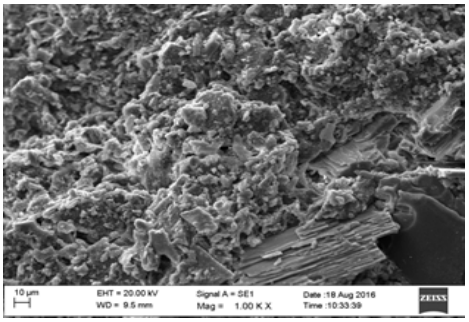

Figure 1. Scanning Electron Microscopic image of Alginate: Kaolin composite material.

Forest degradation and restoration: Over 50% of our forest cover is under dry forests, which receive less than 1200 mm of rainfall. Human activities contributing to forest degradation are many: illicit felling, extraction of non-timber forest products, firewood collection, grazing, cultivation of narcotic plant species, unplanned fires, spread of invasive species, extraction of gravel. Assessment of degradation was done in the Hurulu (Polonnaruwa district) and Nuwaragala (Ampara district) forest reserves. The degree of forest degradation due to anthropogenic disturbances was evaluated using species composition, dominance and forest structure. Forest disturbance was classified into three levels and

forest structure and tree species composition was determined for each level of disturbance; we additionally quantified changes in species traits (wood density and leaf size). Whilst total tree species number increased in more highly disturbed forests, species diversity per plot was highest in least disturbed forests and the tree community composition under the different disturbance intensities was clearly distinct. Relatively high numbers of pioneer, early-successional and exotic species were recorded from the highly disturbed forests whereas least disturbed forests were dominated by late-successional tree species that were also found geographically more broadly in the intermediate and wet zone forest elements in Sri Lanka. There was a pattern of increasing disturbance leading to declines in basal area, tree density, reduced canopy stratification and a more open canopy. Species in highly disturbed forest had smaller leaves indicating a possible response to more open, drier conditions. Species composition, diversity, structure and traits are suitable as complementary guides to evaluate dry forest degradation and restoration in the dry zone of Sri Lanka.

Research Students

Ph.D. – Mr. Anuradha Medawatte
Mr. Rasika Dissanayake

M.Phil.- Ms. Awanthi Wathukarage
Ms. Hirunika Wijesinghe

Key publications

Dissanayake, D.M.R.E.A., Wijesinghe, W.M.K.E.H., Iqbal, S.S., Priyantha, N. and Iqbal, M.C.M. (2016). Fuchsine biosorption using *Asplenium nidus* biosorbent-a mechanism using kinetic and isotherm data. *RSC Advances*, 6, 98682-98692.

Dissanayake, D.M.R.E.A., Wijesinghe, W.M.K.E.H., Iqbal, S.S., Priyantha, N. and Iqbal, M.C.M. (2016). Isotherm and kinetic study on Ni(II) and Pb(II) biosorption by the fern *Asplenium nidus* L. *Ecological Engineering*, 88, 237-241.

Medawatte, W.W.M.B.A., Sudasingha, S.K., Iqbal, M.C.M. (2016). Potential spread of exotic tree species in Sri Lanka: a road side survey from seven agro-ecological regions. Conference on Sustainable Landscapes for People, Business, and Biodiversity, National University of Singapore, 29 June - 2 July 2016. 53-54.

From Left: Ms. S Perera, Ms. H. Wijesinghe, Ms. H. Kumari, Ms. A Wathukarage, Mr. R Dissanayake, Mr. RB Hapukotuwa, Mr. A Medawatte, Mr. C Lekamge, Prof. MCM Iqbal

D.S.A. Wijesundara Ph.D (Biology), City University of New York,1998: B. Sc. Botany Special degree, (1978) and M.Phil in Botany (1991), University of Peradeniya; Curator, Hakgala Botanic Gardens (1980-1989), *Curator* Royal Botanic Gardens Peradeniya and *Curato*r, National Herbarium (1989-1998); *Director, National Botanic Gardens*, (1998-2006), *Director General, Department of National Botanic Gardens* (2006-2015); *Honorary Professor*, University of Hong Kong (2006-todate); *Research Professor* NIFS, Kandy (January 2016 – todate); Presidential awards for Scientific Research. (2001,2002,2007,2008,2009,2011 and 2012). Research publications have received 714 citations (84 in 2016); h-index of 13; Elected Fellow of the National Academy of Sciences 2006.

Plant Taxonomy & Conservation

Sri Lanka has a remarkably rich biodiversity. According to the last enumeration, there are 3,154 species of flowering plants in Sri Lanka, with 348 species of ferns, 788 species of mosses and liverworts, and over 1,000 species of lichens. Nearly one in four flowering plant species is endemic to Sri Lanka. Apart from 894 species of endemic flowering plants, 49 species of ferns are also endemic to Sri Lanka. However, recent surveys have shown that about 44% of flowering plants are threatened. Major areas covered in this project include a) taxonomic and biogeographical studies of flora of Sri Lanka, b) preparation of the National Red List for flora, c) sustainable use of plants, d) factors affecting the conservation of flora of Sri Lanka including Invasive Alien Species, and e) restoration ecology.

Assisted natural regeneration (ANR) is one of the important methods used in restoration ecology. NIFS-Sam Popham Arboretum (NIFS-SPA) is probably the best site in Sri Lanka for ANR. This arboretum was gifted to NIFS (then IFS) by an Englishman, Mr. F.H. Popham in 1989. After taking over, IFS added 27 more acres of adjoining scrub land to expand the arboretum. ANR was practiced to convert that land also into a dense woodland. On account of its significance as a bench mark site for ANR, many forest ecologists and botanists use NIFS-SPA as a research site. It is also a popular tourist destination owing to the presence of unique fauna with a rich bird life and some unique animals such as Slender Loris and Pangolin. NIFS-SPA also has a rich, dry evergreen vegetation consisting of over 200 species of trees. One of the main tasks of this project is to develop this important arboretum. During 2016 work began to develop a GIS map of the vegetation and develop nature trails and interpretative signage within the arboretum.

Preparatory work for the National Red List 2017 was initiated by forming expert teams and planning meetings and appointing research assistants to do data entry work at the National Herbarium. Research activities on natural products from medicinal and invasive plants were carried out in collaboration with Universities of Peradeniya and Sri Jayawardenapura.

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Biogeographical studies of Sri Lanka: Endemism in Sri Lanka shows a specific geographical pattern. The sightings or locations of the endemic flowering plants in Sri Lanka were obtained using records from the National Herbarium and reliable published ecological studies. The locations were plotted in a grid overlaid on a map of Sri Lanka using the GIS software Arc GIS 10. The grid of Sri Lanka consisted of 2847 cells each measuring 5 km x 5 km. There were 84,429 location records. The areas of endemism were identified by using the weighted endemism scores of grid cells and were classified by natural break method and geographic features.

High endemism was recorded for the wet zone of Sri Lanka. In Sri Lanka nine areas were identified where endemism was high (weighted endemism were between 0.7 - 2.5) and were tentatively named as endemic zones (Figure 1). The identified endemic zones are; Central Highlands, South Western Wet Zone, Northern Highlands, Eastern Highlands, Ritigala, Dolukanda, Yala, Wilpattu and Jaffna. Within the nine endemic zones, there were regions with very high endemism and are identified as core endemic areas. The core endemic areas are Sinharaja, Adams Peak, Knuckles, Horton Plains and Kandy. The occurrence of endemic genera (*Adrorhizon, Championia, Cyphostigma, Davidsea, Diyaminauclea, Doona, Hortonia, Leucocodon, Loxococcus, Nargedia, Phoenicanthus, Podadenia, Schumacheria, Schizostigma, Scyphostachys* and *Stemonoporus*) was generally confined to the core endemic areas.

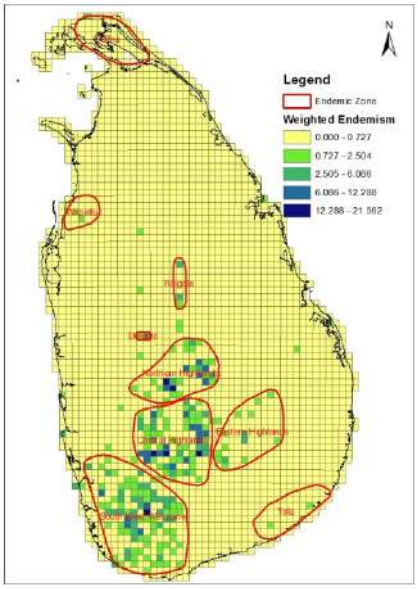


Figure 1. Endemic areas in Sri Lanka

Preliminary investigations of a new invasive plant in Sri Lanka: *Panicum trichocladum* K. Schum**.,** a grass native to Tropical East Africa was first reported in Sri Lanka from Hanguranketha area around 2002. Distribution of this grass appears to be expanding in the country during the last decade. It is mostly seen along the roadsides forming a dense mat covering the ground. In some areas it is found inhabiting coconut estates, home gardens, cultivated areas and wastelands (Figure 1). Up to now, there are no serious investigations carried out to find out its distribution and invasive potential in Sri Lanka. Therefore, a study was carried out to find the occurrence of this grass in relation to different climatic regions of Sri Lanka. In this study, natural distribution of *P. trichocladum* was measured by conducting an island wide field survey. The map of Sri Lanka was divided in to 2 km x 2 km grids laid over agro-ecological regions using Arc GIS software. The field survey was conducted starting from Hanguranketha along coordinal directions; North, South, East and West. Occurrences of *P. trichocladum* along the main roadsides of each direction were monitored and the presence or absence of the grass species was marked and recorded on the 2 X 2 km grids.

No occurrence of *P. trichocladum* was observed in the agro-ecological regions DL1, DL3, DL5, and WU3. *P. trichocladum* was present in all other agro-ecological regions visited. Among those agro-ecological regions where this grass is present, IM1, IM3, WM3 and WL1 showed the highest density compared to the other regions. It appears that this grass prefers wet areas in the low and mid-country and, the dry and cold areas are not invaded.

Figure 2. *Panicumtrichocladum* in Galagedara area

Using an invasive tree for grafting economically important plants: *Clusia rosea* (gal goraka) is a plant species having a highly efficient C4 photosynthetic pathway. This plant, native to Central America, has become a nationally significant invasive plant in wet sub-montane Sri Lanka. However, *C. rosea* has the ability to prosper in marginal landscapes such as heavily rocky areas due to the strong and efficient root system of this plant. Success rate of grafted *Garcinia quaesita* (goraka) and *G. mangostana* (Mangosteen) up to fruiting stage are low due to poor support in nutrient supply by the root stock of their own species. An experiment was conducted at Hapugastenne estate, Maskeliya, to ascertain the possibility of using *C. rosea* as a rootstock in grafting of crop plants such as *Garcinia quaesita* (goraka) and *G. mangostana* (Mangosteen) in the Clusiaceae family to which *Clusia* also belongs.

Grafting of both *G. quaesita* and *G. mangotana* was carried out using *C. rosea* as the rootstock. Mangosteen (55%) and goraka (67%) grafts were alive and healthy at the beginning of acclimatization. However, casualty rate increased. as time passed. Only 32% of Mangosteen survived after one month of acclimatization. Survival rate was seen highest (48 %) in unbranched, smaller (5-10 cm long) goraka scions with 4-6 fully opened leaved twigs.

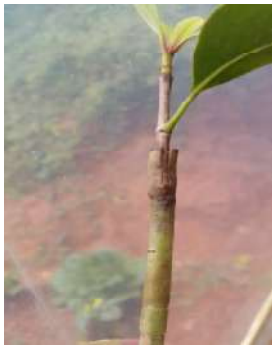


Figure 3: A successful graft of goraka on a Clusia root stock

Research Student

M.Phil.- Mr. Chanaka Lekamge

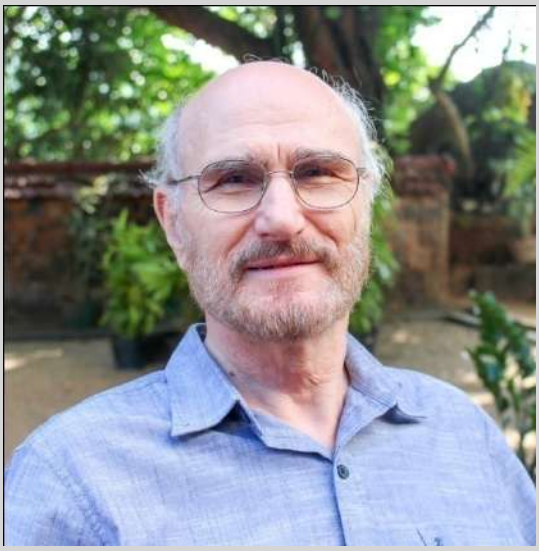
Key publications

Wijesundara, D.S.A., Perera, D. (2016). Endemic flowering plants and their distribution in Sri Lanka. Proceedings on South Asian Symposium on Sustainable Environment Management. 107-110.

