# ENVIRONMENTAL ACTION IN SELECTED INDIAN COLLEGES AND UNIVERSITIES

*A Compendium*

**Editors**

*Paul P. Appasamy*

*Nirmala Jeyaraj*

**Published by**

*United Board for Christian Higher Education in Asia*

**ENVIRONMENTAL ACTION IN SELECTED INDIAN COLLEGES AND UNIVERSITIES: A COMPENDIUM**



Printed by: El-Shadai Printers, Madurai.

*Contact email id: mspurgeon@unitedboard.org*

# CONTENTS

## Part-3: Novel Initiatives



## Part-4: Other Initiatives

# FOREWORD

The United Board for Christian Higher Education in Asia is honored to have been able to lend support to projects at Christian colleges in India designed to explore the intersections of environment and health and develop responses and interventions to advance the wellbeing of both. This initiative has involved educators and students at a dozen institutions over a five-year period (2010-2015). The initiative resulted in numerous projects that reflect the diverse needs and resources of each institution.The fruits of these efforts are featured in this volume.

As the following pages make clear, prerequisites for successful efforts to improve the environment of college campuses and nearby communities, and thereby advance the health of those living and working there, begin with a clear and comprehensive analysis of problems, needs, and opportunities. Scholar educators and their students can play a unique role in advancing knowledge of problems and engaging the wider college and social community to address challenges that affect the lives of all. The projects profiled in this volume provide innovative models of research, analysis, and partnership, and we hope not only that they will be sustained at the respective campuses, but that they will help to inspire similar efforts on other campuses in the years to come.

We commend and congratulate the project leaders for their vision and dedication in conceiving and developing these projects and their tireless efforts to ensure their success. We also applaud the leadership of the colleges in lending their support and encouragement to these important efforts, and thank colleagues at Bishop Heber College for their important role in facilitating and supporting good work. Finally, we express our deep gratitude to the editors, Dr. Paul P Appasamy and Dr. Nirmala Jeyaraj, for their leadership and commitment at every stage of this initiative, as well as for their generosity in volunteering to edit this volume and their skill in completing the task so ably.

**Nancy E. Chapman**,
President,
United Board for Christian
Higher Education in Asia

## MESSAGE FROM VICE PRESIDENT

Like many other religions and cultures, the Hebrew Bible paints a beautiful picture of creation with heaven and earth, light and dark, air and waters, fishes, animals, vegetation and all living things. The Book of Genesis even places human beings at the centre of all creation and assures them of the highest glory of sharing the image of God. It also charges them with the grave responsibility to "rule" the planet world with all the ambiguous meanings of the word. Indeed, human beings have emerged as a conqueror of the wild, taming floods and riding the waves and air currents to a good extent. And yet before too long, we realized that nature with its living things are "subdued" by us so much that they are destroyed and vanquishing in an astronomical scale. The Food and Agriculture Organization of the United Nations predicts that by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity; oil reserve of the world will be finished by 2062, natural gas by 2075, Coal 2204. If these dates sound far away, American Association for the Advancement of Science estimates about 550 million people are being killed every year by polluted air, most of them live in newly developed economies such as China and India. When God said, "be fruitful, and multiply, and replenish the earth, and subdue it; and have dominion over ...every living thing that moveth upon the earth" (Gen 1: 28), Godmust not mean ruthless exploitation of the creation and all natural resources. It cannot be. For it would then mean imminent death of the human beings God so graciously created. Rather, creation of human beings is deeply rooted in the soil and the air, which all living things equally share. The only explanation for "dominion" musttherefore the exercise of stewardship. Stewardship of the environment refers to protecting the environment through our desire for change from excessive living. Recycling, conservation, regeneration, and restoration only make sense if we, human beings, placed at the centre of all creation by God, determine to change. Stewardship of the environment means taking responsibility for our choices, whether big or small, long or short term every day. This would include also demand the request for justice, meaning resistance to inequitable economic patterns that are maintained at great environmental cost and unsustainable economic growth that based on unlimited supply of "cheap" or "free" natural resources.

I am very happy to learn about the environmental projects shared and reflected on by the network schools of the United Board in this volume. I am grateful for all the efforts made by the universities and colleges in the past decade in India, facilitated by the United Board, to infuse the aspiration and hope for changefor all the creation which human beings are only a small part of. My sincere wish to all partakers of the stewardship of the environment—for your continuous courage and passion to be agents of change so that our society may become sustainable for all living things.

**Wai Ching Angela WONG**
Vice President for Programs, United Board
September 2016, Hong Kong

## GREETINGS

It gives me immense pleasure to convey my greetings for this Compendium. At the outset let me congratulate the editors, Dr. Paul Appasamy and Dr.Nirmala Jeyaraj, and all other authors of articles for the great work done to accomplish this task.

The role of education is not only preparing people for livelihood but also for life. The objective of education is to prepare responsible citizens for the common good. The vision of the United Board is Whole Person Education and its mission is to facilitate intellectual, moral and spiritual development of the young people through the institutions of higher education in Asia. The United Board began its work in India in 1970s and has supported several projects one of its concerns being Environment. Bishop Heber College, Trichy known for its Environmental Studies program, has been recognised as a nodal institution by the United Board, to promote environmental concerns through networking with other member institutions during 2010-2015.

I sincerely thank Dr. Paul Dayabaran, the Principal of Bishop Heber College and Dr. Alagappa Moses, the coordinator of the UB Project for their work and support in consolidating this work. I would also like to place on record our sincere gratitude to Dr. Paul Appasamy and Dr. Nirmala Jeyaraj for their hard work and commitment to bring out this Compendium at the appropriate time.

It is appropriate that this book is released at the Golden Jubilee Celebration of AIACHE. When the United Board began its work in India it had given a substantial amount to AIACHE as endowment fund in 1969. I also thank Dr. Danial Ezhilarasu, the General Secretary of AIACHE for agreeing to release the book on this auspicious day.

I am sure that this Compendium will enable young people to develop a sense of responsibility towards our environment. Let us understand that we have not received the environment and the natural resources from our forefathers to use indiscriminately, but have the responsibility to preserve and pass it on to our children and the future generations. I wish all the authors and the editors the very best for their vocation of sharpening the young minds and shaping their character for a better world.

**V.M Spurgeon**
Regional Program Consultant
United Board.

## Acknowledgements

The United Board for Christian Higher Education in Asia has funded projects in Environment and Health in several of its partner institutions in India. This Compendium attempts to capture the experiences and lessons learnt by the Faculty and students while implementing the projects particularly during 2010-2015. The President Dr. Nancy E. Chapman has supported these initiatives as well as the publication of the Compendium. We are grateful to her for writing a Foreword. The former Vice President for Programs, Dr. Glenn Shive mooted the idea of a Compendium as a concluding activity. Dr. V.M.Spurgeon, the Regional Program Consultant for South Asia monitored the process of bringing out the Compendium, and ensured the funding of the Authors Workshop and the final publication. We are grateful to them and the United Board for their support.

The Compendium would not have been possible without the full cooperation of the Faculty in the partner institutions in writing the articles and attending the Authors Workshop. We would like to thank each of them as well as the respective Vice Chancellors/Principals of the institutions who implemented the projects and contributed the articles despite other commitments. A list of contributors is given at the end on Page.

Our sincere thanks to Bishop Heber College, Trichy and particularly to Prof. Alagappa Moses, Coordinator of Environmental Studies and his team, who took care of all the financial arrangements for the Workshop. We wish to thank the Principal and Bursar of Bishop Heber College who facilitated the process.

Thanks are due to Karunya University for hosting the Authors Workshop in May 2016. Dr. S. Karthikeyan, Head, Extension did an outstanding job of the workshop arrangements assisted by Mr. Seelan. We are grateful to them and to the Vice Chancellor, Registrar and Finance Officer of Karunya University for their unstinted support.

We owe our deep gratitude to the two subject experts, Dr. E.J.James former Vice Chancellor, Karunya Unviversity and Dr. Mathew Sebastian, Extension Officer, Salim Ali Centre for Ornithology and Natural History (SACON) for carefully reviewing the papers and giving their comments and suggestions to the authors at the May workshop.

Finally, we would like to thank the administrative support given by Ms. R. Saraswathi in Chennai, and the DTP work by Mr.Samuel David and printing by El-Shaddai Printers, Madurai, which enabled us to bring out the Compendium in a timely manner.

**Paul P. Appasamy**
**Nirmala Jeyaraj**
(Editors)

## INTRODUCTION

The United Board for Christian Higher Education in Asia ("United Board") has been providing small grants to partner institutions in India and other Asian Countries for many years. The United Board decided to fund three thematic areas: Environmental and Health; Local Knowledge; and Inter Religious Dialogue/Peace studies for a five year period from 2010-2015. Around 60 per cent of the small grants given to Indian partner institutions was in the area of Environment and Health, since many institutions had already started initiatives in this area. The grants were either given directly to the Colleges or in some cases through the Bishop Heber College in Trichy which served as a nodal agency. Bishop Heber College was chosen because it had already developed a reputation for teaching and research in Environmental Sciences. Over five years, the United Board provided grants totalling about US$250,000 to about a dozen partner institutions in India either directly or through the Heber partnership. A list of the institutions that received grants for Environment and Health is given in Annexure - I.

The Environment and Health programs undertaken by the partner institutions covered several different areas:

1. **Campus Initiatives** – Solid Waste Management, Water Management, Biodiversity Assessments of the campus to improve the quality of the campus environment as well as to enable students to understand environmental issues in a practical way. Some efforts were also made towards **campus audits** in areas such as water and waste water Management, energy management, conserving biodiversity etc.

2. **Community Initiatives** –
   a. Students were encouraged to work with the local communities near their campus in areas like solid waste management, reduction of plastics use, and conversion of plastic waste as well as paper waste to more valuable products.
   b. There were also studies of environmental health problems in the local communities and steps needed to mitigate these problems. A closely related area is "Environmental Service-Learning" whereby students could learn about environmental problems while studying the environment of local communities.
   c. Interaction and working with neighbouring schools and community members provided an opportunity for students to learn as well as

educate the public on key environmental issues relevant to their local content. This was done both in formal and informal ways.

**3. Novel Initiatives**

a. One of the Colleges constructed a micro-hydel project on the campus to reduce electricity costs, while another college did an energy audit and explored the idea of solar energy as a supplemental source of energy.

b. Calculation of green house gas emissions and carbon footprint of the college; and steps to make the campus carbon neutral and reduce GHG emissions

c. Local knowledge for tribal communities on medicinal plants and herbs was studied to relate traditional knowledge to environment.

**4. Publications**

a. Most of the colleges have surveyed the Biodiversity of their campuses in order to know and protect their own campus environment. This has resulted in several publications on campus fauna and flora.

b. Some have also produced text books and in house curricular materials to make their teaching more effective.

c. Some faculty members have published their findings in research journals, magazines, newspapers, etc.

**5. Institutional Initiatives**

a. Some Colleges have set up Interdisciplinary Centres / Departments of Environmental studies which could draw on the expertise of various departments of their college. This has lead to the design of a few innovative courses of multidisciplinary nature offered under the credit based system in few autonomous colleges.

b. In one institution, the Centre for Social Action has been using the waste from the campus to produce useful products using women self help groups.

c. Most colleges have evolved "Best Practices" related to the campus environment.

**Compendium - from Idea to Reality**

While reviewing the "Environment and Health" projects carried out between 2010-15, the former Vice-President for Programs of the United Board. Dr. Glenn Shive suggested that the projects output should be "harvested" in the form of a Compendium. All the partner institutions had

submitted reports at the end of the respective projects to the United Board. However, it would be useful if the Project Investigators could reflect on their experiences and the lessons learnt in the form of articles. A collection of these articles would form the basis for the Compendium. The present Editors (Dr. Paul P. Appasamy and Dr. Nirmala Jeyaraj) volunteered to edit the Compendium.

The Bishop Heber College organized a Workshop at Karunya University in November 2015 as a concluding activity of the partnership with the United Board. Some of the Colleges which had received grants attended the workshop and made presentations. In December, the editors wrote to the Principals/Vice-Chancellors of all the partner institutions who received grants for Environment and Health to request their faculty members to prepare one or more articles for the Compendium. A style guide was provided to maintain a common format to the extent possible.

Some of the colleges responded promptly by January 2016. Follow up letters were sent to the institutions which did not respond. Almost all the institutions sent the first draft of the articles by the end of March. The Editors provided feed back to the authors for revising their articles. The Regional Program Consultant, Dr. V.M. Spurgeon suggested organizing a workshop for the authors to receive feedback and also for them to know about the contributions of the other authors/colleges.

Accordingly, the Authors' Workshop was held again at Karunya University on May 23-24, 2016. Two experts – Dr. E. J. James, former Vice-Chancellor and Director, Water Institute, Karunya University and Dr. Mathew Sebastian, Scientist, Salim Ali Centre for Ornithology and Natural History (SACON) and former Head, Extension Karunya University provided comments on each of the articles. Each of the authors made a short presentation which was followed by comments from the expert and from the floor. The experts appreciated the sincerity with which the colleges had carried out the projects and in writing the articles for the Compendium. The authors were given one more month to revise their papers based on the comments that they received at the Workshop.

## PART- 1: Campus Initiatives/ Audits

**Samrat Bhattacharjee** of **Scottish Church College**, Kolkata one of the oldest Christian liberal arts and sciences College in India, explains how the architectural heritage as well as the gardens have been conserved despite the location of the College being in the middle of Kolkata. The campus audit included energy, water and fire safety. The Faculty and students

identified the floral and faunal biodiversity of the campus. There are more than 90 plant species (including medicinal plants), 26 bird species and 45 insect species. The College also carries out environmental awareness programs in nearby schools.

**Rana Sen** of the same college discusses two green campus initiatives, namely vermicomposting and recycling laboratory water. Grass and plant residues and uncooked kitchen wastes are converted to compost using earthworms. The yearly production of around 2000 kg of vermi compost meets the entire demand of fertilizer in the college, saving the college about Rs.60,000 per year. Efflux water from four water distillation plants are stored and reused. Around 400-600 litres of efflux water is used from the storage tanks which not only saves water but also the electricity used to pump that water to the overhead tanks.

**Phinu Jose, The Centre for Social Action, Christ University**, Bangalore explains how the University has been working for more than 8 years towards the goal of a zero waste campus. With 15,000 students and faculty, the University generates a huge quantity of solid and liquid waste. Initial emphasis was on waste segregation practices organic wastes are composted, while food wastes are digested in a biogas plant for energy generation. Paper wastes are recycled through a handmade paper recycling unit. Tetrapacks are converted to useful products by a self help group, providing employment and income generation opportunity for the poor women. Liquid wastes are treated in a waste water treatment plant and used for the gardens.

**Jibu Thomas and S. Karthikeyan of Karunya University**, Coimbatore did a solid waste audit of the campus. The first audit done during a normal week quantified the different kinds of waste (paper, plastic and metal) from the departments and from the 11 hostels where about 7000 students reside. Estimates were made of the quantum of food waste from the hostels during a normal week. The second audit was carried out during an intercollegiate sports tournament when hundreds of students from other colleges come to Karunya. There was a threefold increase in the quantum of waste especially on the first day. The authors suggest various methods of reducing waste generated and ways to manage the waste.