Ranil, R.H.G., Fraser-Jenkins, C.R., Pushpakumara, D.K.N.G., Wijesundara, D. S. A., Parris, B.S. (2016). The Endemic Pteridophyte Flora of Sri Lanka: Taxonomy, Geographical Distribution and Conservation Status. Indian Fern Journal 33: 1-36

Tennakoon, T.M.S.G., Abeysekera, A.M., de Silva, K.T.D., Padumadasa, C., Wijesundara, D.S.A. (2016). Essential Oil Composition of *Platostoma menthoides* (L.) A. J. Paton whole plant, Journal of Essential Oil Bearing Plants, DOI: 10.1080/0972060X.2016.1224688

From Left: Prof. DSA Wijesundara, Mr. C Lekamge



Wolfgang Dittus, McGill University, Canada: BSc (1965); MSc (1968).University of Maryland: PhD Zoology (1974). Smithsonian Postdoctoral (1975-76). Principal Investigator, Smithsonian Primate Biology Program in Sri Lanka (1977 to present, with NIFS since 1983). **Teaching**: US Fish and Wildlife Service and Government of India (1982); African Wildlife Foundation, UK (1995-1999); Millennium Foundation, UK (1996-2003). **Consulting/Associate Editor**: International Journal of Primatology (1989-1992); American Journal of Primatology (1991-2003); Journal of Primatology (2011 to present). **Conservation:** IUCN Primate Specialists Group (1995 to present); Director, Clean Reserve Project, Polonnaruwa**,** Ministry of Cultural and Religious Affairs, Sri Lanka (1998-2003). **Chairman**, Association Conservation Primate Diversity (2003 to present). **Public education, international films:**23 documentaries (1979-present). Off-Broadway theatrical play, New York, USA (2007-2011). **Financial Grants**(n=39, 1965-2007): Woodrow Wilson; Phillip Carpenter; National Geographic Society (2 grants); USA National Science Foundation (6 grants); various Smithsonian Institution (11 awards);Deutsche Forschungsgemeinschaft(2 grants); Earthwatch Institute (7 grants); Ministry of Cultural and Religious Affairs, Sri Lanka (1 grant); Harry Frank Guggenheim Foundation (2 grants). **Honorary Awards:** 2003-2008, Sri Lanka President's Award for Research (5 awards); NRC Merit Award for Scientific Publication (2015). **Publications:** 1970 citations, h-index 32.

Primate Biology

The research concerns 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 behavior 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 documentary films with an eye towards - not only educating and entertaining, but also gaining public support for conservation efforts in the local and international communities. Our films contribute positively to the image of Sri Lanka as a tourist destination.

The scientific work has been buttressed by studies in population genetics, paternity exclusion, epidemiology and physiology as they relate to the behavior, ecology and vital statistics of wild monkeys. In practice, at our study site at Polonnaruwa, we have identified several thousand individual monkeys. For each macaque, we trace its behavioural, genealogical, ecological and demographic history and in this way link 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. Some years ago we have begun similar investigations of the gray and purple-faced langur at our research site at Polonnaruwa. New studies focus on the slender loris as well.

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1. Demography and range use of toque macaque *Macaca sinica sinica*. Routine monthly census of 20 groups of toque macaques to monitor rates of birth, death, immigration and emigration. Census of "lost groups" of toque macaques that have left limits the 3 km^2 designated study area and transferred into surrounding human inhabited areas. Initiate drafting new maps to incorporate expanded areas of occupancy by 34 study groups. Monitor group fission.

Researchers: Mr. Suniul Gunathilake and Chameera Pathirathna, professionally certified naturalist staff of the Association for the Conservation of Primate Diversity (ACPD), Polonnaruwa.

2. Demography and range use of hanuman langur *Semnopithecus priam thersites*. Routine monthly census of 11 groups hanuman langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year.

Researchers: Mr. Sunil Gunathilake, senior naturalist of the ACPD, Polonnaruwa.

3. Demography and range use of purple-faced langur (PPF) *Semnopithecus vetulus philbrickii*. Routine monthly census of 14 groups PPF langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year.

Researcher: Mr. Sunil Rathnayake, naturalist staff of the ACPD, Polonnaruwa.

4. Nocturnal observation of slender loris *Loris lydekkerianusn ordicus*in and around the field research station (n=12) at Polonnaruwa. Aim to identify social organization, range use, diet and vital statistics such as birth and death.

Main Researchers: Chameera Pathirathne and Sunil Rathnayake, naturalist staff of the ACPD.

5. Public education program: American International School of Cairo, Egypt. 37 participants.

6. Scientific consultancy and logistic support for professional film crews in 2016: NHK – Japan National Television (Male toque macaques)

Researchers: all Primate Project staff

7. Data analyses, trip to USA (Smithsonian Institution) for collaboration in analyses and publication preparation of toque macaque data regarding (1) general milk composition (2) Vitamin D in macaque milk and (3) weaning and amenorrhea.

Researcher: W. Dittus and colleagues (Oftedal, Jayawickrema, Power and Baker).

Key Publications:

Dittus, W., Gunatillke, S. (2015). Validating Skin fold Thickness as a Proxy to Estimate Total Body Fat in Wild Toque Macaques (*Macaca sinica*) Using the Mass of Dissected Adipose Tissue. Am J. Primat. 77,618–632.

Dittus, W. (2013). Arboreal Adaptations of Body Fat in Wild Toque Macaques (*Macaca sinica*) and the Evolution of Adiposity in Primates. Am. J. Phys. Anthropol., 152,333–44.

Dittus, W. (2013). Subspecies of Sri Lankan Mammals as Units of Biodiversity Conservation, with Special Reference to the Primates, *Cey. J. Sci. (Bio. Sci.)* 42,1-27.

From Left: Dr. W Dittus, Mr. S Gunathilake, Mr. S Rathnayake, Mr. C Pathirathna


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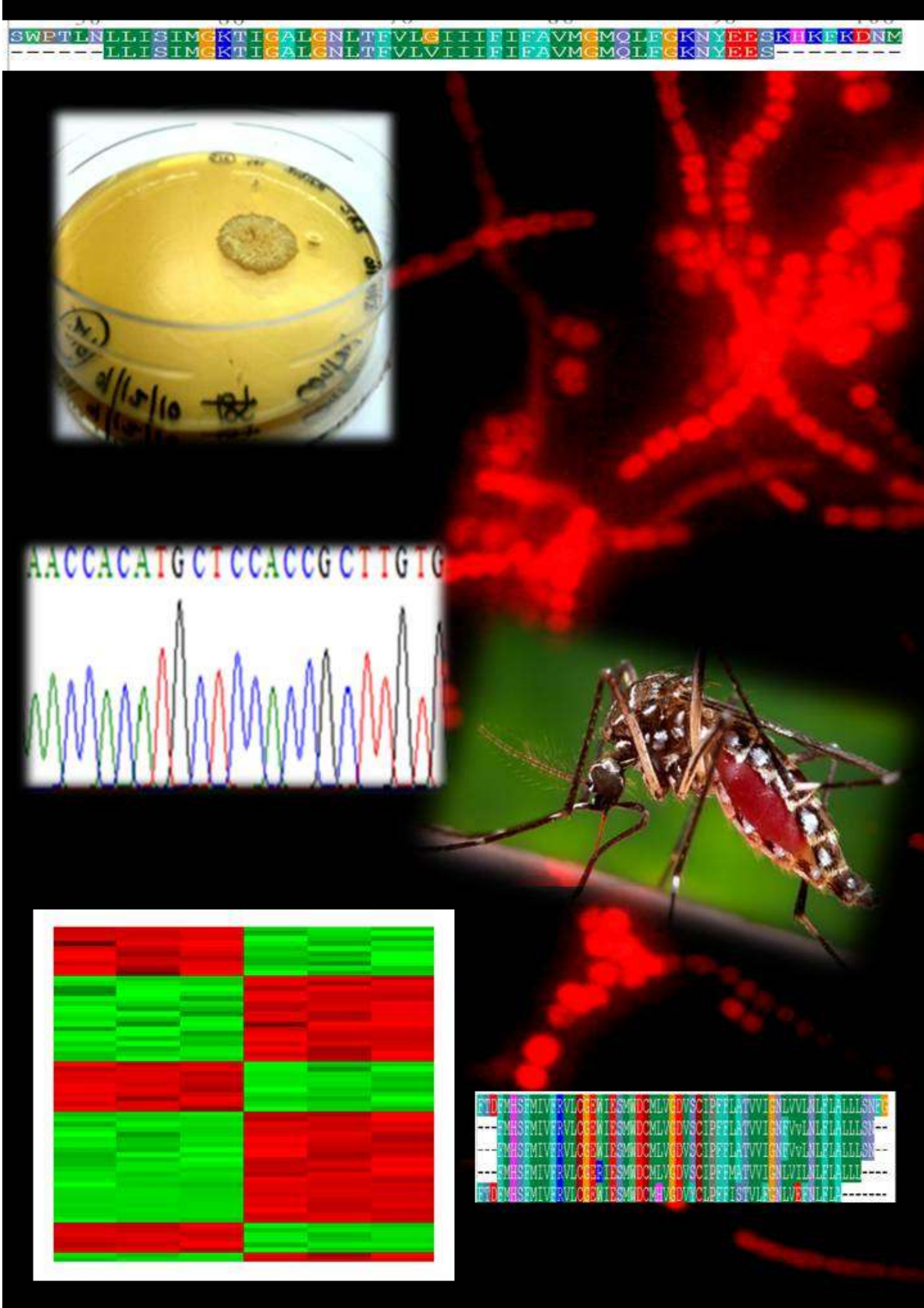

Molecular Biology & Biotechnology

With the application of advanced molecular biological technologies in to the study of microorganisms, there are many advances on identification and detection of microbes, as well as treating and prevention of diseases caused by them. In Molecular Microbiology & Human Diseases research project we try to understand the distribution of different microbial communities in the environment; mainly in air and also the role of lung microbiota in pulmonary diseases. Our interests also focuses on chronic kidney disease of unknown aetiology (CKDu), the major public health issue in Sri Lanka, for the past two decades. Our aim is to identify the transcriptome patterns and thereby analysing molecular mechanisms for a better understanding of the disease to develop biomarkers for early diagnosis.

DNA barcoding and phylogeny of Sri Lankan mosquitoes, molecular basis of insecticide resistance, Wolbachia bacteria in mosquito control and vectors of zoonotic diseases are the major research focuses of the Medical Entomology project.

- Molecular Microbiology & Human Diseases
- Medical Entomology

D. N. Magana-Arachchi B. Sc. (1994), Faculty of Science, University of Colombo; Ph.D,(2001), Faculty of Medicine, University of Colombo; Senior Research Fellow /Project Leader, Cell Biology, National Institute of Fundamental Studies (NIFS), Sri Lanka (August 2013 to date);Research Fellow /Project Leader, Cell Biology, Institute of Fundamental Studies, (December 2004 –July 2013);Post-Doctoral Research Associate, University of Nebraska Medical Center, USA (Nov.2002 - Sep.2004). Research Fellow, Plant Cell Biology, Institute of Fundamental Studies (December 2001 to October 2002). Assessor for Laboratory Accreditation ISO 17025 & for Good Laboratory Practice (GLP)- Sri Lanka Accreditation Board for Conformity Assessment (SLAB). **Awards;** Paul Ehrlich Foundation Fellowship (2008); Presidential Research Awards (1999, 2008); WPSC Young Investigators Award (1998); 6th Western Pacific Congress of Chemotherapy and Infectious Diseases, Malaysia; Prof. K. Rajasuriya Award for Tropical Medicine (1998) - Sri Lanka Medical Association; Prize for the Scientific Paper (1995) - Sri Lanka College of Microbiologists.

Cell Biology

The key research areas of interests in the Cell Biology Project revolve around microbial ecology and Human diseases, mostly in understanding the distribution of microbial communities in environment; mainly in air and in the human lung. The study of human diseases include both communicable and non-communicable diseases namely pulmonary diseases and chronic kidney disease of unknown aetiology (CKDu) which is the most prevailing health issue in Sri Lanka.