**Anand Gideon and others, Bishop Heber College**, Trichy focus on the floral biodiversity of the College, which has come up on clayey agricultural land previously used for paddy cultivation. The open green cover occupies about 16 acres accounting for 60 per cent of the total area of the campus. There are 197 genera of plants with 74 species of trees, herbs (59), shrubs

(4), and Climbers (13) and 17 grass species. There is also an Arboretum where 25 species are maintained. The authors list all the species found on the campus with botanical name, common name, local name, nativity and family. 124 non-native species were introduced for greening the campus. However, efforts are being taken to replace the non-native species with native species. **Anand Karunakaran** and others of the same college carried out an energy audit of the campus buildings with a view to conserve energy and also possibly substitute solar energy for grid power.

## PART-2: Community Initiatives

**Dhanaseeli and Pricilla** of **Lady Doak College**, Madurai, conducted a study of Sellur, a highly polluted neighbouhood with the residents at risk of health problems caused by air and water contamination. A service-learning programme was implemented to promote good quality of life. A socio-economic base line survey was conducted as well as studies of air and water contamination. An awareness program and a medical camp were organized for the residents. The community was sensitized to the environment and health problems. Students were able to apply the knowledge to promote better quality of life in the neighbourhood.

**Leonilla Menezes (Sr.M.Clare) and Sharmila Mascarenhas of St. Ann's College of Education**, Mangaluru organized an Environment and Health Awareness "Programme through community based activities with a service learing approach. The goal was to provide teachers and students an opportunity to identify and learn the needs related to environment and health conditions in rural areas and to find suitable solutions. The teachers prepared action plans followed by evaluation and reflection.

**Priscilla and others of Lady Doak College**, Madurai conducted a health impact study in and around an open air crematorium at Thathaneri, Madurai. A questionnaire based socio-environmental base line survey was carried out, followed by geo-mapping using ARC-GIS software to get a reference map. The emission of carbon dioxide and carbon monoxide at the time of cremation was measured in terms of the ambient quality. Microbiological analysis of air and waster revealed the presence of bacterial and fungal allergens. Since open cremation causes pollution and affects health, the Government can encourage the use of the electric crematorium which already exists in the same premises.

**Samar Thapa and Sandeep Sundas** of **Salesian College** discuss how the Siliguri campus shares a boundary with the dumping ground of Siliguri, which has resulted in the visual pollution and spread of obnoxious smell.

The college has started an awareness program among the students and has also petitioned the district administration to manage the solid waste in an environmentally sound manner. Water testing of open bore wells revealed high levels of Coliform bacteria. A Writ Petition was filed by an activist before the Sub-divisional Magistrate against the Mayor, Siliguri Municipal Corporation to restrain dumping of solid waste. The activists in the area have requested the administration to relocate the dumping ground and create clean, healthy, living conditions

**Mary Pearl and Betsy Selvakumar** of **Women's Christian College**, Chennai undertook an assessment, sensitization and mitigation program to reduce the use of plastic bags in the college and two local communities. The attitude and behaviour of the College community and the local community were studied through both pre-project and post-project surveys. The students also developed various educational tools to communicate the message. 90 per cent of the respondents said that they have made an attitudinal/behavioural change after the "White Pollution Campaign".

## PART-3: Novel Initiatives

**Samar Thapa** of **Salesian College**, Darjeeling discusses a micro-hydel project which taps the energy from the vertical fall of water near the campus. The power generated could be used to supplement grid power. Micro-Hydel projects are a clean source of energy and also do not require submergence of forest area. The economic benefits are estimated to be INR 2,16,000 per year as well as the reduction of 145.8 tonnes of CO2 emissions. However, for synchronization with grid power, the generated electricity must have equal line voltage, frequency, phase sequences, etc. Permissions from the local authorities also have to be obtained.

**Priyatharsini Rajendran, and others** of **Lady Doak College**, Madurai did a study on Sustainable Resource Management at their college using the concepts of "ecological footprint" and "carbon footprint". Ecological foot print was based on the use of resources such as water, food, fuel, energy and other commodities. Carbon foot print analyzes the amount of green house gas emissions based on the energy consumption. The ecological foot print expressed in hectares of land was calculated separately for resident and non-resident students, teaching and non-teaching staff and housekeeping staff. The vegetation on the campus sequesters a small percentage of the carbon emissions. Mitigation measures are suggested by the authors.

**Nancy Jaba Priya** of **Madras Christian College** has developed a service learning strategy for solid waste management. It involves the interaction

with informal recyclers and the chemical recycling of polyethylene terephthalate (PET) waste. The widespread use and non-biodegradability of PET bottles cause a serious problem in waste management. The PET waste was converted to solid terephthalic acid which brings a good return for the recyclers, compared to the PET bottles which would fetch then only one-fifth of the revenue. However, the economics of conversion have to be studied since the catalyst used is expensive. The students benefited from participating in the program.

**Priscilla Jebakumari and Sathya Bama** of **Stella Maris College** have been working with the Irula tribe to understand local knowledge of medicinal plants. Ethno-botanical methods such as open and semi-structured interviews were conducted with Irula Women. They enumerated the medicinal plants in terms of the local name, botanical name, and the potential medicinal uses. Other cultural practices of the Irulas were also documented. An "Irula Corner" has been initiated in the existing herbal garden of the college, housing the plants used as medicine and food by the Irula tribe. A seed bank repository comprising 40 different seeds from medicinally important plants has been set up.

## Annexure - I

**Institutions that Received UB Grants for Environment and Health (2010-2015)**

American College, Madurai
Bishop Heber College, Trichy, Tamil Nadu
Christ University, Bangalore, Karnataka
Karunya University, Coimbatore, Tamil Nadu
Lady Doak College, Madurai, Tamil Nadu
Madras Christian College, Chennai, Tamil Nadu
Salesian College, Siliguri, West Bengal
Scottish Church College, Kolkata, West Bengal
St. Ann's College of Education, Mangalore, Karnataka
Stella Maris College, Chennai, Tamil Nadu
Union Christian College, Aluva, Kerala
Women's Christian College, Chennai, Tamil Nadu

PART- 1:

# CAMPUS INITIATIVES

# CAMPUS AUDIT AND ASSESSMENT OF FLORAL-FAUNAL DIVERSITY

1

Samrat Bhattacharjee
*Scottish Church College, Kolkatta*

**Abstract**

***The Scottish Church College- "Heritage Building' [Class A]"*** *is one of the oldest Christian Liberal Arts and Science Colleges in India. The auditing of the campus was carried out during 2011-12 with respect to the electricity and water usage. The college has adopted initiatives to conserve energy by solar lighting and conserving run-off water from distillation plants in laboratories. Biodiversity study in the campus recorded about 90 medicinal plants and about 75 animal species including diverse plethora of insects, birds and mammals. The Brazilian tree Pseudobombax monguba has been attributed the Flagship plant species and Oriolus kundoo the Flagship bird species of the college. As part of the study, awareness programmes for school and college students were carried out. The schools and colleges have initiated assessment of biodiversity in their campus through eco and biodiversity clubs and inspired by this work, Undergraduate Board of Studies in Zoology, University of Calcutta, has included* ***Environment Audit*** *as part of the syllabus for UG students.*

**Key words:** *Campus audit, infrastructure energy audit, Biodiversity, energy conservation, awareness programme*

## Introduction

Campus Audit aims to address the need for more comprehensive and focussed education training and development of an institution. In the world of advanced researches and globalisation, an audit programme of the institution provides knowledge about the detailed working of the various campus entities and the scope for betterment in areas of education and environmental action programmes. The moot areas of campus audit are the building and infrastructure audit, human resources audit, energy audit, waste audit, hazard material (fire) audit, biodiversity audit and so on. The outcome of such audit programmes gives an insight into better running of the institution and judicious utilisation of its available resources, their improvement, quality enhancement, conservation and spreading the information through awareness

programmes. Such practices help build holistic personality of pupils and faculty members and are imperative towards shaping the way of "Service Learning" programme and its successful implementation.
Scottish Church College being one of the oldest Christian Minority Educational Institution in India is committed towards shaping its students and faculty members following principles of Value Education. As part of such programme the college has been receiving projects from various funding institutions including United Board for Christian Higher Education in Asia towards Service Learning and Environmental Action initiatives. As part of such programme the college received a project in 2012 on Campus Audit: Assessment of Floral & Faunal Diversity. A synoptic finding of the said project will be presented in this paper.

**Method and Methodologies followed**

The study on one hand focuses on the Infrastructure available in the campus and on the other hand the energy and biodiversity audit (floral and faunal) and fire audit. For the study of infrastructure, a group of undergraduate students guided by faculty members did a detailed survey of the buildings, the total area, the hostels, the students' uptake, student-teacher ratio and so on.
The energy audit was done on the basis of the two year study of the electricity consumption and the water resource utilisation (2011-12). For fire audit the pockets of fire prone areas in the college including various laboratories were identified. Fire extinguishers were installed and training programmes for the staff members were organised for fire management. Relevant information on the college was obtained from IQAC office, College office and Senates Secretary's office.
Campus biodiversity study programme was conducted by the postgraduate students of Botany department and undergraduate students of Zoology department. The different plants in the campus were identified and recorded. Their medicinal values were identified. Similarly the entomofauna, avifauna, mammals were studied in the campus. The identification was done following the expert guidance of faculty members and relevant literatures viz. Hooker (1872-97), Bingham (1897, 1903), Prain (1905) and Ali (2003). The photographs were taken in Semi SLR point and Shoot camera. The photographs of ants and other insects were taken using stereo zoom binocular microscope.

**The College Infrastructure Audit**

The **Scottish Church College** is the oldest continuously running Christian Liberal Arts and Science Colleges in India. It is affiliated to University of Calcutta for degree courses for graduation and Post graduation (in Botany & Chemistry). The college aims to produce **morally upright and intellectually sound human beings** who would become better citizens of the country.

A selective co-educational institution, it is known for its academic standards, intellectual milieu, and its English Palladian architecture. Students and alumni call themselves "Caledonians" in the name of the college festival, "Caledonia".

The institutional origins are traceable to the life of Alexander Duff (1806–1878), the first overseas missionary of the Church of Scotland, to India. Known initially as the General Assembly's Institution, it was founded on 13 July 1830 by Alexander Duff with the assistance of Raja Rammohan Roy. Hence the main building is 185 years old. Because of the illustrious history the main building of the college has been declared a **'Heritage Building' [Class A]** by the Statutory Body constituted by the Government of West Bengal and the Calcutta Municipal Corporation.

The built in area of the college is about 80660 sq.ft. and the ratio of roof area to open space is about 3:1. The college maintains a lush green environment through its own nursery. The plants are exclusively manured by the compost generated through vermicomposting in the college itself.

The Heritage building is maintained by the College Heritage Committee which includes Heritage maintenance expert from Kolkata Municipal Corporation. In strict compliance with the Heritage rules the building is being developed and maintained.

Student uptake in the college is about 2155 and the ratio of Teacher to student is about 1:22

**Energy Audit**

The energy audit mainly was carried out with respect to the electricity and water usage for the period 2011-2012. Months with peak usage load are March, April, June, July, August and September [September being highest 500 kWh] Monthly average unit consumption being 8520 (apprx.) and average per capita annual unit consumption is 40.9. Monthly average water usage is about 23.8 kilo litre. Annual per capita

consumption being 0.12 kilo litre.

**Electricity Conservation Initiative:** The collage has set up 10 solar light units in the campus and planning to set up solar panel in larger numbers to address the issue of energy conservation. (Fig.B).

**Water Conservation Initiative:** The Chemistry and Microbiology departments have set up collection unit for their distillation plant outlet. The collected water from the distillation unit is used for gardening purpose (Fig. C). College is planning on rainwater harvesting project.

**Fire Safety Audit**

Different fire extinguishers are installed in the college. These are maintained by Fire Maintenance Company via Annual Maintenance Contract. The different types of extinguishers and their total numbers are ABC Type (2Kg.)-10, ABC Type (5 Kg.)-45, DCP Type (5 Kg.)-3, DCP Type (10 Kg.)-30, DCP Type (50 Kg.)-4 and CO2 Type (2 Kg.)-3.

**Floral and Faunal Biodiversity in the Campus**

The Campus although located in the heart of the city maintains its greenery. Survey conducted by the faculty members of Botany department with the post graduate students identified about 90 plant species of various genera. Most of the recorded species have medicinal importance. Pictures of some of the floral elements are given in Fig. D. The college maintains its own nursery to cultivate various other useful medicinal plants. This floral diversity provides a conducive ambience to wide gamut of faunal elements to be present in the campus. This includes a rich diversity of insects including butterflies, ants, wasps, birds and mammals. Till date the survey recorded about 26 bird species (Fig. E), 45 insect species (Fig.F,G,H), and 4 mammalian species (Macrochiropteran bat, Cat [Felis sp.], Bandicota sp. and Rattus sp.).

The Brazilian tree Pseudobombax monguba of family Malvaceae has been attributed the Flagship plant species and Oriolus kundoo the Flagship bird species of the college.

**Outcome of the Project**

The college is now driving towards a green campus. Various conservation strategies viz. solar lighting installation, water conservation, rain water harvesting (to be initiated) is being adopted. Through awareness programmes neighbouring schools and colleges

have been guided to practice vermicomposting and energy conservation measures. Schools and colleges have taken initiative to set up Eco/ Environment clubs through which students are practising ways to maintain green campus and assessing in simple ways the bioresources present in the campus. Very recently (27 June 2016), inspired by the UBCHEA workshop programmes held in Scottish Church College, the Under-Graduate Board of Studies in Zoology, University of Calcutta, has incorporated in their Zoology undergraduate curriculum a section titled "Report on Environmental Audit". Here students will have to study at least two faunal diversity, along with ecological notes and photographic documentations, for two seasons, in their campus or nearby locality. The new syllabus becomes operational from the current academic session i.e. 2016-2017.

**Awareness Programmes [Community Outreach]**

Awareness programmes form part of the projects that the college has undertaken. The college has undertaken various awareness programmes and training programmes with the school students of nearby schools (Fig.J). In these programmes the school students and teachers are encouraged to undertake Environment Action programmes in their institutes and technical assistance is rendered by the faculty members of the college to initiate such programmes. The schools where these programmes have been undertaken are Scottish Church Collegiate School, Bethune Collegiate School and St. Margaret's School. Some pictures of the awareness programmes are given below.

**Acknowledgement**

The author wishes to acknowledge the funding agency UBCHEA for sponsoring the projects. For floral diversity assessment Dr. Kasinath Ghosh, Dr. Satabdi Ghosh and the contribution of the postgraduate students of Botany department is worth mentioning. For faunal diversity assessment and awareness programmes the roles played by the Sri. Bibidishananda Basu, undergraduate students of Zoology, Prof. Swagata Chattopadhyay and Dr. Narayan Ch. Das is unparallel. Special note of appreciation is due to Dr. John Abraham- Rector and Secretary, Dr. Amit Abraham- the Principal, Dr. Arpita Mukerji-the Vice Principal, Dr. Mousumi Manna- the Senatus Secretary, Dr. Supratim Das- the IQAC Coordinator and Dr. Rana Sen for their manifold assistance during the course of study and preparation of this report.

**References**

*Ali. S. (2003). Book on Indian Birds. Oxford Publisher.*

*Bingham, C.T. (1897). Wasps and Bees. The Fauna of British India including Ceylon and Burma. Taylor & Francis, London. Hymenoptera I. London: 1-413.*

*Bingham, C.T. (1903). Ants and Cuckoo Wasps. The Fauna of British India including Ceylon and Burma. Taylor & Francis, London. Hymenoptera II. London: 1-506.*

*Hooker, J.D. (1872-97). Flora of British India. L. Reeve & Co., London. 7 Vols.*

*Prain, D. (1905). Bengal Plants. Botanical Survey of India. 2 Vols.*

Fig. B- Solar light in Campus

Fig. C- Distillation efflux water collection

Fig. J-Environment Awareness & Biodiversity Programmes in Scottish Church Collegiate School



Fig. K- Environment Awareness Programme in Scottish Church College for Students of Neighbouring Schools

**Fig.D:** Floral Diversity:

*Atalantia monophylla*

*Abroma agusta*

*Morinda citrifolia*

*Wrightia tinctoria*

*Clerodendrum indicum*

*Costus speciosus*

*Coleus blumei*

*Pimenta racemosa*

*Ocimum gratissimum*

*Hygrophila spinosa*

*Tylophora indica*

*Mimosa pudica*

**Fig.E:Faunal Diversity:** Some Common Birds Visiting the Campus (Fig-E)

*Acridotheres tristis*

*Corvus splendens*

*Spilopelia chinensis*

*Athene brama*

*Psittacula krameri*

*Pycnonotus jocosus*

*Halcyon smyrnensis*

*Dendrocitta vagabunda*

*Pycnonotus cafer*

*Columba livia*

*Dicrurus macrocercus*

*Oriolus kundoo*

**Fig.F:** Entornofauna: Order-Lepidoptera (Butterflies)

*Tirumala limniace*

*Ariadne merione*

*Euthalia aconthea*

*Mycalesis perseus*

*Melanitis leda*

*Eurema hecabe*

*Papilio polytes*

*Elymnias hypermnestra*

*Delias eucharis*

*Euchrysops chejus*

*Danaus chrysippus*

**Fig.G Order:** Hymenoptera (Ants, Wasps & Bee)

*Camponotus wasmani*

*Crematogaster sp.*

*Meranoplus bicolor*

*Solenopsis geminata*

*Plagiolepis longipes*

*Oecophylla smaragdina*

*Pompilus sp*

*Anthophora sp*

*Apis indica*

Fig. H- Order: Diptera [Flies]

*Stilbum cyanurum*

*Tachytes sinensis*

# 2

# GREEN CAMPUS INITIATIVE: VERMICOMPOSTING AND WATER MANAGEMENT

Rana Sen
*Scottish Church College, Kolkata.*

**Abstract**

*In an effort to create and maintain a clean and green campus in Scottish Church College, situated at the heart of the megacity Kolkata, we adopted the good practice of vermicomposting and water management with generous help from the United Board for Christian Higher Education in Asia. The grass and plant residues, as well as uncooked kitchen waste, were converted to valuable organic manure by earthworms in specially constructed vermicomposting pits. The soil sample analysis carried out showed remarkable improvement in faunal and microbial quality of the soil. The yearly produce of vermicompost (around 2000 kg) meets the entire demand of organic fertilizer in the college, with something to spare. Management of water usage is carried out by storing and recycling the efflux water from the four (electrically operated) water distillation plants. Awareness programmes were carried out in the college and a number of neighbouring schools. The faculty members from the college interacted with students and teachers of these schools and spread the knowledge of the benefits of vermicomposting and water management in educational institutions.*

**Key words:** *Vermicomposting, Solid waste Management, Water Management, Organic fertilizer, Biodegradable.*

## I. Vermicomposting

### The Goal:

Waste disposal management is a growing concern in cities. The main waste matter in cities consists of kitchen waste, plant and tree waste and various other organic wastes most of which are biodegradable. Vermicomposting can go a long way in solving the problem of waste disposal.

Vermicomposting is the method of allowing redworms or earthworms, and other decomposer organisms, to process the organic waste matter and convert it into a very useful natural fertilizer called vermicompost. The concurrent breeding of worms also helps to aerate the garden soil.

Adapted for a college campus of modest dimensions, it readily leads to a Green Campus Initiative and a Green Awareness in the neighbourhood.

**The Infrastructure and the Methodology:**

a. Suitable sites were chosen, within the campus, for setting up the vermicomposting pits made of brick and cement mortar. The individual vermicomposting pits were 6 feet by 3 feet and 1 foot high. Eight such pits were constructed spread over two buildings on the campus. Care was taken to locate them near the canteens and gardens, and far away from the classroom area. Five deep cement lined pits (6ft x 3ft x 4ft) were constructed to store the composting material in the early stages (pre-composting stage), before they were transferred to the vermicomposting pits. Three big and deep pits (8ft x 4ft x 3ft) made of bricks and cement mortar were constructed to hold and store the semi-dry dairy slurry that needs to be mixed with the composting material for quicker action. The dairy slurry is a very rich source of earthworms, and we did not need to buy any earthworm separately for the purpose of vermicomposting. All the pits were covered suitably so that they were protected from direct sunlight and the rains. The pits need to be watered frequently but in measured quantities. A batch of vermicompost becomes ready in about six months time. We 'harvest' two batches of vermicompost in a year, amounting to about 2000 kg. This natural fertilizer is packed in plastic lined jute bags (approximately 25 kg to a bag) and stored in a room fitted with ventilators. The vermicompost is utilized throughout the year. Manual labour is an important input, which adds substantially to the manufacturing cost of the fertilizer.
b. The vermicomposting technique bio-degrades organic waste with the help of earthworms at an ambient temperature. This procedure does not liberate a lot of heat, nor does it produce obnoxious fumes or gases or stench. It is suitable for open-to-the-air pits, which are protected from direct sunlight and rainfall. The vermicompost produced contains a rich variety of micro-nutrients which are good for plants bearing flowers and fruits. The earthworms that are bred in the pits help to aerate the native soil. The whole process is not too costly, and a break-even point arrives barely three years from the start. The result of this endeavour is an eco-friendly, 'green' campus.
c. The segregation and collection of kitchen, vegetable and plant waste

has to be carried out carefully. No cooked food should be introduced into the pits, because oil or fat in any form is detrimental to the health of the earthworms. The grass on the campus is the main feed, followed by the dead leaves and uncooked vegetable residue from the canteen. We were not able to tap the vegetable residue etc. from the homes of the staff who reside on the college campus. When this becomes possible the output of vermicompost can shoot up to three times its present level in the same period of time.

d. A preliminary analysis of the soil samples have been carried out. The samples were collected from the vermicomposting pits. The various soil fauna were separated on the basis of their sizes, in the laboratory. The macro- and meso-fauna were isolated in the Zoology laboratory. A Tullgren funnel was used for isolation. The funnel was lit with a 40 Watt incandescent lamp and kept overnight. Periodically the soil samples were placed in this setup and the fauna were collected in 70% ethanol.

The microbes were isolated in the Microbiology laboratory by the following steps:

i) The soil sample collected from the vermicomposting pit was dried in an air-oven and pulverized to a fine powder.
ii) 1.0 gram of the dried powder was added to 1.0 ml distilled water and centrifuged.
iii) The supernatant liquid was collected, serial dilution was done and plating was performed.
iv) Nutrient Agar plate was used for bacterial plating and MRBA for fungal plating.
v) The colonies that developed were studied for identification.

In a balanced soil, plants grow in an active and vibrant environment. Without the activities of soil organisms organic materials would accumulate and litter the soil surface. Without bio-degradability there would be little food left for the plants to grow. The soil biota is classified based on size as follows;

* Megafauna: size 20 mm upwards
* Macrofauna: size 20-2 mm
* Mesofauna: size 2 mm-100 micrometre
* Microfauna and Microflora: size 100-1 micrometre

Of these, bacteria and fungi play key roles in maintaining a healthy soil. They act as decomposers that break down organic materials to produce

detritus and other decomposition products. Soil detrivores, like earthworms, ingest detritus and decompose it. Saprotrophs, well represented by fungi and bacteria, extract soluble nutrients from delitro. The identification of the soil fauna in the vermicomposting pits was performed to obtain an insight into the faunal composition of the soil in the pits.

**Table -1: The composition of soil fauna collected from the vermicomposting pits**

| Fauna | Example |
|---|---|
| Macrofauna | Earthworms, Beetles, Grubs, Millipedes, Ants |
| Mesofauna | Mites , Springtails |
| Microflora, Microfauna | Bacteria, Roundworms |

The species level identification of the earthworms and other groups of organisms are periodically carried out. Earthworms from the vermicomposting pits were submitted to the laboratory of the Zoological Survey of India (ZSI) in Kolkata for identification. The following is the list of identified species till date.

**Table -2: List of identified species**

| | | | |
|---|---|---|---|
| 1. | Millipedes | Class: Diplopoda | Genus: Orthoporus sp |
| 2. | Ants | Class: Insecta (Hexapoda) | Genera: Diacamma sp., Camponotus sp., Crematogaster sp. |
| 3. | Mites | Class: Arachnida, Order: Acari | Jacotella sp., Dinychus sp. |
| 4. | Beetles | Class: Insecta (hexapoda) Order: Coleoptera | Onthophagus sp. |
| 5. | Earthworms | Class: Oligochaeta | Indet |
| 6. | Bacteria | | Nitrosomonas, Nitrobacter, Azobactor. |

**The quality of vermicompost produced in the College**

In our campus the raw material for vermicomposting consists mainly of hay, straw and leaves (loose and dry) along with uncooked kitchen waste from the college canteen. A pre-composting period of three months is followed by a vermicomposting period of three months. After the process is complete the organic manure is dried, the earthworms are sorted out and the material is carefully sieved. Packing is done in empty

cement bags with polymer lining; one such bag contains typically about 25 kg of the fertilizer. Analysis of the vermicompost is listed in Table: 3; some seasonal variation of the composition has been observed.

**Table-3: The Nitrogen (N), Phosphorus (P), Potassium (K) and Acidity (pH) values of the vermicompost**

| Input | % N | % P | % K | pH |
|---|---|---|---|---|
| Leaves, hay, straw Kitchen waste | 2.1 – 2.6 | 1.5 – 1.7 | 1.4 – 1.6 | 7.2 – 7.6 |

N.B. The figures quoted for N-P-K are in grams of the respective element per 100 grams of dried vermicompost.

**The Eonomics of vermicomposting**

Vermicompost sells in the horticultural nurseries of Kolkata at an approximate price of Rs 30/= per kilogram. We produce in our College around 2,000 kg of vermicompost each year. This has a commercial value of Rs 60,000/=. The produce is principally consumed in the nurseries, flower gardens and medicinal plant gardens of the college and its four hostels. We now have no need to buy fertilizers from the market, and savings on this account is obvious.

**The awareness effort**

We make every effort to reach out to the educational fraternity and our immediate community. We share our experience with them in form of seminars, workshops, quiz and informal exchange of information. Our target is to make aware the school and college students, their teachers and their families the importance of vermicomposting; especially its role in solid waste management.

**Source of information**

An excellent source is the web portal of Tamil Nadu Agricultural University (Agritech Portal, Organic Farming) <agritech.tnau.ac.in>; see also <hilagric.ac.in>. Elaborate details are provided, keeping the Indian scenario in mind, which will satisfy an enquiring mind. Wikipedia also provides easily comprehensible details of vermicomposting, and elaborates on the different scales in which vermicomposting can be practised. Excellent textbooks are available at the school level (CBSE curriculum) where students from class six

onwards are taught the basics of solid waste management. There, vermicomposting finds a pride of place as an important methodology that is easy to understand and simple to implement. Different steps are spelt out so that vermicomposting can be adapted at the micro level too, i.e. in individual households.

**II. Water Conservation and Recycling**

Water conservation and recycling was adopted as a key component in our effort to reduce water usage in the campus. Potable quality water is supplied to the College by the Kolkata Municipal Corporation (KMC) at some fixed hours of the day. The water is lifted by a couple of pumps, operated by electrical motors, in the two buildings to large overhead tanks. The electricity is supplied by CESC (Calcutta Electric Supply Corporation Limited). Water from the overhead tanks is supplied to all corners of the College through pipelines. Distilled water is required in considerable quantities in all science laboratories. To meet this demand, electrically heated Water Distillation Plants have been set up in the departments of Chemistry (two), Botany (one), and Microbiology (one).

Each litre of distilled water produced requires 10-15 litres of water (depending on the temperature of the prevailing season) for condensation purposes. When the College is in full swing and the students in science laboratories (Chemistry, Botany, Zoology and Microbiology) are working 4-6 hours every day, the demand for distilled water is very high. The consumption varies between 40 - 60 litres every day, on an average. This means that around 600 - 900 litres of water is needed as a coolant. This warm efflux water is stored in PVC tanks situated adjacent to the electrical distilling units. This huge quantity of water is reused for gardening, washing utensils in the canteen, bathing, washing clothes of the families residing in the campus, and sometimes also for car washing. This valuable resource, water, is thus conserved and twice used. Moreover the use of electricity is reduced because there is no need to pump this huge amount of water up again into the overhead tanks for its second use.

The efflux water, (hot, clean and of potable quality) was earlier poured down the drain. It was simply wasted! We set up four (4) large PVC tanks (two 500 L, one 600 L and another 750 L capacity) at convenient places on the campus, and adjacent to the distillation units, to collect and store the efflux water. We thus have a simple mechanism whereby the same

water is used twice. In future a large underground tank may be constructed to hold greater quantities of efflux water when the demand for distilled water grows. Water is thus effectively and efficiently conserved. It is also recycled in a novel way for various purposes.

**Monitoring the stored water**

The water stored in the PVC tanks is carefully monitored. Two things have to be kept in mind: (1) No litter must get into the water. Sometimes the lid may be carelessly kept open. Strict vigilance is necessary to prevent this. (2) The stored water may act as a breeding ground of mosquitoes. In spite of our best efforts this sometimes does happen and the Municipal Corporation takes harsh measures if we are at fault. To minimize the risk we cover the inner lid and the overflow pipe end with a double thickness of very fine mosquito net. This prevents mosquitoes from entering the water tanks and laying eggs on the water surface. The mosquito net pieces are changed periodically, lest they get torn in any way. We cannot afford to be relaxed in our vigil in this respect.

There is also a big tank made of reinforced cement concrete, raised above the ground, which measures around 8 ft X 8 ft X 6 ft and it is divided into 6 compartments. The top is open to the air but covered with a strong but fine mesh of iron. Water from the city supply and rain water is stored in it. Some aquatic plants are bred here. The tank serves as a collector of rain water. Guppy fish, also known as million fish or rainbow fish, are allowed to breed in these tanks. These fish (Poecilia Reticulata) eat mosquito larvae and hence keep the stored water free of the menace of dengue and malaria causing mosquitoes. The Corporation sleuths have never been able to discover any mosquito larvae in this tank. The intelligent use of the guppy fish has been a success story for us.

We may now claim that we have veritably come very close to our professed ideal of a clean and green campus. The beautiful flower gardens and the colourful potted plants in our campus are the result of our initiatives in vermicomposting and water conservation. The waste that was generated on the campus, from the garden and kitchen, could be turned into wealth. We could also save precious water and use it twice over at our own convenience. In addition, a small prototype for rain water storage has been successful where we have also done away with the mosquito larvae nuisance.

**Awareness Programmes**

Knowledge that is gleaned from experience needs to be shared in the society for mutual benefit. The neighbourhood schools were our immediate target. We arranged for lectures with PowerPoint presentations in two renowned schools in our neighbourhood, namely Bethune Collegiate School (for girls only) and Scottish Church Collegiate School (for boys only). Four of our faculty members participated in this exercise. There was enthusiastic response in both the schools from students and teachers alike. The school authorities showed interest in adopting the venture of vermicomposting, especially.