A combination of modern molecular microbiology techniques (PCR, qPCR, Microarrays, next-generation sequencing, etc.), techniques involved in analytical chemistry (HPLC and LC-MS) and the biochemical and biophysical techniques (ELISA, flow cytometry, etc) to answer the who, where and how questions of microbes leading to respiratory/pulmonary diseases as well as on what and why questions about the factors that lead to chronic kidney diseases.

The current research on CKDu focuses on identifying the blood transcriptome patterns of CKDu patients in different stages of the disease in comparison to healthy individuals, and to identify significantly differentially expressed genes (DEGs) in relation to biological processes. Analyzing molecular mechanisms will provide better understanding of the disease, earlier diagnosis and personalized treatment protocols.

More precisely in lung microbiome studies, we are interested in knowing how the lung microbiota differs with different pulmonary diseases, identification of microbes in relevance to specific disease, variation in host microbial interactions with different hosts and identification of not yet identified microbes in human lungs.

In all these studies I was ably assisted by my four Postgraduate Research students and in year 2017 we will be renaming our project as Molecular Microbiology & Human Diseases which is more appropriate with all our present research interests.

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Biomarker identification to predict causative factor/s and understand pathology of chronic kidney disease of uncertain etiology (CKDu) in Sri Lanka: Gene expression analysis was selected to identify causes of CKDu and suitable biomarkers for the disease. Preliminary studies with real time PCR of a selected panel of genes showed oxidative stress among the population of a CKDu endemic area including CKD patients and apparently healthy individuals, and possible biomarkers were identified which could be further studied. Whole transcriptome analyses are currently in progress for each stage of CKDu and an apparently healthy population of an endemic area compared to an apparently healthy population of a non-endemic area. Significant differentially regulated pathways are being analyzed to understand the molecular basis of the disease. Common differentially expressed genes (DEGs) in all stages of CKDu have also been selected for further validation as potential biomarkers. Real time PCR validations and statistical analyses are being carried out for the selected pathway as well as for the potential biomarker genes.

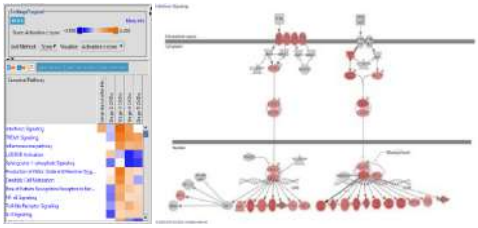

Figure 1. Snapshot from pathway analysis software with differentially expressed pathways and up regulated genes in red.

Isolation and identification of airborne bacterial and fungal community in atmospheric particulate matter in Kandy, Sri Lanka: Exposure to microorganisms associated with particulate matter has an effect on the public health. Samples were collected from nine sites within Kandy city which were selected based on the traffic congestion. Identification of microbes was done using DNA sequencing. Twenty nine bacterial and five fungal species were identified. Culturable microorganism concentrations were determined. Total microorganisms were measured using epi-fluorescence microscopy and real-time PCR. The culturable microorganisms ranged from 0 – $4.14x10^4$ CFU/ml. Total microorganisms were quantified using fluorescence microscopy which ranged from $2.00x10^3$ to $7.80x10^4$ cells/ml. There was no significant difference in culturable microorganisms and the total microorganisms among the sampling sites (<0.05). However, quantification of total microorganisms using real-time PCR analysis showed that total cell number was ranging from 1.00 - $4.49x10^{10}$ copies/ml. Total count using real-time PCR was significantly highest at the site of Trinity College which is a highly traffic congested site in the middle of the Kandy city (<0.05).

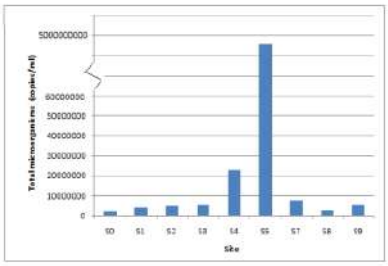

Figure 2. Concentrations of total microorganisms using real-time PCR in the nine sites. S0 – NIFS, S1 – Railway Station, S2 – Police Station, S3 – Fire brigade station, S4 – Children's Park, S5 – Trinity College, S7 - Lewalla, S8-Dodanwela, S9 - Tea research institute

Quantification of airborne bacterial and fungal community in selected areas of Kandy Hospital: Exposure to biological agents (including microorganisms) is associated with a wide range of major public health issues, such as infectious diseases, acute toxic effects and allergies. There are a number of factors that may be related to the generation of bio-aerosols in a hospital. Airborne Microorganisms and other sources of contamination in hospitals must be reduced to a minimum, as many of the people passing through hospitals could be very sensitive to these hazardous agents. Quantification of airborne microorganism has been reported in hospitals from many parts of the world but not from Sri Lanka. Hence the study was initiated to identify and quantify the microorganisms in a hospital atmosphere. Seven sampling sites were selected from Kandy Hospital; respiratory wards (male & female), bronchoscopy unit, OPD, ICU, theater and office. NIFS was selected as the control site. From preliminary analysis, culturable microorganisms were significantly differed among the sites. Highest number of culturable microorganisms was obtained from OPD where more than 1000 patients enter per day.

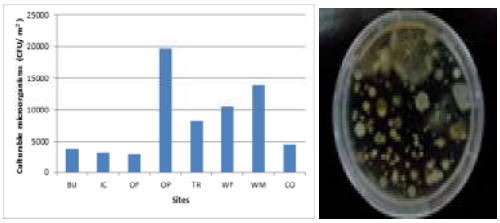

Figure 3. Concentrations of culturable microorganisms in Kandy hospital

Study of lung microbiota in lung cancer and bronchiectasis patients: The respiratory tract is the main portal through which a microorganism has access to the human body and as such the study of microbiota of the lungs could be beneficial. The study of the lung microbiota in respiratory diseases is important as the pathogenic microorganism's interaction with the host and disease severity may vary according to the

microbiota. This research focuses on two respiratory diseases; lung cancer and bronchiectasis. Microbial dysbiosis as well as presence or history of an infection is thought to alter the risk and probability of lung cancer and bronchiectasis. The aim of the proposed study is to determine the changes that occur in the lung microbiota (bacteria and fungi are being considered) due to different respiratory diseases.

In this study, two types of respiratory samples are being used, bronchoalveolar larvage (BAL) and oropharyngeal swabs (OP) representing lower and upper respiratory tract, respectively. The samples are cultured to isolate bacteria including *Mycobacterium tuberculosis* and fungi. Gram's staining and Ziehl-Neelsen acid fast staining are performed as a preliminary identification. Molecular identification and bacterial species abundance will be determined using real-time PCR and 16S metagenomics while total bacterial abundance will be determined by MUSE cell analyzer. The project is still at initial stages and to date most samples from patients with suspected lung cancer yielded Gram negative isolates (Figure. 4).

Figure 4. Culture and Gram's staining of a healthy person's OP swab.

Research Students

Ph.D.- Mr. S. Sayanthooran

M.Phil.- Ms. R. W. K. Amarasekara
Ms. E.M.U.A. Ekanayake
Ms. S. Mendis

Key Publications

Liyanage, H.M., Magana-Arachchi, D.N., Abeysekara, T., Guneratne, L. (2016). Toxicology of freshwater cyanobacteria, *J. Environ Sci Health C*, 34 (3), 137-168.

Keerthirathne, T.P., Magana-Arachchi, D.N., Madegedara, D., Sooriyapathirana, S.S. (2016). Real time PCR for the rapid identification and drug susceptibility of Mycobacteria present in bronchial washings, *BMC Infect. Dis.*, 16, 607.

Sayanthooran, S., Magana-Arachchi, D.N., Gunerathne, L., Abeysekera, T.D.J., Sooriyapathirana, S.S. (2016). Up-regulation of oxidative stress related genes in a chronic kidney disease attributed to specific geographical locations of Sri Lanka, *BioMed Res. Int.*, 2016, 7546265.

From Left: Ms. EMUA Ekanayake, Mr. S Sayanthooran, Ms. RWK Amarasekara

S.H.P. Parakrama Karunaratne, B. Sc. (1984), M.Sc. (by research) (1990), Univ. of Peradeniya; Ph.D, (1994) London School of Hygiene and Tropical Medicine, University of London, UK; Director & Senior Research Professor, NIFS (Oct 2015 to date); Dean, Faculty of Science (2007-2013); Senior Professor & Chair of Zoology (2001 to date), UoP; Wellcome Trust Research Fellow (Oct 2002 – Sept 2004) & Visiting Research Professor (2004 – 2010), Liverpool School of Tropical Medicine, UK; Visiting Research Fellow, School of Biosciences, Cardiff University, Wales, UK (1994 – 2001); Member of the DDT expert group, WHO, Geneva, Switzerland (2015 – 2019); Elected Fellow of the National Academy of Sciences (2006 to date) & Elected Fellow of the Royal Entomological Society, London, UK (1997 to date). Awards: CVCD Excellence Award for the most outstanding senior researcher, Sri Lanka (2017), Vestergaard Frandsen Award for outstanding research contribution, NAVBD, Indian Council of Medical Research (2011); Bernard Soysa Memorial Award (Gold Medal) for Outstanding Scientific Research, SLAAS, Sri Lanka (2005); Hiran Thilakaratne Award for Outstanding Postgraduate Research, UGC, Sri Lanka (2001); Young Scientist Award, TWAS- Italy & NSF- Sri Lanka (1999); Presidential Research Awards (1999, 2000, 2001, 2004, 2005, 2007, 2008, 2010); NRC Merit Award for Scientific Publication (2012, 2013), NRC- Sri Lanka; Best Research Award in Science (2000), UoP; NSF Merit Award for the Best Scientific Research in Biology (1999), NSF- Sri Lanka; Wilson Peiris memorial Award (1989) Sri Lanka Medical Council. Research publications have received 1848 citations (Feb 2017); h-index of 23.

Medical Entomology

Five research projects in collaboration with Department of Zoology, University of Peradeniya, Sri Lanka.

DNA barcoding of Sri Lankan mosquito species: Molecular taxonomy/"DNA barcoding" has become the most powerful method of species identification and evolutionary relationship determination today. Morphological characterization often faces difficulties in identifying sibling species and field collected damaged samples. Our work aims to characterize Sri Lankan mosquitoes, using the genetic markers *Cytochrome c Oxidase subunitI* (*COI*) and the Internal Transcribed Spacer 2 (ITS2) region. Fifteen species of Anopheline mosquitoes and 14 species of Culicine mosquitoes have been characterized so far and the phylogenetic trees have been constructed. Several of these sequences have been submitted to the GenBank. Vector species of important mosquito borne diseases and several sibling species have been characterized. Further investigations, especially on the haplotype diversity in different populations and population structure of these species, are also being carried out. The outcome will assist in proper planning of vector control programmes as uniform control measures may not be equally effective for genetically different populations.

Target site insensitivity of dengue mosquitoes *Aedes aegypti* and *Aedes albopictus* to pyrethroid insecticides: *Aedes aegypti* and *Ae. albopictus* are the vectors of dengue, chikungunya and yellow fever in Sri Lanka. They are mainly controlled by pyrethroid insecticides and the development of resistance to pyrethroids has become a threat to control programmes. We have shown that they have developed resistance against the pyrethroid insecticides cyfluthrin, deltamethrin, etofenprox, permethrin and λ-cyhalothrin. A mutation (V1016I) in the pyrethroid target site, 'voltage gated sodium channel (VGSC)' of the mosquito nervous system, which has been previously recorded from pyrethroid resistant *Ae. aegypti* from Latin America, was found in Sri Lankan *Ae. Aegypti* also. This is the first report to show the presence of this mutation in a Sri Lankan mosquito species. The mutation is known to cause target site insensitivity to pyrethroids and its dispersal can cause a major threat to future dengue mosquito control programmes in Sri Lanka.