We also conducted an awareness programme where we tried to impress upon the staff members (who are residents on the College campus) and their family the importance of segregation of waste and its conversion to vermicompost. Here, however, we got only a lukewarm response. On the occasion of National Social Service Day, 24th September 2011 we arranged an Awareness Programme in our College where five neighbouring schools participated. The students took part in a lively debate on Environment Action, and in the Quiz Competition. The students of our College, during their Activity Day programs held once in every fortnight, have learnt important lessons from our Green campus Initiative. We hope and trust that when the students go back home and discuss it with their families a trickledown effect will come into play. The families will take it up and spread the awareness in their community as well. The megacity of Kolkata, with its fair share of housing estates, may eventually realise the importance of vermicomposting as a means of solid waste management. Scottish Church College may well act as a pioneer in this field and help in spreading the awareness. The water conservation and re-usage program has been enthusiastically discussed in many an educational institutions. We hope some of them will actively practise it.

**Acknowledgement**

We gratefully acknowledge the grant of USD 2500 from the United Board for Christian Higher Education in Asia for the Project entitled "Waste Disposal Management: Towards a Green Campus" in the fiscal year 2010-2011.

Our thanks go to the authorities of Scottish Church College who provided us all help in executing the project then, and for nourishing it for the last five years.

Very special thanks are due to Dr. Kasinath Ghosh (Botany department), Dr Samrat Bhattacharjee , Dr Narayan Chandra Das and Prof Swagata Chattopadhyay (all from the Zoology department), and all the members of staff from the Microbiology department for their help , cooperation , support and encouragement in bringing this project to fruition. The students of Scottish Church College deserve thanks for their continuing support to the project. The gardener of the college Sri Bijoy is to be specially mentioned for the way he has taken care of the vermicomposting pits, the college garden and its beautification.
I record my gratitude to the UBCHEA management for giving us an opportunity to present our holistic experience with the project.

**References**

a) *<agritech.tnau.ac.in>, vermicomposting section, and references therein*

b) *<hilagric.ac.in> , vermicomposting section and references therein*

c) *CBSE (NCERT, New Delhi) textbooks from class 6 onwards, section on vermicomposting.*

# RECYCLING - A WAY OF LIFE AND LIVELIHOOD

3

Phinu Jose
*Christ University, Bengaluru.*

**Abstract**

*This paper is the story of Christ University's journey in establishing an integrated waste management system captured through the efforts of "Parivarthana" Centre for Social Action (CSA). It is an attempt to trace the trajectory that CSA has taken in sensitizing the student community about solid waste management and creating opportunities of livelihood through the same route to marginalized women from the communities served.*

**Key words:** *Solid Waste Management, Zero Waste Campus, Paper Recycling, Composting, Parivarthana, Sustainable Environmental Practices*

## Introduction

Christ University is born out of the educational vision of St. Kuriakose Elias Chavara, an educationalist and social reformer of the nineteenth century. Christ College was established in the year 1969 and has grown leaps and bounds since then. Today, Christ University caters to about 15,000 students with a mission to provide each one 'a nurturing ground for holistic development to make effective contribution to the society in a dynamic environment'. The academic fraternity at Christ University is dedicated to the motto of "Excellence and Service" driven by core values of Faith in God, Moral Uprightness, Love of Fellow Beings, Social Responsibility and Pursuit of Excellence.

In an institutional set up like Christ University, one of the challenging issues that need to be addressed is designing and implementing a systematic waste audit and designing an intervention which is comprehensive and integrated in nature. The biggest challenge before Christ University was to educate the student community and faculty members so as to ensure their participation and commitment in waste segregation at source. For such comprehensive intervention Christ University had to consider the capital investment in terms of machinery and appropriate infrastructure for systematic collection, segregation and recycling of waste. Education of house-keeping staff and other workers associated with waste management process was extremely important for the success of the zero waste campaign.

**Methodology: Zero Waste Campaign and Sustainable Environmental Practices**

Organized effort in ensuring solid waste management practices at Christ University dates back to 2008 when CSA, the social action wing of Christ University initiated Parivarthana - a decentralized Solid Waste Management practice in the campus. Bulk of different types of waste generated in the campus was managed differently without much thought about a comprehensive, scientific and environment-friendly approach to decentralize solid waste management practices. Without safely disposing, many a times solid wastes were incinerated further causing environmental pollution. But such undesirable practices came to a complete halt when CSA struck a new bond of partnership with the Global Communities (formerly CHF International) which supported the concerted effort towards ensuring zero-waste campaign at Christ University campus under "Trash to Treasure" or Parivarthana Project. Today, CSA is proud to say that the Zero Waste Campaign gained a momentum over a period of time as a replicable model.

Following are the specific objectives:

* To ensure sustainable environmental promotion through Zero Waste Campaign
* To ensure trash is converted to treasure and create livelihood opportunities through sustainable and scientific management of wastes generated in the campus
* To develop replicable models of waste management - segregation at source and ensure systematic and scientific management
* To educate the student community and members of faculty, educational institutions, people in the community and other stakeholders such as BBMP and corporate sector

**Scope of Zero Waste campus**

Education and awareness to student community regarding the waste segregation practices, primary and secondary segregation, paper recycling unit, composting unit, bio-gas plant for energy generation from food waste, information centre, waste water treatment plant are the important features of the solid waste management practices initiated at Christ University. About 15000 students and members of the faculty are sensitized and educated on solid waste management practices. From each department students and faculty-members are given exposure to

understand solid waste management practices initiated in Christ University and further encouraged to carry the message back to their home. Waste bins for safe disposal of dry waste, wet waste and food/kitchen waste are kept at different locations to ensure the primary segregation. This practice helps complete 70% of waste segregation by the students. Every one hour waste is collected and taken to sorting unit where the secondary segregation (30%) takes place. All the paper recyclables are processed at paper recycling unit and various types of papers products are made. Tetra packs are sent to Janakiram Layout where SHG members promoted by CSA make artistically designed vanity bags and other products which are being sold to the external markets. Most importantly the student volunteers of Christ University propagate the message of waste segregation and solid waste management practices in the slums through awareness campaign, rally, street play, door-to-door community education, formation of eco-clubs etc.

**How Parivarthana works?**

Parivarthana works with two-pronged strategies i.e. by recycling paper in-house and secondly by bridging the gap between bulk generators of recyclables to the large recyclers that helps fulfill every organization's environmental responsibility. For this no fee is levied. However, the proceeds generated through the recycling of waste is used for supporting the unit and thus promoting sustainable livelihood for marginalized women, which in turn maintains a clean and hygienic environment.

Christ University generates around 800-900 kgs of waste everyday which includes both wet and dry waste; of which dry waste comprises of 80% and remaining 20% is wet waste. The waste is primarily segregated by students and faculties who are being sensitized by CSA team and volunteers to involve and contribute to a clean and green environment, thus making university campus a Zero Waste Campus. The waste is secondarily segregated at the segregation unit which is located in Christ University Campus, and recyclable materials (paper) are used and converted into recycled handmade sheets.

**Handmade Paper Recycling Unit**

Once the paper has been separated, it is put into a Hydro Beater Pulper along with fiber cotton and water, ground to form pulp and set in a Univet thus forming a rectangular sheet. The sheet is passed through a

machine that presses the sheet and drains out further excess water. Then the sheet is allowed to dry for a day. One batch produces roughly 30 sheets. Finally it goes through a calendaring /polishing machine which thins down and evens the sheet. The recycled paper is now ready to be converted into products which are: files and folder, carry bags (small & big), writing /scribbling pads, books (small, medium & big), photo frames, photo albums (small & big), gift boxes, greetings/message cards, diary etc.

**Sorting & Compost Unit**

The wet waste generated in the campus is used in the composting unit for converting it into manure/compost which in turn is being used for gardening purpose in the university campus. The food, fruit and vegetable waste are collected in a container and chopped into smaller pieces. Dry leaves are placed in the compost tank as first layer, and then on top of it wet waste which is collected from the campus is placed evenly all over the composting tank. While leaves and food waste get decomposed, a bucket of water mixed with one spoon of bio-inoculum is sprinkled on the compost every day. Leached water gets drained out of the tank on daily basis. When the leached water is added to the tank and the content gets mixed, the waste starts composting after 25 days. The compost shredder converts the compost into fine powder for further use, which is directly used for the plants and vegetation in Christ University.

**Biogas Gas Plants**

Christ University has established Bio-gas units to ensure carbon neutrality and convert food waste into useful energy. With 500 kgs. of daily feeding capacity, cooking gas equivalent to 25 kgs of LPG is generated every day and the by-product slurry rich nutrient is used for vegetation. Biogas is made in a biogas digester, scientifically it is called a digester because it is a large tank filled with bacteria that eats (or digests) organic waste and gives a flammable methane gas. Technically biogas systems make use of a relatively simple, well-known, and mature technology. The main part of a biogas system is a large tank, or digester. Inside this tank, bacteria convert organic waste into methane gas through the process of anaerobic digestion. Each day, the operator of a biogas system feeds the digester with household by-products such as food and kitchen waste. The methane gas produced inside biogas system is used for cooking in Dharmaram College. Waste that has been fully digested exits the biogas system in the form of slurry or organic fertilizer.

CSA has set up one scaled-up versions of the ARTI model at paper recycling unit in Christ University Campus for showcasing and educating various stakeholders including the members from the community on the concept and practice of energy generation from food waste. This design is utilized to showcase a small household sized model. 2-3 kg/day plant supplies gas to a stove which is being used to make tea for the workers at the unit. The goal of this plant is not only to supply gas to the recycling plant workers, but to showcase a very affordable, thus replicable, working model for various stakeholders. The system can be built by local materials, and the skills required to assemble the materials are minimal.

CSA has installed Bio-tech - a floating dome style bio-gas plant at Christ University premises. This plant is to showcase a working and replicable model that can supply significant gas to a small family. The dome shaped (floating devise) allows for a chamber to collect the biogas produced from the slurry inside. An output tank is designed to capture and allow the new waste to be extracted easily for use as fertilizer. This initiatives is one of its kind to showcase and disseminate information to various stakeholders on different models.

**Information Center**

Information Centre forms one of the important components of "From Food Waste to Good Energy" project. The goal of the information center is be to make technologies surrounding sanitation available to future communities. The information center is designed to educate and disseminate information to various stakeholders on affordable technologies. It also serves as a center for sanitation workshops and ultimately assist with the spreading these technologies and various solid waste management practices initiated by Christ University. The ultimate goal of the information center is dissemination and education of knowledge and understanding of eco-friendly practices. The information center is a sustaining resource for different organizations, education institutions, communities and individuals around Bangalore who wish to pursue these technologies. A number of different IEC materials (handbills, posters, pamphlets, training modules, brochures, and video footages) of various models, in both Vernacular and English language, is made available for various stakeholders.

**Recycling of Tetra packs**

With a primary objective of empowering women as the main bread winners, Christ University through CSA has been imparting training to women in hand-skills and business development skills while at the same time setting up self-help groups and building their livelihood sustenance skills. CSA started Anuspandhana Business Unit in March 2010. A total of 15 women were trained to make high quality products from used and discarded tetra packs and embroidered cement bags. The women learnt all the business skills needed to run the unit including sourcing, production and sale of the products independently. The unit has been registered as a Private Company. The vision of CSA/Christ University is to provide women from the slum with additional income from this business practice by enabling them with strong business and life skills, as well as ensure access to better health care and education.

**Waste-water Treatment Plant**

The principal objective of waste-water treatment at Christ University is generally to allow effluents to be disposed off without danger to human health or unacceptable damage to the natural environment. Christ University Gardening and Vegetation Irrigation Work is the result of utilization of effective form of waste-water disposed. This is one of the major waste water treatment practices being adopted at Christ University.

By this process sewage (waste water) is collected through pipelines into a collection sump after screening through bar screen chamber to remove the floating as well as settle-able coarse solids. The collected sewage is homogenized using diffuser in the sewage collection sump. Then the sewage is pumped to an activated sludge process (ASP) system for the reduction of organic pollutants. The air required for the aeration tank is supplied through air blower connected to grid piping. Then the wastewater sludge mixture is allowed to flow by gravity into a secondary settling tank (tube settler), where the sludge will be settled at the bottom and the clear supernatant would overflow into the clarified water tank. The excess sludge is recirculated to ASP tank through recirculation pumps. Hypochlorite solution is dosed in the clarified water tank for disinfection. The secondary treated waste-water is passed through a tertiary treatment plant comprising of pressure sand filter and activated carbon filter for fine polishing. The sludge from the settling tank is sent to sludge drying beds and periodically disposed.

**Management of Other Kinds of wastes**

Student volunteers of CSA-Christ University undertake awareness campaigns on E-waste Management; Christ University has ensured systematic way of collection of E-wastes which are sold in the scrap market to generate revenue for the Parivarthana unit. Toilet waste and laboratory wastes are managed safely and systematically.

**Results /findings-Evidence of Success**

Christ University is a hazard-free environment thanks to the successful implementation of the Zero Waste Campaign.

* Continuous education of student community by the student volunteers with primary focus on "Reduce, Reuse, Recycle and Safe and Scientific management of waste.
* Comprehensive waste segregation system established in the campus to ensure 70% primary segregation at source and sorting cum composting unit for ensuring 30% of secondary segregation.
* Establishment of Bio-gas units to ensure carbon neutrality and convert food waste (with 500 kgs of daily feeding capacity, cooking gas equivalent to 25 kgs of LPG generated every day and slurry rich nutrient is used for vegetation) and establishment of Information dissemination unit to educate other stakeholders.
* Kitchen waste, fruit/vegetable waste and other bio-mass are converted into organic manure used for vegetation.
* Paper and tetra packs are recycling unit mobilizes a sizeable amount of revenue. Waste resources such as bottles, newspapers, aluminum foils, chocolate wrappers, plastics etc. which cannot be recycled are sold in the scrap market and revenue generated is about Rs. 150,000 a year.
* Every day in the main campus about 300000 liters of grey water is being treated and used for vegetation and gardening. Similarly grey water is being treated and used for vegetation and gardening in Kengeri campus as well.
* Rain water harvesting promoted in Kengeri Campus is one of the unique features of judicious utilization of water resource. With the concept of "catch rain water where it falls", Christ University ensures recharging of ground water. Roof top rain water and run-off water is channelized and collected in a swamp and used for watering the gardens.
* With a view to managing E-wastes, systematic way of collection is

ensured which are sold in the scrap market to generate revenue for the Parivarthana unit.

* Toilet waste and laboratory wastes are managed safely and systematically.

**Conclusion**

Parivarthana, an initiative of Christ University has been awarded by Rotary Club for comprehensive waste management initiative in the campus as well as in the slum community. Educating the student community with the culture of primary segregation concept and practice, educating the house keeping staff and other workers associated with waste management process, and staff attrition are still some of the constraints which need be addressed.

**Acknowledgement**

The Centre for Social Action acknowledges the unconditional support of each and every Christite in contributing to the success of this effort, the unwavering support of the members of the Management of Christ University in permitting and lending all assistance in the form of logistics, finance and administrative policy, the Staff of Parivarthana and CSA for their devotion to the cause of Zero Waste Management, also to the NGO Partners-Global Communities CHF, Caterpillar Foundation and The Environment Group/ReapBenefit for laying the foundation and strengthening the entire process right from its inception. The final article took this wonderful shape thanks to the recommendations of the experts and the assistance from the Office of Registrar and Centre for Publications, Christ University

**References**

*Biogas and Biogas plants - Biotech India (www.biotech-india.org)*

*Build a Biogas Plant - ARTI-Biogas (www.build-a-biogas-plant.com)*

*http://www.simgas.com/advantages-of-biogas/how-does-biogas-work/item46*

*Parivarthana Project Document and Annual Reports*

*Triennial Report of CSA*

**Annexure**

**Physical Facilities**

Christ University is currently functioning in three locations in Bengaluru having a total built up area of 314797.45 square meters. Apart from the Hosur Road location the University is located at Kengeri and the Bannerghatta Road. Classrooms and laboratories are independent and separate for all departments. Common facilities like auditorium, IT facilities, and Estate Services are served by independent offices and shared by all departments.

The infrastructure of the University is distributed in three locations in Bengaluru-Hosur Road, Kengeri, Bannerghatta Road. The facilities at the Hosur Road have six major blocks extensively used for teaching-learning-research processes. These blocks are named as Block I, Block II, Block III Block IV, Central Block and Auditorium Block.

Cafeterias, Kiosks and food courts is made available in all locations.

Separate hostel facilities are available for men and women students. Adequate vehicle parking space is available for students, faculty members and visitors.

Other physical facilities provided for students and faculty include Student Halls, Sports Complex and Play Grounds as presented in Table 4.1 to 4.3.

The University has won the 'Best Campus Award' over the past several years. In the recent India Today-Nielsen Survey the University has been rated for Best Cultural Events, Best Canteen, Best Crowd, and Best Hangout Zone in Bengaluru.

Common facilities such as library, conference rooms, seminar halls, Panel rooms are shared by all departments.

**Infrastructure at Kengeri**

The facility at Mysore Road has a built up area of **304000 square meters (16.75 Acres)** and consists of 5 blocks named as Block I, Block II, auditorium Block, Block III, Block IV, and Block V.

In addition to the above Blocks, it provides **Halls for women-Christ Hall - 200 beds, Open Auditorium,** Band Stand Block V, and Residential facility for visiting faculties.

**Devadan Hall with** Research Labs for Botany and Engineering and seminar and Discussion Halls, Men's Hall, accommodation facility for Men's cafeteria with 800 seating capacity, Rooms with twin, triple and

four sharing facility, Recreation hall, Study Hall, warden rooms, Washrooms and washing and open area for drying clothes.

Solar power is tapped for hot water and lighting with lift facility and ramp, Playgrounds- Flood-lit basketball courts, Basket Ball Courts-2 Nos without flood lit, Football/Cricket/Hockey field, Throw ball court, Volley Ball Court, Tennis Court and Badminton courts are also provided.

The Additional infrastructure includes Birds Park, Bore-wells, Chavara Chapel-A prayer hall with a seating capacity of 700 people and a Sewerage Treatment Plant which recycles up to 2 Lakhs of waste water per day. Recycled water is used for garden maintenance. Dry leaves and food waste are converted as manure for garden plants. Two plant nurseries produce new plant seedlings. Solar power is adopted in few areas of the campus for lighting, Lawn, Pathways, relaxation seats in the gardens, seven rainwater harvesting tanks with 8000 square meters area, Reverse Osmosis plant for drinking water, Sewage Treatment Plant and storage tanks, Medicinal Herbal Garden, South Indian Bank ATM and Open parking for four and two wheelers.

**Maintenance of Campus Facilities**

The University has a dedicated Estate Office and a designated Estate Officer. Some of the campus-specific initiatives are maintenance of Zero-Waste Campus, rainwater harvesting, water-recycling, and disable-friendly buildings among others.

The University as part of its extension services permits the use of its various facilities to key stakeholders such as government organizations, NGOs, institutions, boards and industry for academic-related activities such as meetings, AGMs discussions, workshops and competitive entrance examination services.


**Bio-Gas Plant**


**Paper Making Unit**


**Awareness Campaign**


**Paper Segregation**


**Production of Hand Made Paper**

# SOLID WASTE AUDIT IN KARUNYA UNIVERSITY

4

Jibu Thomas and Karthikeyan .S
*Karunya University, Coimbatore*

**Abstract**

*Presently in India, about 960 million tons of solid waste is being generated annually as by products during industrial, mining, municipal, agricultural and other processes. Of this, 350 million tones are organic wastes from agricultural sources; 290 million tones are inorganic waste of industrial and mining sectors and 4.5 million tones are hazardous in nature. Coimbatore Corporation generates around 750 tons of waste a day. Residential educational campuses are reported to generate voluminous amount of solid waste every day. This case study reports the types and quantity of waste generated in each department and from various student residences of Karunya University. This report also suggests various methods to reduce waste generated and ways to manage it. Solid waste audit was conducted in two phases. One during a week of normal activity and the other during a week of high activity viz., Karunya Evangeline Memorial Tournament (KEMT).Observations and documentation of the solid waste was done by dividing the campus into 3 sectors 1) University campus, 2) Men's residences (FDR, EGR, AR, HR, JMR, JVR, BRR, BR) and 3) Women's' residences (DMR, PRG, SRR, SRR(extension), SPR, EVR, OPRAH). Different kinds of solid waste like Styrofoam- plate, plastic, paper, leather, rubber, metal, and cloths, etc. were segregated and weighed. Results observed were discussed.*

**Keywords:** *Solid waste, Audit, Campus, Segregation*

## Introduction

Solid waste accounts for any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities.

They can be classified into different types depending on their source as a) Household waste is generally classified as municipal waste, b) Industrial waste as hazardous waste, and c) Biomedical waste or hospital waste as infectious waste.

**Municipal Solid Waste**

Municipal solid waste consists of household waste, construction and demolitiondebris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition gets changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste; in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped or well managed and are not lined properly to protect against contamination of soil and groundwater.

**Hazardous waste**

Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases. India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated across the states.Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure. Most hospitals in India do not have proper disposal facilities for these hazardous wastes.In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.

**Hospital waste**

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. These wasteare highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner. It has been roughly estimated that of the 4 kg of waste generated in a hospital at least 1 kg would be infected.

**Karunya University and waste generation activities**

Karunya University is a fully residential university housing 19 department with about 8100 students sprawling in 720 acres of land in the foothills of Siruvani, Coimbatore District Tamilnadu. University has 8 hostel for men and 7 hostels for women with adequate facilities apart from restaurants, eateries, rural community hospital, play area, seminar halls, indoor auditoriums and outdoor stadiums etc. The day to day activities of the university result in generation of various types of wastes. Karunya University is known for sports activities particularly the South India level Karunya Evangeline Memorial Tournament which attracts lot of players and spectators across the nation that too invite lot of generation of wasters in the campus.

Hence, the objective of the present study was to document the waste generation activities of the campus and to suggest remedial measures to develop Karunya University as a model for solid waste management. The wastes generated from external activities like guest houses and Rural community hospital are not included in the present study.

**Materials and Method**

The materials included for the sample collection are weighment bags, spring weighing balance, barrels, etc. The samples were collected from the site of origin, segregated accordingly, weighed and transported to the site of composting for disposal unless otherwise mentioned.

**Collection of wastes**

The solid wasteswere collected (i) during normal week days and (ii)

during a week of high activity viz., Karunya Evangeline Memorial Tournament (KEMT). It is noted that many students from different colleges come to participate in different sports events during KEMT and stay in the campus for over a weeks' time

**Experimental design**

The documentation of the amount of wastes generated in the campus was done by dividing the campus into three sectors

1) University Campus
2) Men's residences (FDR, EGR, AR, HR, JMR, JVR, BRR, BR)
3) Women's' residences (DMR, PRG, SRR, SRR(extension), SPR, EVR, OPRAH)

**Table 1.List of some of the hostels in Karunya University**

| Sl.No. | Name of the residence |
|---|---|
| 1 | Father Duraisamy Residence – FDR |
| 2 | Edward George Residence – EGR |
| 3 | Angelina Residence – AR |
| 4 | Hepzibah Residence - HR |
| 5 | Jerry Manuel Residence – JMR |
| 6 | Johnson Victor Residence – JVR |
| 7 | Dakshnamoorthy Residence – DMR |
| 8 | Sundararaj Residence – SRR |
| 9 | Sevugapandian Residence SPR |
| 10 | Evangeline Residence – EVR |
| 11 | PR Garg Residence– PRG |
| 12 | BRR – Babu Raj Residence |
| 13 | BR – Bethany Residence |

**Collection of waste**

The solid waste was collected in bags and segregated based on the type of material and its biodegradability. The waste was weighed using a suspended spring weighing balance.For food waste, first the weight of the empty collection barrels was noted and then barrels filled with food wastes were weighed to get the amount of food waste generated.

**Collection at University Campus**

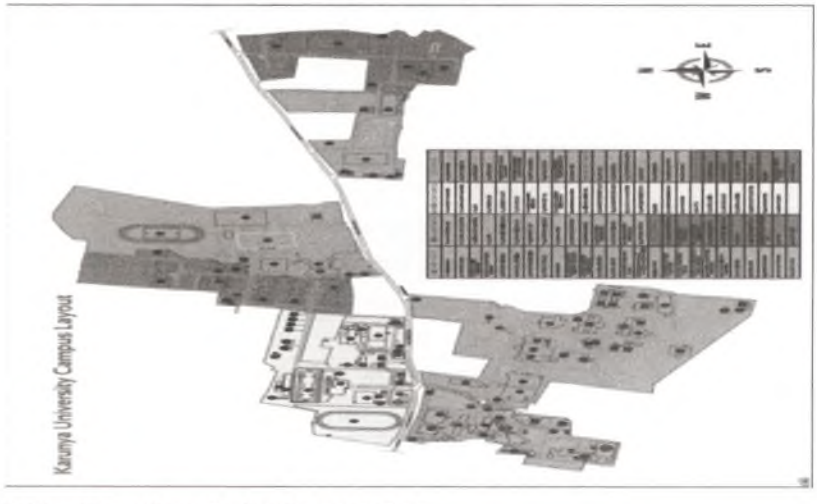
The Solid waste was collected in bags from all departments for three consecutive days. Waste materials collected were segregated based on the type (bio-degradable and non bio-degradable) and each waste material collected was weighed individually using spring weighing balance and noted.

**Collection of waste at various residences**

Waste were collected from both men's and women's residences in a bag and each bag was weighed everyday individually for three consequtive days and were noted.

For food waste empty barrels were weighed and then these foodwaste was collected in these barrels and weighed. the weight of food waste collected was obtained by subtracting the final weight of the barrel containing the food waste and the weight of empty barrels.

**Layout of the Karunya University Campus**




**Collection of waste during KEMT**

Karunya Evangeline memorial tournament (KEMT) is a 5 days' sports tournament where students from different colleges of south India participate in different events.It is a state level tournament organized by Karunya University every year. This event records participation from various colleges from different states. The event goes on for over a week with enormous boost in the individuals from other colleges visiting Karunya University as participant or as spectators.The solid waste generated on these days were collected in plastic bags and weight was

recorded using spring weighing balance. The event also hosts many food stalls installed by students and local vendors and hence the amount of solid waste is enormous compared to the normal days. In the current research, the solid waste was analyzed from these food stalls as well as the hostels and campus. The solid waste was found to be much greater than the waste on other days. The waste was measured in the same way as mentioned above.

**Results And Discussion**

The data collection and observation was done for three consecutive days. The solid waste was collected in the bags from every department individually. The waste material was segregated based on the type (bio-degradable and non-bio degradable). They were separated and weighed individually. The values are given below:

**Fig. 4 Solid waste generated in the university campus**

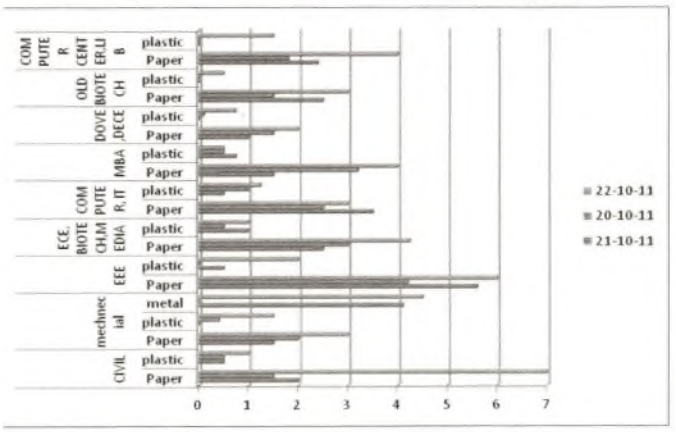
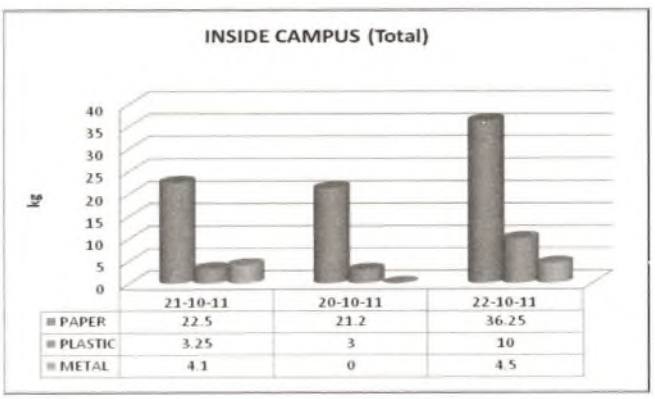
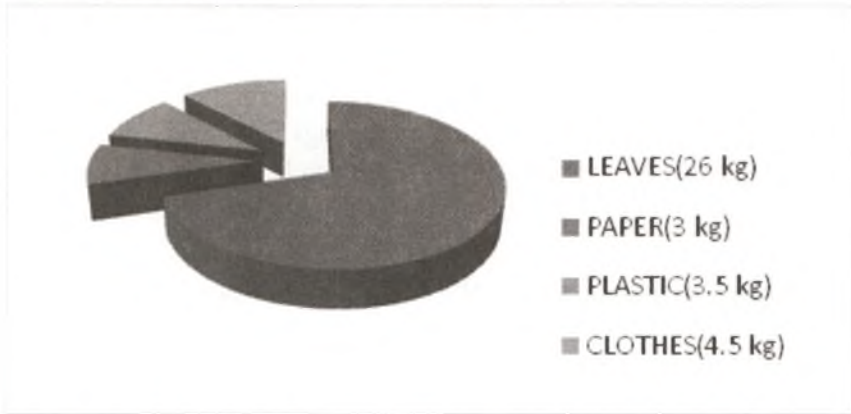



**Fig.5 Categorization of the waste generated**



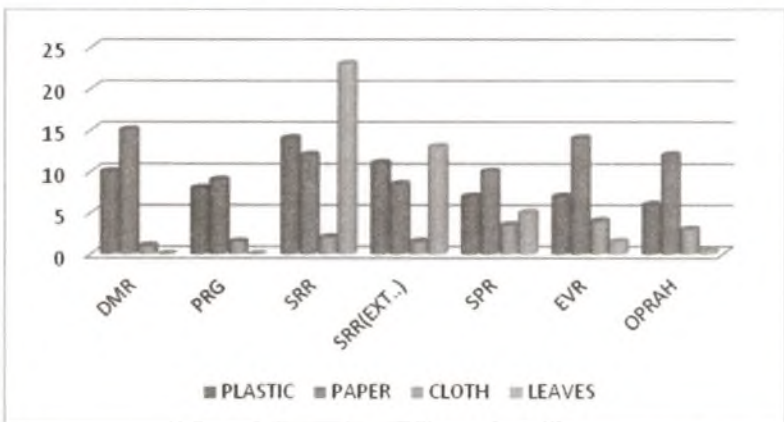
The above results show that the amount of paper waste was more compared to other wastes and the metal waste was restricted to the department of mechanical engineering. The results indicate that the type of the waste generation is dependent on the type of activities carried out in the respective departments

**Fig 6.Solid waste generated in men's residences:**




The above values show the amount of waste generated in the FDR and EGR during normal days. Comparatively leaf (degradable waste) waste is more due toautumn season but that may not the case in all the seasons.