Distribution and phylogeny of *Wolbachia* strains in wild mosquito populations in Sri Lanka: Application of symbiotic *Wolbachia* bacteria to control of mosquito-borne diseases has attracted immense attention during the past few decades. Infections with *Wolbachia* cause to decline the host population, and also induce the host resistance to a wide range of pathogens including viruses, bacteria, protozoans and nematodes. Our research investigate the prevalence and host preference of *Wolbachia* strains present in natural populations of mosquitoes by PCR using strain specific *wsp* and *groE* primers. This will provide the basic information necessary to use *Wolbachia*as a biological control tool in future mosquito control

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programmes. So far the results show that the dengue vectors *Ae. Aegypti* is negative for *Wolbachia* infections while *Ae. Albopictus* shows a 100% infection rate. Japanese encephalitis vectors, *Culexgelidus* and *C. triteaneorynchus* and *Anopheles* vectors of malaria are also negative for *Wolbachia* infections. The infection rate is relatively high in the filarial vector *C. quinquefaciatus*. *Ae. albopictus* is super infected with *Wolbachia* strain A (*AlbA*) and B (Pip) super groups. Phylogenetic analysis of the *wsp* sequences has showed two major branches confirming identities obtained from the PCR screening with strain specific primers.

Frog- and bird- biting mosquitoes in Sri Lanka: Blood feeding pattern and host choice of mosquitoes are major biological events that facilitate the transmission cycles of vector-borne pathogens. Frogs and birds serve as amplifying hosts for many pathogens including viruses that are transmissible to humans and other wildlife. Such disease causing pathogens are transmitted to humans and wildlife through the bites of mosquitoes. In Sri Lanka, any description on these mosquitoes and their role in transmitting diseases to wild birds and other organisms have never been reported. The aim of this study is to determine the diversity, distribution, abundance and biting behavior of frog- bird- biting mosquitoes, and to identify the potential zoonosis diseases that can be transmitted from birds to humans and wildlife of Sri Lanka.

Mechanisms of acaricide resistance in the cattle tick *Rhipicephalus (Boophilus) microplus* and the brown dog tick *Rhipicephalus sanguineus*in Sri Lanka: High tolerance of ticks to acaricides is increasingly becoming a problem. Characterization of acaricide resistance in the cattle tick, *Rhipicephalus (Boophilus) microplus* and the brown dog tick, *Rhipicephalus sanguineus* (Acari: Ixodidae), collected from cattle farms and Sri Lankan Police Kennels respectively, are being carried out. Ticks become resistant to acaricides through increased metabolism of acaricides by tick metabolic enzymes and through insensitive target sites. So far the results have shown that the cattle tick populations have a wide cross-resistant spectrum. They have enhanced activity of esterases for increased metabolism and the insensitive organophosphate and carbamate target site AChEs. kdr type mutations G72V was found in the sodium channel regulatory protein (target site of the pyrethroids and DDT) of *R. (B.) microplus*. Systematic and sophisticated insecticide resistance monitoring programmes and a better understanding on the mechanisms which govern resistance development are vital for future tick control programmes.

Research Student: Ms. J. Bandara

Key Publications:

Abeyasuriya, K.G.T.N., Nugapola, N.W.N.P., Perera, D.B.M., Karunaratne, W.A.I.P., **Karunaratne, S.H.P.P.** (2016). Effect of dengue mosquito control insecticide thermal fogging on non-target insects. *International Journal of Tropical Insect Science.DOI*: https://doi.org/10.1017/S1742758416000254.

Marasinghe, J.P., Hemachandra, K. S., Nugaliyadde, L., **Karunaratne, S.H.P.P.** (2017). Control failure of Sri Lankan whitefly (*Bemisiatabaci*Genn.*)* is due to high resistance development against recommended insecticides. *Journal of the National Science Foundation* (in press).

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From Left: Ms. J Bandara, Ms. H Sandukalani, Ms. C Ekanayake, Mr. D Chathuranga, Prof. SHPP Karunaratne, Mr. N Nugapola, Dr. WAPP de Silva, Ms. T Weeraratne

S. A. Kulasooriya, B. Sc. (Special) 1966, University of Ceylon; Ph. D. 1971, University of London; D. Sc. (Honoris causa) 2012, Sabaragamuwa University of Sri Lanka; Visiting Research Professor, NIFS (2009 to date); Emeritus Professor of Botany, (since 2006); Dean, Faculty of Science (2000 – 2003); Chair of Microbiology (1981) UoP; Research Fellow (1978/79) International Rice Research Institute, Philippines; Visiting Consultant (1982/83/84) International Atomic Energy Agency, Austria; Visiting Scientist (1987/88) Weizmann Institute of Science, Israel; Visiting Professor, Washington State University, USA (1999/2000); Senior Fellow, GSI, San Jose State University, USA (2003/04); Fellow, Institute of Biology (since 1982); Fellow National Academy of Science (since 1986); Best Research award (Bioscience) NARESA (1986); Titular National Honor, *Vidya Nidhi* (1986); Presidential awards for publications 1999, 2000, 2007, 2008. **Publications** 2 books, 85 peer reviewed papers, 155 Research communications.

Research interests:

Rhizobiology of food and forage legumes

Research and development of rhizobial inoculants to enhance biological nitrogen fixation in food and forage legume plants in order to improve natural soil fertility and minimize the application of chemical nitrogen fertilizer that contributes to environmental pollution.

Water pollution and Cyanobacterial toxin production

Evaluation of toxigenic cyanobacteria (blue-green algae) in freshwater bodies of Sri Lanka and conduct research on amelioration of water pollution that leads to bloom formation by these organisms.

Utilization of cyanobacteria and their symbiotic systems

Use of beneficial cyanobacteria like *Spirulina* as food supplements and symbiotic systems such as *Azolla* as biofertlizer and animal fodder.

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Collaborative & Consultative Division

Rhizobium Project

Prof. S. A. Kulasooriya, Visiting Research Professor

Inoculants for food and forage legumes

NIFS Participants: Mr. E. M. H. G. S. Ekanayake, Mr. R. K. G. K. Kumara, Ms. A. M. H. D. C. Abeyratne, Mr. A. H. M. A. Tennekoon and Ms. E. M. N. Ekanayake.

Collaborators: Mr. H. M. A. C. Gunarathne and Mr. L. K. C. Prithiviraj (Plenty Foods PLC); Mr. Sumith Silva and Mr. Laksman Dissanayake (Oasis Marketing Private Ltd); Mr. A. M. Sarath Bandara, Mr. S. S. Shirantha and Mr. Weerakone Bandara of Ambewela Farm; Mr. Buddhika Abeysinghe, Assistant Director (crop leader for soybean), Department of Agriculture.

Goals & Objectives

Research, development and application of isolated, screened and field tested rhizobial inoculants to food and forage legume crops in order to improve their nitrogen fixation capabilities and replace/reduce the application of chemical N-fertilizer (urea). Final objective is to reduce cost of production of legumes, sustain soil fertility and minimize environmental pollution.

Activities/ Sub activities listed in the Action Plan 2016 under the Project

As the inoculation of our inoculants to soybean *(Glycine max L.)* has been successful to replace urea fertilizer completely, the main efforts this year were to extend the areas of its application. For vegetable bean (*Phaseolus vulgaris* L.) and mung bean (*Vigna radiata* (L.) R. Wilczek) continuation of field testing of inoculants was necessary prior to their release for use by farmers.

Significant scientific research findings and inventions

Inoculants for soybean supplied to 4300 acres. The department of Agriculture was provided with 3000 small packets of inoculants to be distributed among its farmers as the department has targeted to extend their soybean cultivations to at least to 10,000 ha in 2017. Field testing of inoculants for vegetable bean in Doragala, Hanguranketha, Rikillagaskade, Welimada, Balangoda and Bandarawela was successful and 3000 inoculant packets were released to Oasis Marketing for distribution. Field testing of inoculants for mung bean at Beralihela, Handungamuwa and Tissamaharama areas has been successful. Plenty Foods PLC has purchased inoculant packets for initial distribution to 140 acres of mung bean.

Inoculated vegetable bean at Balangoda

Examining nodulation of field grown, inoculated Mung bean at Tissa

Field testing of inoculants for the forage crop Clover (*Trifolium repens* L.) in experimental plots at Ambewela Farm has been quite successful. Large scale mechanized seeding using coir dust based inoculant coated seeds and machine spraying of liquid inoculants after crop cuts, have given positive results. The farm management has decided to adopt large scale application of our inoculants to clover from January 2017.

Machine application of inoculum coated (insert) seeds

Field applicator for liquid inoculants

Other projects coordinated by the CCD

1. **Biofilm-Biofertilizers (BFBFs)***

NIFS Participants: **Prof. G. Seneviratne**, Prof. S. A. Kulasooriya, Mr. E. M. H. G. S. Ekanayake, Ms. P. Wijepala, and Ms. S. Gunaratne

Collaborators: Mr. Samantha Kumarasinghe, Mr. Samuditha Kumarasinghe and Mr. Ananda Jayasekera

Field testing of BFBF fertilizer with tea, rice, maize and a number of vegetable crops in several locations in Sri Lanka is progressing well.

Collaborator: Kurunegala Plantations Limited.

Field testing of BFBFs with young coconut trees is in progress.

*Detailed results are presented under progress of the Microbial Biotechnology Unit.

2. Collaboration with the South Eastern University of Sri Lanka on the purification of Sri Lankan natural vein graphite for novel technological applications.*

NIFS scientist: Dr. Athula Wijayasinghe assisted by Mr. P. T. S. Hewatilake

Project completed

3. Collaboration with the Sri Lanka Institute of Nanotechnology (SLINTEC) on the development of Sri Lankan natural vein graphite for nano-technological applications.*

NIFS scientist: Dr. Athula Wijayasinghe

4. Collaboration with the Uwa Wellessa University of Sri Lanka on the development of next generation advanced materials for future applications including nano-technology.*

NIFS scientist: Dr. Athula Wijayasinghe.

*Detailed results of these activities are presented under the Nano Technology and Advanced materials project of Dr. Athula Wijayasinghe.


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President's Awards for Scientific Publication


NIFS
National Institute of Fundamental Studies

Academic Activities - 2016

Publications in Journals
Book chapters
Intellectual Properties
Publications in Conference Proceedings
News Paper & other Publications
Awards & Recognitions
Grants Received
Postgraduate Degrees Completed in 2016
Equipment Development

Publications in Journals

ENERGY & ADVANCED MATERIALS

Condensed Matter Physics & Solid State Chemistry

Dissanayake, M.A.K.L., Divarathna, H.K.D.W.M.N., Dissanayake, C.B., **Senadeera, G.K.R.,** Ekanayake, P.M.P.C., Thotawatthage, C.A. (2016). An innovative TiO_2 nanoparticle/ nanofibre/ nanoparticle, three layer composite photoanode for efficiency enhancement in dye-sensitized solar cells , Journal of Photochemistry and Photobiology A: Chemistry, 322-323, 110-118.

Dissanayake, M.A.K.L., Kumari, J.M.K.W., **Senadeera, G.K.R.,** Thotawatthage, C.A. (2016). Efficiency enhancement in plasmonic dye-sensitized solar cells with TiO_2 photoanodes incorporating gold and silver nanoparticles, Journal of Applied Electrochemistry, 46, 47–58.

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Kumari, J.M.K.W., Sanjeevadharshini, N., **Dissanayake, M.A.K.L., Senadeera, G.K.R**., Thotawatthage, C.A. (2016). The effect of TiO_2 photoanode film thickness on photovoltaic properties of dye-sensitized solar cells, Ceylon Journal of Science 45, 2016: 33-41

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Energy & Advanced Material Chemistry

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NATURAL PRODUCTS & FOOD CHEMISTRY

Natural Products

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SOIL MICROBIOLOGY & CARBON SEQUESTRATION

Microbial Biotechnology

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Intellectual Properties

Energy & Advanced Material Chemistry

Title: Fabrication of superhydrophilic filter using natural and hydrothermally treated mica nanoparticles for waste oil-water separation in service station waste water. (Local patent: Pending)

Team: Mr. U.B. Gunatilake, Prof. J. Bandara

Condensed Matter Physics & Solid State Chemistry

Patent pending for a bacteria removing nano water filter.

Nanotechnology & Advanced Materials

Three local patent applications filed on development of Sri Lankan graphite.