**Fig. 7 Solid waste generated in women's residences**




The above values show the amount of waste generated in the women residences during normal days. Comparatively paper and plastic occupied a major share while the amount of leaf litter was dependent on the number of trees in the respective hostels.

Solid waste generated during Karunya Evangeline Memorial Tournament (KEMT):

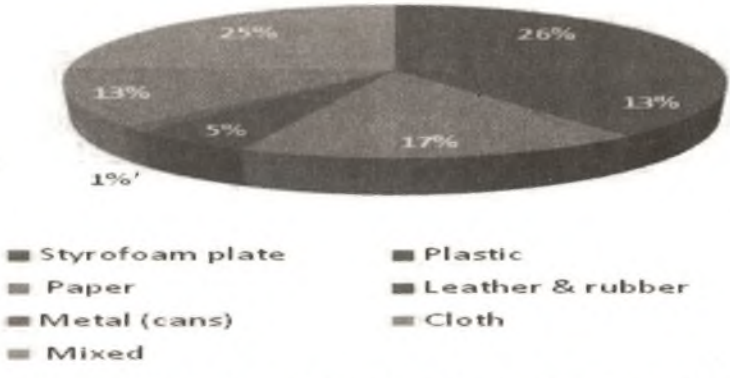



**Fig.8 Relative distribution of the various forms of wastes during KEMT**

The results indicate that the Styrofoam plates contributed to the major share among the wastes generated during the KEMT followed by mixed wastes and paper. It was interesting to note that the wastes generated on the initial day of the sports activity was high and then the amount of waste gradually got reduced.

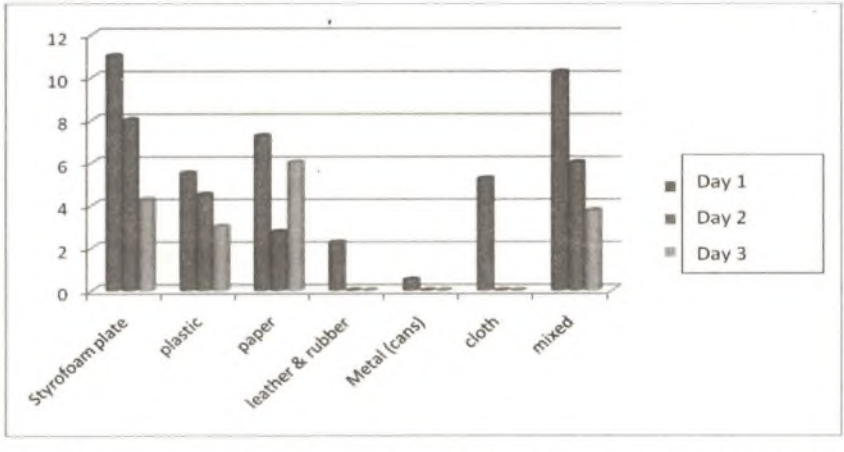



**Fig.9 Comparison on the various types of wastes on the days of KEMT**

The above values were taken during KEMT (Karunya Evangeline Memorial Tournament) which took place at FDR and EGR premises. During segregation it was found that the feather light Styrofoam plates topped the list weight wise on the first day but was reduced in the subsequent days since the number of participating guest teams reduced.

A comparative study was carried out among the normal activity day with that of the KEMT days. Threefold increase in the amount of wasted was noticed during the KEMT days. This indicates that adequate solid waste management system to be planned along with the planning of these mega events in the campuses

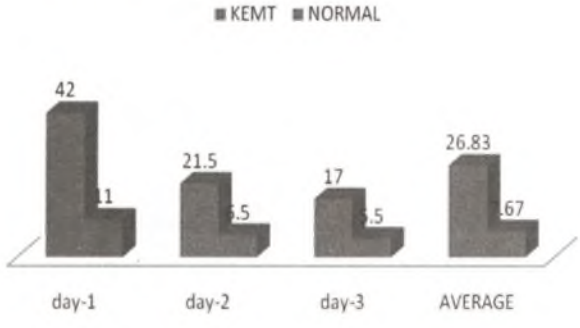
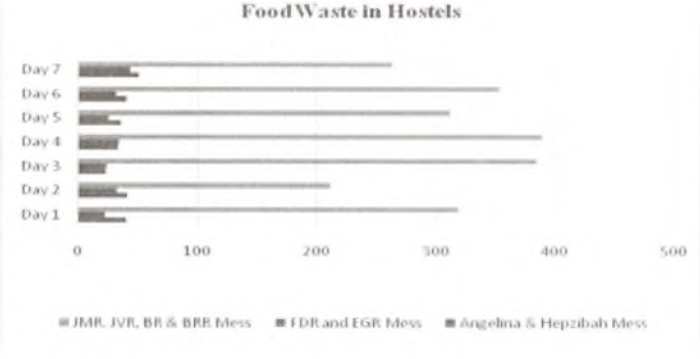



**Fig.11Comparison between normal day and KEMT**

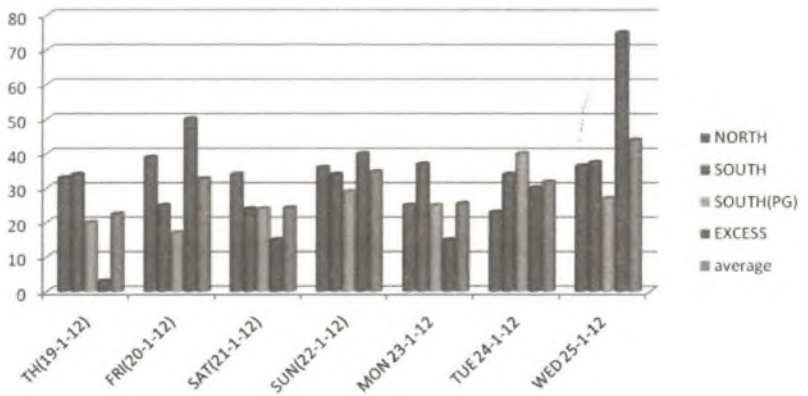
**Food waste**

Food waste always remained to be the major contributor among the solid wastes generated in any residential campus. It was documented that there could be various reasons towards the generation of food waste like taste of the food, quality of the food, personal preference, repeated menu etc. The food waste was measured in all student messes. Initial assessment indicated that the amount of food waste varies based on the menu,hence food wastage was measured for all the 7 days in a week. The below table gives the details of solid waste generated only during dinner time.

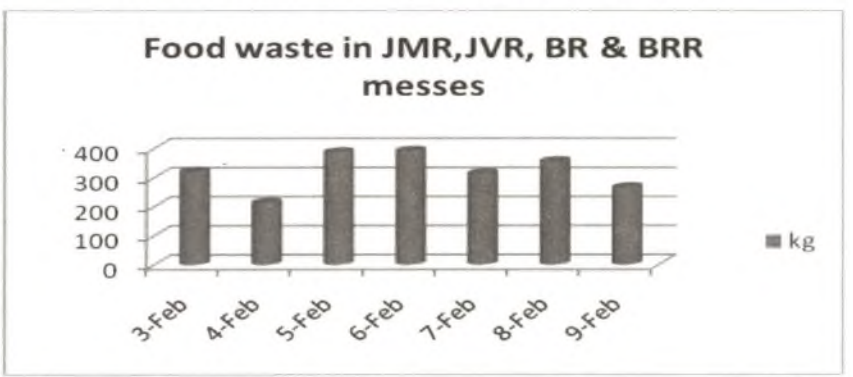
**a. Food waste in Angelina &Hepzibah messes**

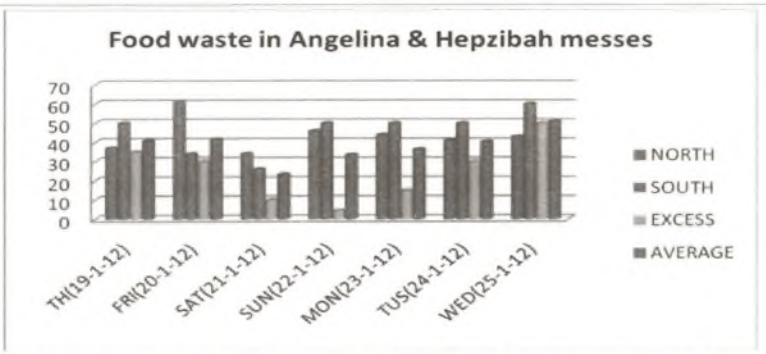


**b. Food waste in FDR and EGR messes**




**c. Food waste in JMR, JVR, BR, BRR messes**




The audit team also visited and took photos of dumping sites in Karunya Nagar. The garbage dumped here is generated by the shops, restraunts and butcher shops on the Siruvani road of Karunya Nagar. The waste ranges from paper, plastic to chicken refuse and hair from the barber shops. The chicken refuse comprising of the innards and feathers of

slautered chicken coming from the butcher shops creates the characteristic smell everytime. Awarness among the shop keepers and liasioing with the municipal authorities are suggested to address these issues.

**Conclusions**

The solid waste audit prompts for some sustainable remedial measures, as listed below:

* Decentralization of the messes to increase the food quality and taste which leads to increase in consumption and reduction in wastages.
* Restructuring the menu completely and making it flexible.For eg. Wednesday menu has not been changed for at least 4 years and it has become a custom that most students dine outside which results in heavy wastage of food.
* Prior intimation could be given by the students to the mess authorities before the specified time through SMS. Food shall be prepared and served only for the students who have reserved for the meal on time. Students are strictly fined with double the mess bill for the day if they don't take food after intimation. The messes can be provided with a computerized system to which, students send an SMS message (at least a blank message) to their respective mess numbers. A data base can be created with Name, Reg.No, Mobile number of the students, etc. such that the software shows the total number of students opted to have meals.
    * For breakfast before 10:30 P.M (the previous day)
    * For lunch before 09:00 A.M
    * For dinner before 02:00 P.M
* Leaf – Composting and/ or Vermi composting is preferable than burning which causes pollution and loss of valuable nutrients that could reach the soil. Plastic, Styrofoam and any non-degradable material should be banned.
* Segregation is the key: Arrangements should be made to segregate the solid wastes at the source of generation. Segregation into wet ie., degradable organic (Food), dry ie., Cellulose products (Paper, Cardboard, paper cups & plates etc, and others ie., Metal & Glass, and plastic waste will not only help in eliminating the burden of solid waste but also turn waste into a resource.
* Student Clubs such as NCC, Nature Club, Community Health Services and other interested clubs may coordinate with the

maintenance department to implement waste segregation and disposal.

As the heart of the issue lies in the attitude of the people, awareness camps conducted with domain experts in the field of solid waste management who can motivate students and staff into practicing waste management will help in making solid waste management a habit.

**Remedial Measures**

The following remedial measures are proposed as the outcome of the present study

* Installation of a paper recycling unit can help in safely handling the paper wastes
* Plastics can be processed and used as reinforcement materials with concrete by the civil engineering department.
* Leaf litters are a major source of nutrients and hence could be composted using vermi technology and the compost inturn could be used for gardening and organic cultivation of the agricultural land. This will also enhance the land use efficiency
* Since, the university has got good amount of agricultural land the compost generated can reduce the cost on inputs and an integrated farming approach could be developed
* Wastes materials like tins and metals can be sold out, all e-wastes should be disposed of safely.
* Soiled food can be transported to piggery which in turn can also bring in revenue to meet up the cost of operations.
* Thus, integrating the food waste management along with organic farming and agricultural management and developing a paper recycling unit employing daily living to the underprivileged and old age could initiate the process of development of model for sustainable waste management in Karunya University.

**Acknowledgements**

Authors express heartfelt thanks to the former heads of Department of Extension and Continuing Education, Karunya University – Dr. Mathew K Sebastian, Mr. P.K. Kurian, Dr. Maya Mahajan and to the secretarial assistance of Mr. JebaseelanPonraj. Thanks are due to the Faculty Coordinators and the student volunteers who were involved in data collection and execution of this project. Special thanks to **United Board for Higher Education in Asia, Hong Kong** for the financial assistance to execute this project at Karunya University. A word of thanks to the

then Vice Chancellor Dr. Paul P Appasamy and Registrar Dr. Anne Marry Fernandez for their motivation and support.

**References**

*Akolkar, A.B. (2005). Status of Solid Waste Management in India,Implementation Status of Municipal Solid Wastes, Managementand Handling Rules 2000, Central Pollution Control Board,New Delhi.*

*Bernstein, J. (2004). Toolkit for Social Assessment and Public Participation in Municipal Solid WasteManagement. Urban Environment Thematic Group, The World Bank, Washington, D.C.http://www.worldbank.org/urban/uswm/socialassesstoolkit.pdf*

*CalRecovery, Inc., Handbook of Solid Waste Properties, Governmental AdvisoryAssociates, Inc., New York, New York, USA, 1993.*

*CPCB (2000). Status of Municipal Solid Waste Generation, Collection Treatment, and Disposal in Class 1 Cities, CentralPollution Control Board, Ministry of Environment and Forests,Government of India, New Delhi.*

*Diaz, L.F., G.M. Savage, and C.G. Golueke, Resource Recovery from Municipal SolidWastes: Vol. I, Primary Processing, CRC Publishers, Inc., Boca Raton, Florida, USA, 1992*

*Medina, Martin (1997). Informal Recycling and Collection of Solid Wastes in Developing Countries:Issues and Opportunities. United Nations University, Institute of Advanced studies. http://www.gdrc.org/uem/waste/swm-ias.pdf*

*MOUDPA (2000). Manual on Solid Waste Management, Ministryof Urban Development and Poverty Alleviation, Governmentof India Publications, New Delhi.*

**Fig.1 Volunteers segregating and collecting the waste**

**Fig.-2 Volunteers weighing the solid waste**

**Fig. 3 Collected and weighed wastes**

**Fig.10 Various types of wastes obtained during KEMT days**

# BIODIVERSITY AUDIT – FLORA: GREEN TREASURES OF BISHOP HEBER COLLEGE

5

V. Anand Gideon, A. Alagappa Moses and Vivekraj,P.
*Bishop Heber College, Trichy*

**Abstract**

*Enumeration on the floral diversity of bishop Heber College campus and the surrounding region was undertaken which forms important greenery in the urban environment of Tiruchirappalli city, India. Extensive field surveys were carried out in the study area occupying 33 acres of land during 2012 to 2016 covering four different seasons viz. summer, winter, monsoon and spring to cover annual, biennial and perennial plants. A total of 167 plant species comprised or 74 trees, 59 herbs, 17 Grasses, 13 climbers and 4 Shrubs in the bishop Heber College Campus. The flora covers 43 Indian Native species and all other plants from exotic species in the study area. Most of the plant species recorded in the study area are of considerable ecological and economic importance, with medicinal value and useful as bio-resources to vild fauna and human beings. The results of this study provide insights into the importance of urban green space and reemphasize the need for conservation, planning and management of greenery for carbon sequestration and carbon neutrality.*

**Keywords:** *Urban Environment, Exotic flora, Ecological impacts, Medicinal Plants, Conservation.*

## Introduction

**Bishop Heber College** fosters a sense of connectedness and ecological citizenship in responding to the environmental challenges while preparing its students as environmental stewards of God's creation. Realizing the God-given mandate to take care of the earth, the College with various departments like Environmental Sciences and Biology continuously focuses on the mission to ensure Environmental Sustainability, preservation and restoration of nature.

The College campus which was built originally on the alluvial clayey soil where there used to be cultivation of Paddy and other agricultural crops over generations. The campus spreads across 23.5 acres of land area with the open green cover occupying 15.96 acres (nearly about 60%

of the total area) and the remaining area is occupied by nearly 40 buildings intermingled with metal roads (Fig. 1 & 2).

The green treasures which spreads across the campus is recorded with 167 genera of plants categorized into Herbs, Climbers, Grasses, Shrubs and Trees. Trees represented the highest no of genera with 74 followed by Herbs (59), Shrubs (4), Climbers (13) and Grasses with 17 species.

Though the tree population is lesser in number they contributed to the maximum diversity in terms of genus. This is due to the fact that the trees were planted all along the campus and also with the maintenance of Arboretum inside campus where nearly 25 genera are maintained.

The herbs that outnumber in terms of the population grow naturally all along the entire campus and with the well maintained aesthetic spots throughout the campus. The college strives its best to maintain the green cover in the campus through which the college gains its popular name **"The Beauty Bishop"**.


**Fig.1. Bishop Heber College Campus google image**

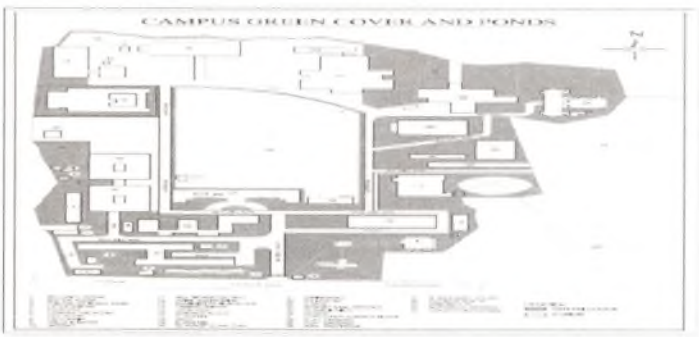



**Fig.2. Bishop Heber College Campus layout**

The college inculcates stewardship responsibility among the stakeholders through the following green initiatives: Rain water harvesting, Environmental education to school children, International students and to the local public by eco-tours, field trips and nature camps, bird watching, survey, rescue, breeding and release of orphaned or abandoned birds. Environmental awareness campaigns by observation of No Vehicle/Drive day, World Environment Day, Forest Day, Sparrow Day, Water and Earth Day. Tree planting, establishment and maintenance of nursery and issuance of saplings to different beneficiaries like NSS, NCC and other voluntary agencies as part of improving the green cover around the campus as regular and routine activities.

Establishment of Arboretum, Ficadorium, Bambusetum and Medicinal plant garden for the purpose of education and creating awareness. Conservation of endangered and endemic plants from the ecologically sensitive Western Ghats Mountains (One of the Hot Spot of Biodiversity) is being undertaken using Micro propagation and other breeding methods.

**Herbs**

The components of herbs in Bishop Heber College Campus comprised of 59 plants belonging to 53 genera included under 22 families. Amaranthaceae was found to be the dominant family with 7 species. Solanaceae and Asteraceae were found to be the next dominant families with 6 species in each. Euphorbiaceae, Malvaceae and Acanthaceae families with 5 species in each. Fabaceae family was found with 4 species followed by Nyctanginaceae and Lamiaceae families with 3 species in each. 5 families viz.,

Capparidaceae, Rubiaceae, Aizoaceae, Verbenaceae and Boraginaceae were represented with 2 species in each and 8 other families viz., Commelinaceae, Violaceae, Convolvulaceae, Utricaceae, Portulacaceae, Bignoniaceae, Zygophyllaceae and Apocynaceae were represented by single species.

**Climbers**

The Campus supports 13 climbers belonging to 9 genera. Convolvulaceae has 4 species while Cucurbitaceae has 2 species. All other families (Polygonaceae, Sapindaceae, Passifloraceae, Combretaceae, Menispermaceae, Ascelpiadaceae and Asteraceae) are represented only by a single species.

### Grasses and Cyperus

The category of grasses and sedges are represented by 17 plant species in the College premises. They belong to 15 genera of just two families viz. Poaceae (13 genus) and Cyperaceae (4 genus).

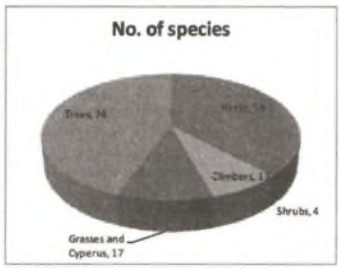
### Shrubs

There are 4 shrubs in the campus, with 4 genera belonging to 4 families viz. Nyctaginaceae, Verbenaceae, Malvaceae and Bignoniaceae which are represented only by one species.

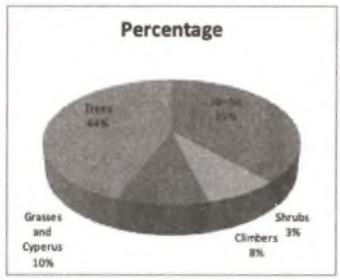
### Trees

The College Campus is represented by 74 tree species belonging to 63 genera and 29 families. Fabaceae was found to be the dominant family with 15 species. Moraceae was found to be the next dominant family with 8 species, followed by Arecaceae with 6 species. Bignoniaceae and Myrtaceae families were recorded with 4 species in each followed by Rutaceae and Sapotaceae families with 3 species in each. 9 families (Malvaceae, Rubiaceae, Euphorbiaceae, Sterculiaceae, Sapindaceae, Combretaceae, Anacardiaceae, Meliaceae and Annonaceae) were represented with 2 species in each and other 14 families represented by only single species.

| Plant forms | No. of species |
|---|---|
| Herbs | 59 |
| Shrubs | 04 |
| Climbers | 13 |
| Grasses and Cyperus | 17 |
| Trees | 74 |




| Plant forms | Percentage |
|---|---|
| Herbs | 35% |
| Shrubs | 3% |
| Climbers | 8% |
| Grasses and Cyperus | 10% |
| Trees | 44% |



**Observations**

Of the total species found in the campus 124 species (Annexed) were identified as non-native species which certainly outnumbers the native species composition. This phenomenon is attributed to the fact that over the period of establishment and beatification of the campus, several non-native species were introduced. After the study on green treasures, efforts are being taken to replace the non-native species and reintroduce native species population. The effect of non-native species over the indigenous plant community is considered for investigation.

96 medicinal plant species were recorded in the Bishop Heber College campus. These medicinal plants were recorded with properties for treatment of various diseases like common fever, cough, sore throat, skin disease, wound healing, snake bite, diabetes, cancer, malaria, ulcers, stomach disorders, dysentery, etc...

**Impacts of the Study**

The Floral diversity of Bishop Heber College campus is an important component as it encompasses the native and exotic species of flora which are being conserved. The floral diversity of the campus holds a lot of potentiality in terms of conservation, carbon sequestration and carbon neutrality. The vegetation areas identified during the present study accorded special attention and future development plans of the campus are being made with special consideration to protect the rich greenery.

As a follow up to the study, species repositories of special importance like Bamboo, Ficus and Ferns and medicinal plants are being established and maintained inside the botanical garden and in an arboretum with number of species being added as and when available from nearby forests for the purpose of education as well as for conservation. Special attention and care is also undertaken to maintain and improve the green cover percentage of the campus to meet the global requirement standards for achieving carbon neutrality. Sapling nurseries of native plant species as well as medicinal plants are also being established and maintained for free distribution to various social organizations to improve green cover wherever necessary.

The leaf (plant) litter collected from the entire campus is taken for composting in the compost pits located near the collection points daily and the composted material is used as manure for the campus garden.

As a follow up to the study, species repositories of special importance like Bamboo, Ficus and Ferns are being established and maintained inside the botanical garden with added number of species as and when available in each from nearby forests for the purpose of education as well as for conservation.

**References**

*Anonymous (1948 - 1992). The Wealth of India – Raw Materials. Vols. 1 – 11. Council of Scientific and Industrial Research, New Delhi.*

*Gamble, J. S. and Fisher, C.E.C. 1915 - 1936. Flora of the Presidency of Madras. Adlard & Son Ltd., London.*

*Hendry, A. N., Chithra, V. and Balakrishnan, N. P. 1989. Flora of Tamil Nadu, India. Botanical Survey of India, Coimbatore.*

*Mathew, K. M. (1981-88). Flora of the Tamil Nadu Carnatic. Vols. 1-4. Rapinat Herbarium, Thiruchirapalli, Tamil Nadu.*

*Mathew, K. M. 1999. Flora of the Palni Hills, South India Vols. 1-3. Rapinat Herbarium, Thiruchirapalli, Tamil Nadu.*

*Make Life Healthy. www.herbpathy.com/.*

*Acalypha indica L.*
Euphorbiaceae

*Aeschynomene indica L.*
Fabaceae

*Alysicarpus vaginalis L.*
Fabaceae

*Cleome gynandra L.*
Capparidaceae

*Commelina benghalensis L.*
Commelinaceae

*Evolvulus alsinoides L.*
Convolvulaceae

*Gompherna serrata L.*
Asteraceae

*Hybanthus enneaspermus (L.) F. Muell.*
Violaceae

*Indigofera linnaei Ali.*
Fabaceae

*Mollugo nudicaulis Lam.*
Aizoaceae

*Ocimum basilicum L.*
Lamiaceae

*Phyla nodiflora (L.) Greene.*
Verbenaceae

*Sida acuta Burm. f.*
Malvaceae

*Wedelia chinensis* (Osbeck) Merr.
Asteraceae

*Hibiscus rosa-sinensis L.*
Malvaceae

*Tecoma stans* (L.) Juss ex Kunth
Bignoniaceae

**Plate:1. Green Treasures of Bishop Heber College**

*Cyperus difformis* L.
Cyperaceae

*Cyperus rotundus* L. subsp. rotundus
Cyperaceae

*Chloris barbata* Sw.
Poaceae

*Dactyloctenium aegypticum* L.
Poaceae

*Antigonon leptopus* Hook. & Arn.
Polygonaceae

*Melothria maderaspatana* (L.) Cogn.
Cucurbitaceae

*Cardiospermum halicacabum* L.
Sapindaceae

*Quisqualis indica* L.
Combretaceae

*Bauhinia purpurea* L.
Fabaceae

*Cassia fistula* L.
Fabaceae

*Couroupita guianensis* Aubl.
Lecythidaceae

*Delonix regia* (Boj. Ex Hook.) Raf.
Fabaceae

*Kigelia pinnata* (Jacq.) D.C.
Bignoniaceae

*Lagerstroemia flos-reginae* Retz.
Lythraceae

*Millingtonia hortensis* L.
Bignoniaceae

*Peltophorum pterocarpum* (D.C.) Heyne.
Fabaceae

**Plate:2. Green Treasures of Bishop Heber College**

# TABLES

## Table 1: Checklist of Flora with vernacular names, medicinal uses and nativity

| S.NO | BOTANICAL NAME | COMMON NAME | TAMIL NAME | IUCN STATUS | FAMILY | MEDICINAL USES | NATIVITY |
|---|---|---|---|---|---|---|---|
| | | | Herbs | | | | |
| 1 | *Abutilon indicum* L. | Country mallow | துத்தி | Least concern | Malvaceae | Blood piles | Asia |
| 2 | *Acalypha indica* L. | Indian Acalypha | குப்பைமேனி | Least concern | Euphorbiaceae | Skin allergies | South Asia |
| 3 | *Achyranthus aspera* L. | Prickly chaff flower | நாயுருவி | Least concern | Amaranthaceae | Anti-inflammatory | Trop. America |
| 4 | *Aerva lanata* (L.) Juss. | Mountain Knot Grass | சிறுபீளை/பூலை | Not Evaluated | Amaranthaceae | Skin disease | Asia |
| 5 | *Aeschynomene indica* L. | Indian joint Vetch | நெட்டிதக்கை | Least concern | Fabaceae | - | Trop. America |
| 6 | *Alternanathera pungens* Kunth. | Khaki Weed | ஓட்றமுள் | Least concern | Amaranthaceae | - | Trop. America |
| 7 | *Alysicarpus vaginalis* L. | Buffalo Clover | நாமாபூண்டு | Threatened | Fabaceae | Anti-cancer | Trop. America |
| 8 | *Amaranthus viridis* L. | Green Amaranth | குப்பைகீரை | Not Evaluated | Amaranthaceae | Stomach disorder | Trop. America |
| 9 | *Asystasia dalzellina* Sant. | Violet Asystasia | மிதிகீரை | Least Concern | Acanthaceae | - | Trop. America |
| 10 | *Boerhavia diffusa* L. | Hog weed | முக்கிரட்டைக்கொடி | Not Evaluated | Nyctaginaceae | Fever and cold | Africa |
| 11 | *Boerhavia erecta* L. | Erect Spiderling | சீமை முக்கிரட்டை | Not Evaluated | Nyctaginaceae | Fever and cold | Brazil |
| 12 | *Cleome gynandra* L. | Cat's Whiskers | நிலவேளை | Not Evaluated | Capparidaceae | - | Trop. America |
| 13 | *Cleome viscosa* L. | Wild Mustard | நாய்க்கடுகு | Least concern | Capparidaceae | Dysentery | Trop. America |
| 14 | *Commelina bengalensis* L. | Tropical Spiderwort | கானாங்கோழை | Least Concern | Commelinaceae | Skin disorder | Asia |
| 15 | *Corchorus aestucans* L. | Jew's Mallow | காட்டுத்துத்தி | Not Evaluated | Malvaceae | Piles and ulcers | Trop. America |
| 16 | *Croton sparsiflorus* Morong. | Ban Thulasi | ரயில் பூண்டு | Not Evaluated | Euphorbiaceae | Snake bites | South America |
| 17 | *Datura metel* L. | Devil's trumpet | ஊமத்தை | Not Evaluated | Solanaceae | Skin allergies | Trop. Africa |
| 18 | *Desmodium procumbens* (Mill.) Hitchc. | Western trailing tick trefoil | சிறுபுல்லடி | Least concern | Fabaceae | Diabetes | Asia |
| 19 | *Dicliptera paniculata* (Forssk.) I. Darbysh | Panicled foldwing | நாகநந்த | Near Threatened | Acanthaceae | - | India |
| 20 | *Digera muricata* (L.) Mart. | False Amaranth | தொய்யாக்கீரை | Least concern | Amaranthaceae | Food & Diabetes | South West Asia |
| 21 | *Eclipta alba* (L.) Hassk. | False daisy | கரிசலாங்கண்ணி | Data deficient | Asteraceae | Diabetes & ulcer | Australia |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | *Euphorbia hirta* L. | Asthma plant | அம்மான் பச்சரிசி | Least concern | Euphorbiaceae | All Skin disorders | America |
| 23 | *Evolvulus alsinoides* L. | Slender dwarf Morning-glory | விஷ்ணுகிராந்தி | Least concern | Convolvulaceae | Fever & cough | America |
| 24 | *Gompherna serrata* L. | Prostrate Globe Amaranth | | Data deficient | Amaranthaceae | - | Trop. America |
| 25 | *Gompherna globosa* L. | Globe Amaranth | வடமல்லி | Not Evaluated | Amaranthaceae | - | Central America |
| 26 | *Heliotropium indicum* L. | Indian heliotrope | தேள் கொடுக்கு | Least Concern | Boraginaceae | - | Asia |
| 27 | *Hybanthus enneaspermus* (L.) F. Muell. | Spade Flower | ஓரிதழ்தாமரை | Near Threatened | Violaceae | Heart disease | Trop. Africa |
| 28 | *Indigofera linnaei* Ali. | Birdsville Indigo | செப்புநெருஞ்சி | Least Concern | Fabaceae | - | Trop. Africa |
| 29 | *Ixora coccinea* L. | Jungle Flame | வெட்சி | Not Evaluated | Rubiaceae | Tooth ache | India |
| 30 | *Justicia glauca* Rottl. | Glaucous justicia | | Least Concern | Acanthaceae | - | India |
| 31 | *Justicia simplex* Don. | Jogotmoden | ஆரம் | Least Concern | Acanthaceae | - | Mexico |
| 32 | *Leucas aspera* (Willd) L. | Common leucas | தும்பை | Not Evaluated | Lamiaceae | Eye disorders | India |
| 33 | *Lycopersicon lycopericum* (L.) H. Karst. | Common tomato | தக்காளி | Not Evaluated | Solanaceae | Food & Dysentery | Asia |
| 34 | *Merremia tridenlata* (L.) Hallier. f. | African Morning-Vine | ஓலைவயார் கூந்தல் | Not Evaluated | Convolvulaceae | Skin allergies | Trop. America |
| 35 | *Mollugo mudicaulis* Lam. | Daisy- leaved chickweed | பாப்பாடகம் | Data deficient | Aizoaceae | - | Brazil |
| 36 | *Mollugo pentaphylla* L. | Five-leaved carpetweed | குத்துத்திராய் | Data deficient | Aizoaceae | - | South America |
| 37 | *Ocimum basilicum* L. | Sweet basil | திருநீற்றுப்பச்சை | Least Concern | Lamiaceae | Fever & Headache | Asia |
| 38 | *Ocimum sanctum* L. | Holy basil | துளசி | Least Concern | Lamiaceae | Fever & Cough | India |
| 39 | *Oldenlandia corymbosa* L. | Diamond Flower | பாப்பன்பூண்டு | Data deficient | Rubiaceae | - | America |
| 40 | *Parthenium hysterophorus* L. | Carrot Weed | கேனத்துப்பூண்டு | Not Evaluated | Asteraceae | - | Trop. America |
| 41 | *Phyla nodiflora* (L.) Greene. | Frog fruit | பொடுதலை | Least Concern | Verbenaceae | Skin & Hair allergies | South America |
| 42 | *Phyllanthus niruri* L. | Stone breaker | கீழாநெல்லி | Least Concern | Euphorbiaceae | Kidney disorders | India |
| 43 | *Phyllanthus maderaspatensis* L. | Madras leaf-flower | நிலநெல்லி | Near Threatened | Euphorbiaceae | - | India |
| 44 | *Physalis minima* L. | Wild cape Gooseberry | கூவந்தி | Not Evaluated | Solanaceae | - | Trop. America |
| 45 | *Pilea microphylla* (L.) Liebm. | Gunpowder plant | ரத்னகிரி | Not Evaluated | Urticaceae | - | Central America |