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ENERGY & ADVANCED MATERIALS

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Other Publications

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Clayton C.I, Piyathilaka P, *Palibodha naashakayen mee massantath balapeem (Pesticides are harmful to honey bee).* 14th March 2016. **Lankadeepa – e**

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Liyanage R, Piyathilaka P, Nelliwala watinaakama thahawruwei (Proven powers of Nelli). 15th January 2016. **Ada**

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Magana-Arachchi D, Piyathilaka P, *Kshaya rogaya haduna ganimu (Novel techniques to detect TB).* 27th July 2016. **Vidya - Dinamina**

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Piyathilaka P, *Rasaayana drawya warada niweradi kireemata jaiwapatala-jaiwapohora (Biofilm bio fertilizers to correct chemicals).* 19th February 2016. **Ada**

Piyathilaka P, *Dakunu Aasiyawe Prathama vidya keti paniwda sewawa 2015 wasara sadaha jayagraahakaya thoorai.* 10th March 2016. **Vidusara**

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Piyathilaka P, *Dakunu aasiyawe Prathama vidya keti paniwda seewawe 1000 wana keti paniwudaya nikuth karai (South Asia's first science message service releases 100th message)* . 19th October 2016. **Vidusara**

Seneviratne G, Piyathilaka P, *Desheeya pohora kunumulle-Rasanayanika pohora wajabille (Mafia of imported bio fertilizers)*. 5th December 2016. **Dinamina**

Tilakarathne K, Bandara P.K, *Denuma awashyakenekuta bashawa prashnaya kwenne neha (Language is not a barrier to learn)* .19th March 2016.**Dinamina**

Tumpale I, Piyathilaka P, *Awruddata baduganne balagenai (Beware of buying goods in New year season)* . 4th April 2016. **Lankadeepa-e**

Vithanage M, Weerasundara L, Piyathilaka P, *Apita wina Katina Apema kasala (Our garbage attack ourselves).* 18th April 2016. Dinamina

Vithanage M, Piyathilaka P*, Lankans get overdose of iodine – NIFS*. 7th April 2016. **The Island**

Vithanage M, Piyathilaka P, *Kidney disease mostly afflicts males*. 26th August 2016. **The Island**

Vithanage M, Piyathilaka P, *Heavy metal content low in areas prone to CKDu: Experts*. 25th August 2016. **Daily Mirror**

Awards & Recognitions

Ms. A.G.A.W. Alakolanga, Research Assistant, Natural Product Project was awarded the Kandiah Memorial Award for Basics Sciences at the 45th Annual Sessions of the Institute of Chemistry Ceylon, 2016.

Prof. J. Bandara received a Presidential Award for his scientific publications in the year 2014 on 22 November 2016.

Prof. J. Bandara received the Alexander von Humboldt Research Fellowship to conduct research work at Max-Plank institute, Germany, July-September 2016.

Prof. J. Bandara was awarded the CAS President's International Fellowship Initiative (pifi) award to conduct his research in China by the Chinese Academy of Science, March, 2017-February 2018).

Prof. M.A.K.L. Dissanayake received a Presidential Award for Scientific Publications for 2014 awarded on November 22nd 2016: 8 publications in SCI journals.

Prof. M.A.K.L. Dissanayake participated as an Invited Speaker in the 15th Asian Solid State Ionics Conference in Patna, India (26th November-02nd December 2016)

Prof. M.A.K.L. Dissanayake was invited for a research visit to the Polymer Research Laboratory at Chalmers University of Technology, Gothenburg, Sweden from 9th to 19th June, 2016.

Prof. M.A.K.L. Dissanayake was a Chairperson at the Technical Sessions of Peradeniya University international research sessions (iPURSE), 4th -5th November 2016.

Prof. M.A.K.L. Dissanayake is currently the Editor-in-Chief, Ceylon Journal of Science, published quarterly by the University of Peradeniya.

Prof. M.A.K.L. Dissanayake is the National Coordinator of the multi-university "*Edu Training"* Five Year R&D programme to develop a skilled workforce competent in Solar Energy Technology for manufacturing solar panels in Sri Lanka, in Collaboration with Sivananthan Laboratories, Inc. (2016-2020): Approved by the Cabinet in April, 2016.

Dr. W.P.J. Dittus delivered a key note address on ''Primate Studies in Sri Lanka: History and future priorities'' at the Asian Primate Symposium, Colombo, 18th to 22nd October 2016.

Prof. M.C.M. Iqbal received an international competitive research fellowship from Erasmus-Mundus program to conduct research in a German University.

Prof. L. Jayasinghe was invited to deliver a lecture on "Fungi associated with medicinal plants as a promising source of bioactive compound" 14th Eurasia Conference on Chemical Sciences, 15th – 28th December, Karachi, Pakistan.

Prof. L. Jayasinghe, Prof. N.S. Kumar and Ms. A.G.A.W. Alakolanga were awarded NRC merit award for scientific publications for 2014.

Prof. S.H.P.P. Karunaratne – CVCD excellence award - 2016 for the most outstanding researcher in the field of Biological Sciences including Agriculture & Allied Sciences by the Committee of Vice-Chancellors & Directors, UGC, Sri Lanka.

Prof. S.H.P.P. Karunaratne, Member of the DDT Expert Group (established under the Stockholm Convention) nominated by the World Health Organization from 2016 - 2019.

Prof. S.H.P.P. Karunaratne was invited to deliver a keynote address on "Vital Role of Academic Researchers in Anticipating Developmental Challenges" at the Annual Research Sessions, Sabaragamuwa University of Sri Lanka, Belihuloya, 17th February, 2016.

Prof. S.H.P.P. Karunaratne delivered an invited lecture on "Isolation of mosquito carboxylesterases" at the National Workshop on Separation Techniques in Natural Product Research, NIFS, Kandy, 19-23 September, 2016.

Ms. C.L. Kehelpannala and Ms. D. Thanabalasingam, Research Assistants attached to the Natural Products Project were awarded *Med. Chem. Com.* Best Poster Presentation Prize by the Royal Society of Chemistry at the National Workshop on Separation Techniques in Natural Product Research, NIFS, Kandy, Sri Lanka 19th - 23rd September, 2016.

Ms. J.M.K.W. Kumari visited the Centre for Ionics, University of Malaya on a NSF-OSTP award for carrying out Collaborative Research from 15th July 2016 to 10th September 2016 to continue a part of her research work on Polymer blend Electrolyte based Dye sensitized solar cells.

Dr. Ruvini Liyanage and her team (Rizliya Visvanathan, Chatuni Jayathilake) were awarded *Med. Chem. Com.* Poster Prize by the Royal Society of Chemistry for a poster presentation at the National Workshop on Separation Techniques in Natural Product Research, NIFS, Kandy, Sri Lanka 19 th -23 rd Sept, 2016.

Dr. Meththika Vithanage received Presidential Awards for Scientific Publications for 2014 on 22 November 2016.

Dr. Meththika Vithanage received TWAS-NSF Award for Young Scientist (Chemistry), 2016.

Dr. Meththika Vithanage received Science popularization, Print media (Sinhala) 2016 by the Sri Lanka Association for the Advancement of Science (SLAAS).

Dr. D.N. Magana-Aracchchi, S. Sayanthooran, L. Gunarathne, T. Abeysekera received best poster award on Microarray analysis in Chronic Kidney Disease of Unknown Aetiology (CKDu) patients: Personalizing Diagnosis and Treatment at Health Science' theme at the NSF Research Summit 2016, 7th -8th July 2016.

Dr. D.N. Magana-Archchi was invited to deliver a lecture on *Recent Advances in the Diagnosis of tuberculosis'* for certificate course on tuberculosis, Postgraduate School of Medical Sciences (PGSM), University of Peradeniya. 7th March 2016

Dr. D.N. Magana-Archchi delivered an invited lecture on *Toxicology of Cyanobacteria at the International Symposium on Water Quality and Human Health: Challenges Ahead:* at PGIS, Sri Lanka. 5th& 6th August 2016

Dr. G.K.R. Senadeera received a Presidential Award for Scientific Publications of 2014 awarded on November 22nd 2016

Dr. G.K.R. Senadeera participated as an Invited Speaker in the 15th Asian Solid State Ionics Conference in Patna, India (26th Novmber-02nd December 2016)

Ms. D. Thanabalasigam, Research Assistant attached to the Natural Product Project has won the Kandiah Memorial Award for Applied Sciences at the 45th Annual Sessions of the Institute of Chemistry Ceylon, 2016.

Mr. C.A. Thotawatthage received a Presidential Award for Scientific Publications of 2014 awarded on November 22nd 2016

Prof. G. Seneviratne and his Research Assistant Ms. P.C. Wijepala won the Best Research Paper Award for the "Biofilm biofertilizers for incorporating biodiversity benefits and reducing environmentally harmful subsidies in agriculture' at the Sri Lanka Next: A Blue-Green Era -International Research Symposium, BMICH, Colombo, 18-19 October 2016".

Prof. N.D. Subasinghe received a Presidential Award for his scientific publications in the year 2014 on 22 November 2016.

Prof. N.D. Subasinghe delivered a key note address at the inauguration of the International Conference on Energy, Environment and Natural Resources 2016 (ICEENR 2016), held in Hangzhou, China on 25 May 2016.

Prof. N.D. Subasinghe was selected as a member of the Energy Expert Group; Vice President of the – Geological Society of Sri Lanka and Reviewer and Editorial Board Member of the Journal of Geological Society.

Dr. Athula Wijayasinghe received NRC merit award for scientific publications for 2014.

Dr. Athula Wijayasinghe was selected as a member of the technical committee to formulate National Mineral Policy for Sri Lanka.

Mr. A.M.J.S. Weerasinghe visited Chalmers University, Gothenburg, Sweden under OSTP fellowship awarded by the NSF and Swedish Research Council Grant from 30th April 2016 - 30th June 2016 to continue a part of his research on dye sensitized solar cells.

Mr. A.M.J.S. Weerasinghe received SPIE (international Society for Optics & Photonics) International Award 2016.

Mr. A.M.J.S. Weerasinghe received Science popularization, Electronic media (Sinhala) 2016 by SLAAS.

Grants Received

Research Grants

Prof. M.A.K.L. Dissanayake received a grant of 2.0 million LKR as a part of a multi university-multi institutional R&D grant (approved by the cabinet) for the development of CdTe solar cell research and related training of personnel from the Sri Lankan Government (through the Ministry of Science, Technology & Research in April 2016).

Dr. H.W.M.A.C. Wijayasinghe (Collaborating Scientist) received a grant for the Development of model treatment facility for remediation of TDS and fluoride in groundwater- a sustainable solution for dry zone drinking water problem - Grant Number NRC-TO-16-015, (2016-2020).

Prof. J. Bandara received a grant from National Science Foundation, Sri Lanka for design of a biological and advanced oxidation technology hybrid reactor system for oil waste water treatment – Grant Number RG/2012/ESA/01 (3.388 million LKR).

Dr. R.R. Ratnayake received a research grant for Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal from Well Water of Jaffna District from Postgraduate Research Scholarship Programme-National Science Foundation of Sri Lanka (NSF/SCH/2016/03) – 2.8 million LKR.

Prof. N.D. Subasinghe received an equipment grant from National Science Foundation, Sri Lanka. (RG/2016/EQ/11) – 1.5 million LKR.

Prof. D.S.A. Wijesundara received a grant from Ministry of Mahaweli Development and Environment on Floristic Survey of IFS-Popham Arboretum, Dambulla - 180,000 LKR.

Prof. D.S.A. Wijesundara received a grant for a preliminary investigation of the occurrence and invasive behaviour of *Panicum trichocladum*in from Ministry of Mahaweli Development and Environment - 440,000 LKR.

Prof. D.S.A. Wijesundara received a research grant for using *Clusiarosea* as a rootstock in grafting economic plants from Ministry of Mahaweli Development and Environment - 180,000 LKR.

Other Grants

Prof. J. Bandara received a travel grant from National Science Foundation, Sri Lanka.

Dr. D.N. Magana-Arachchi received a travel grant from National Science Foundation, Sri Lanka.

Ongoing Grants

Prof. M.A.K.L. Dissanayake received a 3 years grant from Swedish Research Council for collaborative research on dye sensitized solar cells with Chalmers University, Sweden (2015-2017).

Dr. H.W.M.A.C. Wijayasinghe (PI) received a grant for development of Sri Lankan graphite for rechargeable batteries, National Research Council, Sri Lanka (2015-2018).

Dr. H.W.M.A.C. Wijayasinghe (Co I) received a grant for development of thermoelectricity devices, National Research Council, Sri Lanka. (2015-2018)

Dr. H.W.M.A.C. Wijayasinghe (Co I) received an Innovative Research Grant-2013 from the Ministry of Higher Education, Sri Lanka (2013-2016).

Prof. L. Jayasinghe (PI) and Prof. N.S. Kumar (Co I) received a research grant for bioactive metabolites from some selected Sri Lankan fruits and their associated fungi: Possible uses in agricultural, pharmaceutical and functional food products from National Research Council of Sri Lanka (NRC-12-032) – 5.4 million LKR (2012-2016).

Prof. L. Jayasinghe (PI) and Prof. N.S. Kumar (Co I) received a research grant for chemistry and bioactivity of endophytic fungi from six plants used in indigenous medicine in Sri Lanka: Possible applications in health and agriculture from National Science Foundation of Sri Lanka (RG/2014/BS/02) – 2.5 million LKR (2014-2017).

Dr. R.R. Rathnayake received a Presidential Scholarship for Foreign Students grant 2013/14 by the Government of Sri Lanka – 1.9 million LKR.

Dr. R.R. Rathnayake received a research equipment grant from the National Science Foundation of Sri Lanka (RG/2015/EQ/04) – 4.5 million LKR.

Prof. N.D. Subasinghe received a grant from National Research Council, Sri Lanka for the development of thermoelectric devices for energy harvesting and co-generation (NRC 15-119) – 3.28 million LKR.

Dr. M. Vithanage received a 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 from National Research Council Sri Lanka (NRC 15-24) – 3.9 million LKR (2015-2017).

Dr. M. Vithanage received a research grant from International Foundation for Science (IFS, Sweden) for the Hospital Wastewater Project (Grant number W/5068-2) – 12000 USD (2015-2017).

Dr. M. Vithanage received a research grant for the Quantitative assessment of potential human and ecosystem health risks imposed by atmospheric particulates in Kandy, Sri Lanka from National Science Foundation, Sri Lanka – 3.9 million LKR (2014-2016)

Dr. M. Vithanage received Indo-Sri Lanka Research Grant from Ministry of Technology and Research, Sri Lanka for Biochar for pesticide remediation - 5 million LKR (2013-2016)

Prof. S.P. Benjamin received a competitive research grant from national Science Foundation Sri Lanka for study diversity of crab spiders of Sri Lanka based on morphology and DNA barcodes. ~4.0 million LKR (2015-2018).

Prof. M.C.M. Iqbal received a research grant for development of natural adsorbents for heavy metal and textile dye contaminated wastewater treatment from National Research Council of Sri Lanka (NRC-13-087) (3 years).

Prof. M.C.M. Iqbal received a research grant for the study of removal of nitrates and phosphates from drinking water using chemically and physically modified silicate materials from National Research Council of Sri Lanka (NRC-15-022) (2 years).

Dr. D.N. Magana-Arachchi (Co I) received a research grant from National Science Foundation Sri Lanka (RG/2014/EB/03).

Dr. D.N. Magana-Arachchi (Co I) received a research grant (ASP/01/RE/MED/2015/43).

Postgraduate Students - 2016

1st row, from Left: S Sathya, T Seneviratne, D Thanabalasingam, DMDM Dissanayake, T Abhiramy, J Bandara, N Kanagaratnam, WMKEH Wijesinghe, S Premina, RWK Amarasekara, D Dharmagunawardhana, HKSNS Gunaratne, L Weerasinghe, K Nilani, CND Samarawickrema, VK Munasinghe, JMKW Kumari, PC Wijepala, RA Jayarathna, EMUA Ekanayake, S Ranasinghe, IS Illeperuma Archchi, CB Gunawardhana, RPSK Rajapakse, R Visvanathan, S Jayasekara

2nd row, from Left: Y Jayawardhana, AMKL Abeykoon, PVHL Kulathunge, AMJS Weerasinghe, GRN Rathnayake, C Lekamge, KPVB Kobbekaduwa, A Madawatte, MN Jayakody, T Jaseetharan, CA Thotawattage, KMSDB Kulathunge, KNL de Silva, MF Hossain, H Kamalajith, S Sayanthooran, MM Qader, R Dodangodage, DMREA Dissanayake

Postgraduate Degrees Completed – 2016

Ms. Gayani Amaraweera, Ph.D., Development of Sri Lankan vein graphite and modification of $Li(Ni_{1/3}Mn_{1/3}Co_{1/3})O_2$ as electrode materials for lithium-ion rechargeable batteries, University of Peradeniya, Sri Lanka.

Supervisors: **Dr. H.W.M.A.C. Wijayasinghe**, Prof. A.N.B. Attanayake & **Prof. M.A.K.L. Dissanayake**

Ms. Irushika Fernando, Ph.D., Isolation, purification and characterization of glucosidase, amylase and lipase inhibitors from medicinal plants traditionally used for management of diabetes and cardiovascular diseases, University of Peradeniya, Sri Lanka.

Supervisors: Prof. H.K.I. Perera, **Prof. L. Jayasinghe** & Prof. R. Sivakanesan

Ms. R.P. Hettiarachchi, Ph.D., Biofilm biofertilizer for improved plant growth and soil health of rubber nurseries and plantations, University of Peradeniya, Sri Lanka.

Supervisors: **Prof. G. Seneviratne,** Prof**.** A.N. Jayakody & Dr.R.S. Dharmakeerthi

Ms. H.M.N. Sarangika, Ph.D., Development of electrochemical devices based on TiO2 and novel quasi solid gel polymer electrolyte, University of Peradeniya, Sri Lanka.

Supervisors: **Prof. M.A.K.L. Dissanayake** & **Dr. G.K.R. Senadeera**

Ms. H.M.S. Wasana, Ph.D., Assessment of drinking water quality towards the identification of causative factors for chronic kidney disease of unknown etiology (CKDu), University of Peradeniya, Sri Lanka.

Supervisors: **Prof. J. Bandara** & Prof. R. Weerasoorya

Mr. K. Balashangar, M.Phil., Enhancing the Performance of Titanium Dioxide Based Solar Cells, University of Jaffna, Sri Lanka.

Supervisors: Prof. P. Ravirajan & **Prof. M.A.K.L. Dissanayake**

Ms. C.L. Kehelpannala, M.Phil., Naphthoquinones produced by the fungus *Monacrosporium ambrosium* from Tea (*Camellia sinensis*) in culture media; biological activity, effect on caffeine and fungal growth in the presence of trace metal ions, University of Peradeniya, Sri Lanka.

Supervisors: **Prof. N.S. Kumar** & **Prof. L. Jayasinghe**

Mr. S.M.P.R. Kumarathilaka, M.Phil., Mobilization of metals and organics and its neutralization in serpentine soils under influence of perchlorate and chlorate, University of Peradeniya, Sri Lanka.

Supervisors: **Dr. M.S. Vithanage** & Prof. Srimati Indraratne

Ms. S.S. Mayakaduwa, M.Phil., Rice husk and tea waste-derived biochars for remediation of carbofuran in the environment, University of Peradeniya, Sri Lanka

Supervisors: **Dr. M.S. Vithanage** & Dr. Anuruddha Karunaratne

Ms. K.G.E. Padmathilake, M.Phil., Chemistry and Bioactivity of the secondary metabolites isolated from the seeds of *Pouteria campechiana* and associated fungi, University of Peradeniya, Sri Lanka.

Supervisors: **Prof. L. Jayasinghe** & **Prof. N.S. Kumar**

Ms. D. Thanabalasigm, M.Phil., Chemistry and bioactivity of the secondary metabolites produced by the endophytic fungi isolated from *Coccinia grandis* and *Artocarpus altilis*, University of Peradeniya, Sri Lanka.

Supervisors: **Prof. L. Jayasinghe** & **Prof. N.S. Kumar**

Ms. B.W.S.N.K. Batagalla, M.Sc. in Analytical Chemistry, Removal of fuchsine from aqueous solution by seed pod powder of giant sensitive tree, University of Peradeniya, Sri Lanka.

Supervisor: **Prof. M.C.M. Iqbal**

Ms. Bimali Kangaraarchchi, M.Sc., Carbon Stocks and carbon fractions in paddy fields of Pollonnaruwa district of Sri Lanka, University of Peradeniya, Sri Lanka.

Supervisor: **Dr. R.R. Ratnayake**

Mr. S.P.T.K. Pathirana, M. Sc. in Physics of Materials, Magnesium titanate as an anode material for lithium ion batteries, University of Peradeniya, Sri Lanka.

Supervisors: **Dr. H.W.M.A.C. Wijayasinghe** & Dr. L.R.A.K. Bandara

Equipment Facilities & Development

Liquid Chromatograph-Mass Spectroscopy (LC-MS)

X Ray Diffractometer

Gas Chromatograph (GC)

High Performance Liquid Chromatograph (HPLC)

Gas Chromatograph-Mass Spectroscopy (GC-MS)

Ion Chromatograph

Real Time PCR system

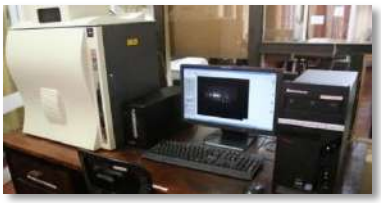
Anaerobic Work Station

Nabond Nanofiber Electrospining Unit

TOC/TN Analyser

Inverted Microscope

Newport AAA Solar Simulator



Gel Doc System

Atomic Absorption Spectrophotometer (AAS)

Constant Environment Chamber

Resistivity Instrument

Fuorier Transform Infra-Red Spectroscopy (FTIR)

Microwave Digestive System

NIFS Sam Popham Arboretum, Dambulla

Organization

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

From Left: Dr. PSB Wanduragala (Secretary), Mr. JMUP Jayamaha, Dr. WKBN Prame, Prof. Namal Priyantha, Prof. MJS Wijeyaratne, Prof. Anura Wickramasinghe (Chairman), Prof. SHPP Karunaratne (Director), 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
  University of Peradeniya

- **The Advisor to the President on Scientific Affairs**

- **Prof. Mohan De Silva**
  Chairman/ University Grants Commission

- **Prof. S.H.P.P. Karunaratne**
  Director/ NIFS

- **Prof. M.A.K.L. Dissanayake**
  Research Professor**/** NIFS

- **Prof. N.G.J. Dias**
  Professor in Computer Science/ University of Kelaniya

- **Dr. W.K.B.N. Prame**
  Former Director General/ Geological Survey & Mines Bureau

- **Prof. C.P. Deepal W. Mathew**
  Senior Professor in Biochemistry**/** University of Colombo

- **Prof. M.J.S. Wijeyaratne**
  Senior Professor of Zoology & Environmental Management, Univ. of Kelaniya
  Chairman/ National Science & Technology Commission

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

- **Mr. J.M.U.P. Jayamaha**
  Additional Director General/ Dept. of Public Enterprises, Ministry of Finance

- **Prof. U.L.B. Jayasinghe**
  Senior Research Professor/ NIFS

- **Dr. P.S.B. Wanduragala**
  Secretary to the Board of Governors/ NIFS

Research Council

Prof. S.H.P.P. Karunaratne (Chairman)
Director/ NIFS

Prof. D.M.D. Yakandawala
Head/ Dept. of Botany
University of Peradeniya

Prof. H.M.D. Namal Priyantha
Director/ Postgraduate Institute of Science
University of Peradeniya

Prof. G.K.R. Senadeera
Department of Physics
The Open University of Sri Lanka

Prof. A. Nanayakkara
NIFS

Prof. U.L.B. Jayasinghe
NIFS

Prof. M.A.K.L. Dissanayake
NIFS

Prof. G.R.A. Kumara
NIFS

Prof. M.C.M. Iqbal
NIFS

Dr. D.N. Magana-Arachchi
NIFS

Dr. R.R. Ratnayake
NIFS

Dr. R. Liyanage
NIFS

Prof. R.D. Jayasinghe
Dept. of Oral Medicine & Periodontology
University of Peradeniya

Prof. R.L. Chandrajith
Head/ Department of Geology
University of Peradeniya

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

Prof. J. Bandara
NIFS

Prof. G. Seneviratne
NIFS

Prof. D.S.A. Wijesundara
NIFS

Prof. S.P. Benjamin
NIFS

Prof. N.D. Subasinghe
NIFS

Dr. M.S. Vithanage
NIFS

Dr. H.W.M.A.C. Wijaysinghe
NIFS

Dr. P.S.B. Wanduragala
Secretary to the Council
NIFS

Director's Office

Prof. S.H.P.P. Karunaratne
Director/ NIFS

Prof. S.H.P.P. Karunaratne is the Director of the National Institute of Fundamental Studies and is the Chief Executive Officer (CEO) of the institute. The Director presides over the research and administrative matters, observes performance and progress of research work and controls the resources and expenditure of the institute. He ensures that the mission is fulfilled and the Institute is moving towards its vision.

Functions of the Director's Office

- Manages the full range of responsibilities and tasks that are needed to be undertaken for effective functioning of the Institute.
- Provides the overall management for the achievement of primary aims of the Institute.
- Supports the institute's research programs, projects, initiatives and innovations to achieve the aims and objectives of the institute.
- Coordinates with the Ministry and other organizations in providing information on research and administrative affairs.
- Organize meetings and other activities essential for the advancement of research and administration.
- Provides services including recruitment and selection of new employees, performance management and evaluation, employee promotions and maintenance of records of all staff members of the institute.

From Left: Mr. DMPDK Malwewa, Ms. DMADE Liyanage, Ms. OWK Seneviratne, Ms. MD Jeewa Kasthuri, Ms. SMSK Kapilaratne

Administration Division

Secretary

Dr. P.S.B. Wanduragala
Secretary to the Board
Secretary/ NIFS

Administration Division consists of the following sections:

- Maintenance
- Reception
- Transport
- Workshop

Duties and responsibilities entitled for the Administration Division

- Maintaining office procedures in Administration division
- Work related to recruitments & contractual services
- Arranging Department Procurement Committee, DPC (Minor) and DPC (Major) meetings
- Calling Tenders and quotations for goods and services
- Preparing Administrative reports annually
- Maintaining leave records of NIFS Staff
- Call for registration of suppliers annually
- Work related to construction and renovations, maintenance of the Building
- Checking overtime, fuel orders and contractual payments
- Insurance coverage of NIFS staff
- Maintain NIFS vehicles and Provide transport facilities for the NIFS staff

From Left: Mr. DMDB Dissanayake, Mr. KM Ariyawansha, Mr. KGTB Gunasekara, Mr. ABGW Jayaweera, Mr. DG Dharmasena, Mr. AGJS Aluthgedara, Mr. DJMWP Jayasekara, Mr. DGK Dorakumbura, Ms. C Ranasinghe, Ms. TP Hettiarchchi, Ms. RPM Weerasooriya, Ms. CLS Ilangakoon, Mr. DG Gunathilake, Mr. MA Lal, Mr. AVAP Kumara, Mr. AGST Gunathilake, Mr. RSK Gunawardhana, Mr. HADN Jayasinghe

Science Education & Dissemination Unit

Objectives

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

Team

From Left: Mr. SDPGP Piyathilaka, Ms. SM Hettiarachchi, Dr. CTK Tilakaratne, Mr. GCKS Bandara, Mr. VM Ekanayake, Ms. KIK Samarakoon, Ms. HMGNN Herath

Forums for the Scientific Community

Special Lectures

- "Enriching the well-being of Sri Lankans through Nanotechnology", Dr. Nilwala Kottegoda, Senior Research Scientist SLINTE. (21st January 2016)
- "Gravitational Waves", Prof. Asiri Nanayakkara, Senior Research Professor, NIFS. (28th March 2016)
- "The science behind juice processing", Dr. Viduranga Waisundara, Research Fellow, NIFS. (6th April 2016)
- "Earth's high temperature lower crust exposed in Sri Lanka: Highlights from Collaborative studies between Geology Department of University of Peradeniya and NIFS". Dr. Sanjeewa Malavirachchi, Senior Lecturer, Department of Geology, Faculty of Science, University of Peradeniya (UOP). (4th May 2016)
- "Mosquito Control and Transgenic Approaches: from a Sri Lankan Perspective, Prof. S. N. Surendran, Professor in Zoology, University of Jaffna. (30th May 2016)
- "Insect Genome Modifications: Transgenics to Gene Editing"by Mr.Channa Aluvihare Research Biologist, University of Maryland.(30th May 2016)

- "Thermoelectrics: Fundamentals to Applications & High Temperature Thermoelectric Generator Modelling", Dr.Waruna Wijesekara of the University of Aalborg, Denmark.(28th July 2016)
- "Introduction on key global health challenges in a global & Sri Lankan Context", Prof. Flemming Konradsen, University Copenhegan, Denmark. (4th August 2016)
- "The Economics of Nature: Using economics to value, protect and restore ecosystem services and biodiversity", Dr. Sahan T. M. Dissanayake, Assistant Professor of Economics, Colby College and Research Consultant at IUCN-Sri Lanka. (16th August 2016)
- "Detection of surface-bound arsenate by bacterial bioreporters", Prof. Rien. van Genuchten, Postdoctoral Research Associate, Department of Earth Sciences – Geochemistry, Utrecht University, Netherlands.(18th October 2016)
- "Pharmaceuticals from Marine Organisms", Professor S. Sotheeswaran, Emeritus Professor. University of the South Pacific, Fiji. (21st November 2016)
- "Endeavor scholarships & Fellowships-Australian Government", Ms. N. Ahamed, Planning Division, Ministry of Science, Technology & Research. (10th June 2016)

Journal Club Presentations by NIFS Research Assistants

- "Efficiency enhancement of solar cells by multi-layering of nano patterned TiO_2 layer", Mr. ChaturangaThotawattage. (16th March 2016)
- "Pollutants & water reduction by constructed wetlands treating waste landfill leachate in a tropical region". Mr. Prasanna Kumarathilaka. (27th April 2016)
- "Insect pests of tea". Ms. C. Kehelpannala. (11th May 2016)
- "Efficient removal of crystal violet using Fe_3O_4-coated biochar: Role of the Fe_3O_4 Nanoparticles and modeling study of their adsorption behavior", Ms. Thilini Wathukarage. (27th July 2016)
- "Application of Magnetotelluric and TDEM methods in structural determination of geothermal resources". Mr. T.B. Nimalasiri. (29th July 2016)
- "The Transformation on molecular phylogenetics by Next-generation Sequencing", Ms. Sasanka Ranasinghe. (16th August 2016)
- "The Role of Soil in Ecosystem Functioning with special reference to soil organic carbon" Ms. Kumari Rajapaksha.(30th August 2016)
- "Microbial Transformation: An Emerging method for production of Bioactive Compounds" Mr. M. Mallique Qader. (9th November 2016)
- "Inducing Secondary Metabolite production by the endophytic fungus through Co-culture with Bacteria", Mr. Nalin Rathnayaka. (16th November 2016)
- "The provocative links between gut microbes and the human: Do gut bacteria rule us?", Ms.P. C.Wijepala. (30th November 2016)
- "Novel Basidiomycetepolyenes: Biosynthesis and a role in fungal defense", Ms. D. Thanabalasingham. (7th December 2016)

Workshops

- "From chemical to Eco friendly agriculture- Role of microbial biofertilizers" workshop 18th February 2016 (NIFS Colombo office).
- Mini Symposium on Outlook on Chronic Kidney Disease of Unknown Etiology (CKDu) was held on 15th of August 2016 at NIFS, Kandy.

- National Workshop on Separation Techniques in Natural Product Research (19-23 September 2016) was organized with the Natural Products Research Group at NIFS.

Laboratory training at NIFS for postgraduate students and undergraduate students

- Undergraduate students of Faculty of Agriculture, University of Ruhuna. (31stMarch 2016) and students from the International Institute of Health Sciences (IIHS), Welisara (4th May 2016) and Final Year students (Biochemistry) of the Faculty of Science, University of Kelaniya visited NIFS (10th November 2016).

PROMOTION OF PUBLIC UNDERSTANDING OF SCIENCE

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

Vidu Nena Hawula - South Asia's 1st Science Message Service and Open Science Circle, also known as OSCEM (Open Science Circle in Electronic Media) was launched in January 2012 with the aim of improving science literacy of Sri Lankans. OSCEM offers a chance to inculcate enthusiasm for science among the school community and the general public. A daily science message service and an open science quiz based on weekly questions via text messages (SMS), e-mail and social media networks is provide. This free service is provided on all weekdays in both Sinhala and English media. http://vidunenahawula.com

The Winner of 2015/2016, Mr. Sanju Darshana who ranked top in the *Vidu Nena Hauwla* weekly science quiz was awarded the Gold Medal from Hon. Mrs. R. Wijialudchumi, Secretary, Ministry of Science, Technology and Research (20th October, 2016).

- **MASS project (Mobile Apps for Science Students)**

Mobile Apps for Science Students (MASS) is the first Mobile Application project that creates mobile apps in Sinhala, to Sri Lankan students.

The second mobile app of this projects was "Sinhala – English Science Glossary" and published on Google Play Store (May, 2016). Users may search for words in both Sinhala and English languages. There are more than 90,000 words which covers many science disciplines. All glossaries can be accessed without an

internet connection (offline access). The app can be downloaded from the following link: http://nifs.ac.lk/?page_id= 3267

- **National Competition on "Science Copies Natures Secrets"**

Objective of this competition was to inspire school children to understand the ways in which nature helps and how nature is imitated (bio mimicry) to improve human life. The competition was organized for Sinhala, Tamil and English medium students of Grade nine. 1,801 articles were received and 1st, 2nd 3rd places and special merit awards were given to student in all three media.

Winners' celebration (20th October 2016) held at the NIFS in the presence of Mrs. R. Wijialudchumi, Secretary, Ministry of Science, Technology & Research.

- **Provincial competition on "Understanding World through Science"**

Objective of the competition was to develop the curiosity and willingness on identification of scientific concepts & their applications among students. They had to find one scientific concept associated with an environmental phenomenon each day, during a period of 20 days. Competition on Understanding world through science was organized in Sinhala English and Tamil medium under two categories (Grade 7 & 8).

The Winners Celebration of Central Province Competition on "Understanding the World through Science" -2016 was held on 25th of October 2016, at the NIFS premises with the presence of Prof.Namal Priyantha, The Director of Postgraduate Institute of Science (PGIS), University of Peradeniya.

- **School Science Programme (SSP)**

Forty third School Science Programme (SSP) was held at the NIFS (20th to 23rd December 2016). SSP is one of the most important annually programmes conducted annually for the dissemination of science among the younger generation. SSP provides an opportunity for them to interact directly with scientists actively engaged in research. Students (138) from all over Sri Lanka participated in the programme.

Lab visits for school community

- Students from C.W.W. Kannangara Central College, Hunumulla, Minuwangoda (6th of April 2016) and Rippon Girls' College, Galle (1st of April 2016) visited NIFS.
- Students of the International Institute of Health Sciences (IIHS), Welisara visited NIFS laboratories (4th May 2016)
- Group of Grade 9 students of Delta Gamunupura Maha Vidyalaya, Kotmale visited NIFS Laboratories to get knowledge on Nanotechnology. (13 July, 2016)

Popularization of Science through Electronic & Print Media

SEDU is engaged in popularization of science and disseminating research findings of NIFS in different ways of communication. It holds and daily update social media networks of NIFS and SEDU such as Facebook, Twitter and LinkedIn which easily enable science communication and dialogue and official websites. News and feature articles are written to printed and electronic newspapers. In 2016, around 30 newspaper articles were published to disseminate science to general public. Besides that, one TV, two television news and two radio news programs were conducted.

Publication in Conference Proceeding

Tilakaratne, C.T.K., Ekanayake, T.M.S.S.K.Y., Dissanayake, D.M.M.P. (2016). Junior Secondary science teachers' views about science teaching. Proceedings of the Peradeniya University International Research Sessions, Sri Lanka (iPURSE), **20**, 44.

NIFS- Sam Popham Arboretum, a unique woodland in Dambulla

This unique site of dry zone forest was once owned by an Englishman, Mr. Francis Home (Sam) Popham, who gifted it to the National Institute of Fundamental Studies (then IFS) in 1989 to carry out research and educational activities. Original site of this arboretum bought by him in 1963 was a seven and half acre-scrub jungle. Mr. 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. Local villagers used to call the arboretum 'Suddagewatta' (White man's property)

During the early years Popham used to live in a mud hut within this site and later he constructed a beautiful stone (granite) cottage designed by the well-known architect, Deshamanya Geoffrey Bawa. Being a keen naturalist and a serious environmentalist Mr. Popham meticulously kept records on climate data of the arboretum including number of rainy days, monthly and annual rainfall, atmospheric temperature, wind patterns -velocity and direction of wind, fluctuations of ground water table etc.

After taking over the land in 1989, the IFS bought another 27 acres of adjoining scrub land to expand the arboretum. Popham's method of "Assisted Natural Regeneration (ANR)' was practiced to convert that land also into a dense woodland.

Currently, NIFS-SPA is visited by many local and overseas researchers for educational purposes and ecological research. On account of its significance as a bench mark site for Assisted Natural Regeneration, many forest ecologists and botanists use NIFS-SPA as a research site. It is also a popular tourist destination owing to the presence of unique fauna with a rich bird life and some unique animals such as Slender Loris and Pangolin. NIFS-SPA also has a rich, dry evergreen vegetation consisting of over 200 species of trees.

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

Internal Audit Division

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

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

The Division is responsible for independent and objective reviews and assessment of the Institute's activities, operation, financial system and internal controls adhering 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 functions below 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 the 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 the 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 investigations wherever necessary.
- Following the guidelines 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.

Four Audit & Management Committee meetings were held during the year 2016 under review on 06th February, 05th March, 09th July and 05th November respectively.

Accounts Division

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

The Accounts 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, other deductions and allowances.
- **Personal Provident Fund**: Maintenance of the contribution of Employees Provident Fund (EPF) by keeping cards and records separately for individual employees, investing, monitoring of fixed deposits and withholding tax.
- **Staff Loans**: Management of EPF and concessionary loan schemes and maintenance of relevant records.
- **Cash Payments**: Payment of a wide verity of purchases, taxes, keeping all supporting documents and files to assure the amount to be paid in compliance with relevant government rules and regulations.
- **Budgeting:** Estimating the sources and expenditure for the period; this serves a number of important purposes such as monitoring and controlling the finances of the Institute.
- **Procurement & Inventory**: Keeping track of all purchases: stationery, hardware, general items and local inventory items.
- **Final Accounts Statement**: Preparation of comprehensive final accounts and statements in compliance with 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

Objective

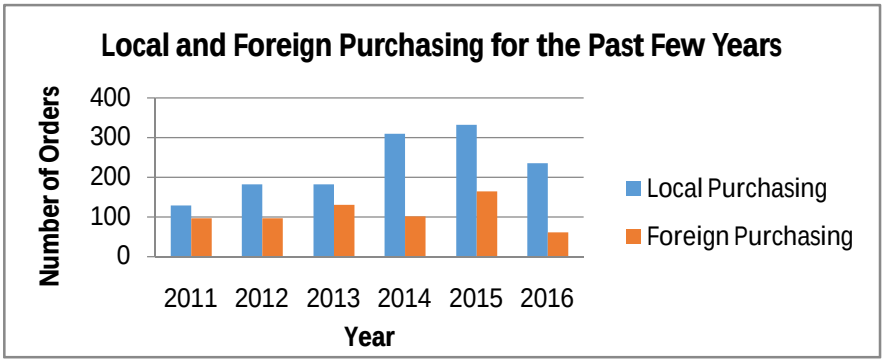
The Procurement and Laboratory Stores is committed to providing the necessary resources to achieve the goals of the Institute.

Our Team

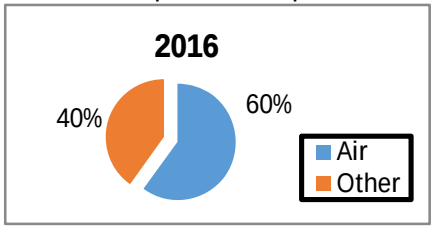
From Left: Ms. GWRP Chandrakanthi, Ms. HMTL Sumanarathne, Eng. Ms. WDSP Perera, Ms. DMKL Kumari, Ms. KGND Dassanayake

Our Services

- Foreign and local purchasing of 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 NIFS is to support and cooperate in the research activities when analytical and technical expertise is required.

The Technical staff of the NIFS mainly supports the ongoing research activities in their respective research projects by; collection of field samples; preparation and analysis of different kinds of samples using analytical instruments.

The Computer Division ensures the smooth functioning of computers, the internet facility and network system of the Institute.

The Instrument Maintenance Division monitors the functioning of all the analytical instruments in the Institute.

The Role of the Technical Staff

- Support and cooperate in the respective research projects in achieving the goals set by the Project Leader.
- Programming, operation and maintenance of computers and network system.
- Maintenance and operation of the PABX and telephone network and automated attendance system for the staff.
- The maintenance of the electrical installation, switchgears, generator and the Central UPS system.
- Maintaining the chemical, glassware store and inventory.
- Web designing, providing technical support to school science programs, conferences, seminars and workshops.
- Act as Heads of Computer and Equipment Maintenance Divisions.
- Engage in nationally important research activities.

An important service to the institute is providing network and instrument services without service agreements with the local representatives. There by saving large sums of money to the Institute.







NP Athukorala, D Aluthpatabendhi, SSK Sakalasooriya, AK Pathirana, WG Jayasekara, AB Herath, RCK Karunarathne, MDK Lakshmi Kumari, RSM Perera, DS Jayaweera, S Opatha, GCKS Bandara, VM Ekanayake, MNB Kulathunga, RB Weerakoon


The Technical staff of the NIFS has conducted a ten day Technical Training Program for the technical staff of the University of Ruhuna in November 2016. Twenty three technical personnel participated in this program.

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 6700 books and about 120 Journal titles covering the Life, Physical and Mathematical Sciences as well as the Philosophy and History of Science, fundamental text books, monographs and edited volumes.

Objective

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

Acquisition of Books, Periodicals and Reports

During the last year 58 new books were added to the collection, consisting of 52 purchased books, and 6 books received on complimentary basis. A large number of periodicals, newsletters, and 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 reference and lending services, 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. Further, this provides online subscriptions to specialized journals to individual scientists. Currently, 40 specialized journals are available online through this scheme.

New Services of the Library

Recently a scientific literature updating service (SLUS), Nature and Science journal content page alert service to the NIFS research staff was introduced.

Digitization of Institute Publications

National Science Foundation digitized our Institute's publications. The aim of the project was to establish an institutional e-repository and provide quick enhanced on-line access to Institute

publications. Here, 1475 entries were electronically scanned and uploaded to the server (ifs.nsf.ac.lk/).

Memberships of External Committees

The Senior Assistant Librarian of the NIFS was appointed as a member of the D.S. Senanayake Memorial Public Library Advisory committee.

Publication in Conference Proceeding

Tilakarathna, T.C.P.K. (2016). Information needs and information seeking behavior of Geo-Scientists in Sri Lanka. International Conference on Library and Information Management (ICLIM) 2016, Department of Library and Information Science, University of Kelaniya, Sri Lanka.

Other Activities

Delivered a series of lectures on "Improving reading habits in children and introduction of the Library System" for Schools at the Hillwood College, Kandy, October 19, 2016.

From Left: Ms. Chandrika Tilakarathna, Ms. RM Witharana

Staff of the NIFS 2016

Director : Prof. S.H.P.P. Karunaratne

Secretary : Dr. P.S.B. Wanduragala

Research Staff

Senior Research Professors

Prof. A. Nanayakkara
Prof. J.M.S. Bandara
Prof. U.L.B. Jayasinghe
Prof. P.R.G. Seneviratne

Research Professors

Prof. M.A.K.L. Dissanayake
Prof. D.S.A. Wijesundara

Associate Research Professor

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

Senior Research Fellow

Dr. D.N. Magana-Arachchi
Dr. R.R. Ratnayake
Dr. M.S. Vithanage

Research Fellow

Dr. R. Liyanage
Dr. H.W.M.A.C. Wijeysinghe
Dr. V.Y. Waisundara

Visiting Research Professors

Prof. S.A. Kulasooriya
Prof. N.S. Kumar
Prof. Y. Fujimoto (Japan)
Prof. N. Kuhnert (Germany)

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. Thotawatthage
Mr. W.W.M.A.B. Medawatte
Mr. P.H.M.I.D.K. Herath
Mr. T.B. Nimalsiri
Mr. M.M. Qader

Research Assistants 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. Rathnayaka
Ms. D. Thanabalasingham
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
Ms. D.M.V.Y.S. Bandara
Ms. P.C. Wijepala
Ms. R. Visvanathan
Mr. K.N.L. De Silva
Ms. R.M.N.M. Rathnayake
Ms. D.M.D.M. Dissanayake
Ms. E.G.C.K. Priyadarshika
Mr. D.M.T.U. Bandara
Ms. N. Kanesharatnam
Mr. S. Sayanthooran
Ms. H.K.S.N.S. Gunarathne
Mr. G.D.K. Heshan
Ms. K.M.U.J. Bandara
Mr. D.R.L. Dodangodage
Ms. J.A.D.M.N. Jayakody
Ms. S.K. Jayasekara
Ms. R.W.K. Amarasekara
Ms. E.M.U.A. Ekanayake
Ms. W.M.L.S. Weerasundara
Mr. P.L.C.U.S.B.Lekamge
Mr. A.M.K.L. Abeykoon

Technical Staff

Chief Technical Officers

Mr. M.N.B. Kulathunga
Mr. W.M.R.B. Weerakoon
Ms. D.M.K. Lakshmi Kumari
Ms. I. Tumpale
Mr. N.P. Athukorale
Mr. W. 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
Ms. R.S.M. Perera
Ms. D. Aluthpatabendi
Mr. A.K. Pathirana

Director's Office

Ms. M.D. Jeewa Kasthuri	Senior Personal Secretary to the Director
Ms. O.W.K. Seneviratne	Stenographer Gr. II
Mr. M.P.D.K. Malwewa	Office Aid

Internal Audit Division

Ms. W.S.N.F. Jayasooriya	Internal Auditor
Ms. C.O. Gunasena	Management Asst. Gr.III

Library

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

Science Education & Dissemination Unit

Dr. C.T.K. Tilakaratne	Head
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. Piyathilaka	Communication & Media Officer
Ms. H.M.G.N.N. Herath	Management Asst. Gr.III

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 Asst.–Book Keeper
Ms. M.P. Palliya Guruge	Senior Staff Asst. – Clerical
Ms. R.M.V.P. Rathnayake	Senior Staff Asst. – Clerical
Mr. G. Ariyaratne	Senior Staff Asst.– Store Keeping
Ms. T.P. Gamalath	Management Asst. Gr.III
Mr. M.K.D. Keshan	Management Asst. Gr.III
Mr. B.J. Weerasooriya	Management Asst. Gr.III
Mr. M.A.P. Perera	Office Machine Operator

Procurement & Lab Stores Division

Ms. W.D.S.P. Perera	Laboratory Manager
Ms. D.M.K.L. Kumari	Chief Technical Officer
Ms. G.W.R.P. Chandrakanthi	Senior Staff Asst.- Stenographer

Administration Division

Ms. R.P.M. Weerasooriya	Senior Staff Asst.- Clerical
Ms. T.P. Wijewickrama	Senior Staff Asst.- Stenographer
Ms. C.L.S. Illangakoon	Senior Staff Asst.- Stenographer
Ms. C. Ranasinghe	Senior Staff Asst.- Receptionist
Mr. D.G. Gunathilake	Record Keeper- Special Grade

Mr. A.G.S.T. Gunathilake	Management Asst. 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. 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	Driver Gr. III
Mr. D.J.M.W.P. Jayasekara	Machinist- Special Grade
Mr. A.V.A.P. Kumara	Machinist- Special Grade
Mr. M.A. Lal	Laboratory Attendant- Special Grade
Mr. R.B. Hapukotowa	Laboratory Attendant- Special Grade
Mr. G.D. Dharmasena	Electrician Gr. I
Mr. D.G.K. Dorakumbura	Mason Gr. I

Colombo Office

Mr. A.D. Gunawardena	Karyala Karya Sahayaka/ Driver

Budget

Item	2010	2011	2012	2013	2014	2015	2016
Recurrent							
Personal Emoluments	51,945	64,723	71,734	84,561	88,317	113,461	122,653
Travel Expenses	570	531	581	532	1,295	1,163	1,257
Supplies	6,763	7,484	8,952	10,018	16,491	16,205	15,431
Maintenance Expenses	5,063	5,454	3,796	2,891	8,496	7,105	8,525
Contractual Servises	9,817	12,488	13,540	14,258	16,396	17,204	19,366
Others	2,509	4,042	4,306	5,185	6,497	18,845	23,818
Recurrent Expenditure	**76,667**	**94,722**	**102,909**	**117,445**	**137,492**	**173,984**	**191,050**
Capital							
Capital Expenditure	15,123	29,731	52,644	49,210	111,897	44,593	126,473
	15,123	**29,731**	**52,644**	**49,210**	**111,897**	**44,593**	**126,473**
Outside Grants	2,996	9,752	17,425	11,068	12,512	13,626	13,626
	2,996	**9,752**	**17,425**	**11,068**	**12,512**	**13,626**	**18,333**
Total	**94,786**	**134,205**	**172,978**	**177,723**	**261,901**	**232,202**	**335,856**