## Table 2: Checklist of Flora with vernacular names, medicinal uses and nativity

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 46 | *Portulaca oleracea* L. | Verdolaga, Pigweed | கோழிக்கீரை | Not Evaluated | Portulacaceae | Food & rich protein | Asia |
| 47 | *Ruellia tuberosa* L. | Snapdragon root | பட்டாகாய் | Not Evaluated | Acanthaceae | - | Trop. America |
| 48 | *Sida acuta* Burm. f. | Morning mallow | வட்டத்திரிப்பி | Not Evaluated | Malvaceae | - | Trop. America |
| 49 | *Sida rhombifolia* L. | Paddy's lucerne | வேளைப்பாசை | Not Evaluated | Malvaceae | - | Central America |
| 50 | *Solanum nigrum* L. | Nightshade | மணத்தக்காளி | Not Evaluated | Solanaceae | Stomach disorders | Asia |
| 51 | *Solanum trilobatum* L. | Purple Fruited Pea Eggplant | தூதுவளை | Not Evaluated | Solanaceae | Cold & Cough | China |
| 52 | *Solanum xanthocarpum* Schrd & Wendl. | Yellow-fruit nightshade | கண்டங்கத்திரி | Not Evaluated | Solanaceae | Skin diseases & fever | India |
| 53 | *Tribulus terrestris* L. | Puncture vine | பல்லேரு முள்ளு | Not Evaluated | Zygophyllaceae | Chest pain & heart care | Trop. America |
| 54 | *Trichodesma indicum* (L.) R. Br. | Indian Borage | கவில் தும்பை | Not Evaluated | Boraginaceae | Skin itching | Asia |
| 55 | *Tridax procumbens* | Tridax daisy | வெட்டுக்காயி தலை | Not Evaluated | Asteraceae | Wound healing | Central America |
| 56 | *Vernonia cinerascens* (L.) Less | Ash coloured fleabane | பூவங்குருந்தல் | Data deficient | Asteraceae | - | India |
| 57 | *Vicoa indica* (L.) DC. | Sonkadi | ஜிமிக்கிப்பூ | Not Evaluated | Asteraceae | - | South East Asia |
| 58 | *Vinca rosea* L. | Periwinkle flower | நித்தியகல்யாணி | Data deficient | Apocynaceae | Anti-cancer | North America |
| 59 | *Wedelia chinensis* (Osbeck) Merr. | Chinese Wedelia | மஞ்சள் கரிசாலி | Least Concern | Asteraceae | Diabetes & Ulcers | China |
| | | | **Shrubs** | | | | |
| 60 | *Bougainvillea spectabilis* Willd. | Great Bougainvillea | காகிதப்பூ | Least Concern | Nyctaginaceae | - | Africa |
| 61 | *Duranta repens* L. | Golden dew drops | காட்டுமருதாணி | Data deficient | Verbenaceae | - | Mexico |
| 62 | *Hibiscus rosa-sinesis* L. | Shoe Flower | செம்பருத்தி | Not Evaluated | Malvaceae | Skin and hair care | Trop. Africa |
| 63 | *Tecoma stans* (L.) Juss ex Kunth | Yellow Trumpetbush | சொர்ணபட்டி | Least Concern | Bignoniaceae | - | South Africa |
| | | | **Climbers** | | | | |
| 64 | *Antigonon leptopus* Hook. & Arn. | Coral Vine | கொடி ரோஜா | Least Concern | Polygonaceae | - | Trop. America |
| 65 | *Cardiospermum halicacabum* L. | Balloon Vine | முடக்கத்தான் | Least Concern | Sapindaceae | Cough & joint pains | India |
| 66 | *Coccinia grandis* (L.) Voigt. | Ivy Gourd | கோவை | Not Evaluated | Curcurbitaceae | Diabetes | America |
| 67 | *Ipomoea alba* L. | Moonflower vine | நாகமுக்கோரை | Not Evaluated | Convolvulaceae | - | Mexico |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 68 | *Ipomoea eriocarpa* R. Br. | Tiny Morning Glory | புளிச்சிவிடு | Not Evaluated | Convolvulaceae | - | Trop. Africa |
| 69 | *Ipomoea quamolit* L. | Cypress Vine | மயில் மாணிக்கம் | Not Evaluated | Convolvulaceae | - | Trop. America |
| 70 | *Ipomoea palmate* Forssk. | Railroad Creeper | | Not Evaluated | Convolvulaceae | - | India |
| 71 | *Melothria maderaspatana* (L.) Cogn. | Madras Pea Pumpkin | முசுமுசுக்கை | Not Evaluated | Curcurbitaceae | - | India |
| 72 | *Oxystemla esculentum* | Rosy Milkweed Vine | ஊசிப்பாலை | Least Concern | Ascelpidaceae | - | China |
| 73 | *Passiflora foetida* L. | Stinking Passion Flower | புரி'ம் வள்ளி | Least Concern | Passifloraceae | - | Trop. America |
| 74 | *Quisqualis indica* L. | Ragoon creeper | இருங்கன்மல்லி | Least Concern | Combretaceae | - | India |
| 75 | *Tinospora cordiflora* (Willd.) Miers. | Heart-leaved Moon seed | சீந்தில் கொடி | Least Concern | Menispermaceae | Anti-diabetes | America |
| 76 | *Vernonia elaeagnifolia* DC. | Curtain creeper | | Not Evaluated | Asteraceae | - | India |
| | | | **Grasses and Cyperus** | | | | |
| 77 | *Acrachne ramose* (Heyne ex R. & S.) Ohwi | Goose grass | காடு காப்பாய் | Not Evaluated | Poaceae | - | Trop. America |
| 78 | *Alloteropsis cimicina* (L.) Stapf | Summer grass | | Not Evaluated | Poaceae | - | Mexico |
| 79 | *Aristida adscenaionsis* (L.) | Sixweeks Threeawn | கோடைபல்ல புல் | Not Evaluated | Poaceae | - | Africa |
| 80 | *Chloris barbata* Sw. | Swollen Finger grass | குருதிபுல்லு | Least Concern | Poaceae | - | India |
| 81 | *Cynodon dactylon* (L.) Pers. | Bermuda grass | அருகம் புல் | Least Concern | Poaceae | Diabetes | North America |
| 82 | *Cyperus difformis* L. | Variable flatsedge | வட்டக்கோரை | Not Evaluated | Cyperaceae | - | Asia |
| 83 | *Cyperus rotundus* L. subsp. rotundus | Common Nutsedge | கோரைகிழங்கு | Least Concern | Cyperaceae | Hair care | Asia |
| 84 | *Cyperus triceps* (Rottb.) Endl. | Globe flatsedge | முதலைக்கோரை | Not Evaluated | Cyperaceae | - | Australia |
| 85 | *Dactyloctenium aegypticum* (L.) P. Beauv. | Crowfoot grass | காக்காகால் புல் | Not Evaluated | Poaceae | - | Africa |
| 86 | *Dichanthium annulatum* (Forak.) Stapf. | Sheda grass | | Not Evaluated | Poaceae | - | Trop. Africa |
| 87 | *Digitaria adscendens* (H.B. & K.) Henr. | Wild Crab grass | அரிசி புல் | Not Evaluated | Poaceae | - | Europe |
| 88 | *Echinochloa colona* (L.) Link. | Jungle grass | கரும்புல்லு | Not Evaluated | Poaceae | - | India |
| 89 | *Eragrostis japonica* (Thunb.) Trin. | Pond love grass | காஞ்சிர புல்லு | Not Evaluated | Poaceae | - | Africa |
| 90 | *Fimbristylis ferruginea* Vahl. | Rusty Sedge | | Not Evaluated | Cyperaceae | - | India |

## Table 3: Checklist of Flora with vernacular names, medicinal uses and nativity

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 91 | *Panicum antidotale* Retz. | Blue panic grass | பீச்சி புல் | Not Evaluated | Poaceae | - | India |
| 92 | *Setaria verticillata* (L.) P. Beauv. | Bristly foxtail | அமரி புல் | Not Evaluated | Poaceae | - | Asia |
| 93 | *Sporobolus coromandelianus* (Retz.)Kunth | Small drop seed | | Not Evaluated | Poaceae | - | India |
| | | | | | | | |
| | | | **Trees** | | | | |
| 94 | *Acacia auriculiformis* A.Cunn. | Ear leaf acacia | கருவேளம் | Least Concern | Fabaceae | Tooth ache | Australia |
| 95 | *Adenanthera pavonina* L. | Red lucky seed | ஆனைகுண்டுமணி | Near Endangered | Fabaceae | - | South East Asia |
| 96 | *Albizia lebbeck* (L.) Benth. | Woman's tongues tree | வாகை | Not Evaluated | Fabaceae | - | Australia |
| 97 | *Annona squamosa* L. | Custard Apple | சீதாமரம் | Not Evaluated | Annonaceae | Food and rich calcium | India |
| 98 | *Areca catechu* L. | Betel palm | பாக்கு | Not Evaluated | Arecaceae | - | Asia |
| 99 | *Artocarpus heterophyllus* Lam. | Jackfruit | பலாமரம் | Not Evaluated | Moraceae | - | India |
| 100 | *Azadirachta indica* A. Juss | Neem | வேம்பு | Not Evaluated | Meliaceae | Cancer & Diabetes | India |
| 101 | *Bauhinia purpurea* L. | Purple orchid tree | நீலதிருவத்தி | Least Concern | Fabaceae | - | China |
| 102 | *Bismarckia nobilis* Hildebr & H. Wendl. | Bismarck Palm | கூந்தல்பனை | Least Concern | Arecaceae | - | Madagascar |
| 103 | *Bombax ceiba* L. | Silk Cotton tree | முள் இலவம் | Least Concern | Malvaceae | - | China |
| 104 | *Caesalpinia pulcherrima* (L.) Sw. | Peacock flower | நாழல் | Not Evaluated | Fabaceae | - | North America |
| 105 | *Carica papaya* L. | Papaya | பப்பாளிமரம் | Not Evaluated | Caricaceae | Stomach & Uterus care | Mexico |
| 106 | *Cassia fistula* L. | Golden Shower tree | சரக்கொண்னை | Not Evaluated | Fabaceae | Rich vit. C & Diabetes | India |
| 107 | *Cassia javanica* L. | Apple Blossom tree | கொன்றைமரம் | Not Evaluated | Fabaceae | - | Indonesia |
| 108 | *Cassia siamea* Lam. | Cassia tree | மஞ்சள்கொன்றை | Not Evaluated | Fabaceae | Diabetes | South Asia |
| 109 | *Cassine glauca* (Rottb.) Kuntze. | Ceylon tea | கருவலி | Not Evaluated | Celastraceae | - | South America |
| 110 | *Casuarina equisetifolia* L. | Whistling pine | சவுக்கு | Not Evaluated | Casuarinaceae | - | South Asia |
| 111 | *Chrysophyllum roxburghii* G. Don. | Indian star apple | குருந்தம் | Not Evaluated | Sapotaceae | - | South East Asia |
| 112 | *Citrus limon* (L.) Burm. f. | Common lemon | எலுமிச்சை | Least Concern | Rutaceae | Control fatty acids | Asia |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 113 | *Cocus nucifera* L. | Coconut | தென்னை | Least Concern | Arecaceae | - | South East Asia |
| 114 | *Cordia sebestena* L. | Orange giger tree | நறுவிலி | Least Concern | Boranginaceae | - | America |
| 115 | *Couroupita guianensis* Aubl. | Cannonball tree | நாகலிங்கமரம் | Least Concern | Lecythidaceae | Anti-toxicity | South America |
| 116 | *Crescentia cujete* L. | Calabush tree | திருவோட்டிக்காய் | Least Concern | Bignoniaceae | Urinary disorders | America |
| 117 | *Delonix regia* (Boj. Ex Hook.) Raf. | Flame tree | மயில்கொன்றை | Least Concern | Fabaceae | - | North America |
| 118 | *Eucalyptus globulus* Labill. | Eucalyptus | தைலமரம் | Least Concern | Myrtaceae | Cold & Headache | Australia |
| 119 | *Eugenia bracteata* (Willd.) Roxb. ex. D.C. | Roxburgh's cherry | கயா | Near Endangered | Myrtaceae | - | Brazil |
| 120 | *Ficus alii* | Sabre fig | | Not Evaluated | Moraceae | - | India |
| 121 | *Ficus benghalensis* L. | Indian Banyan | ஆல் | Not Evaluated | Moraceae | - | India |
| 122 | *Ficus benjamina* L. | Weeping fig | | Not Evaluated | Moraceae | - | India |
| 123 | *Ficus microcarpa* L. | Chinese Banyan | | Not Evaluated | Moraceae | - | India |
| 124 | *Ficus nervosa* Heyne ex. Roth. | | நீர்ஆல் | Not Evaluated | Moraceae | - | India |
| 125 | *Ficus racemosa* L. | Cluster fig | அத்தி | Not Evaluated | Moraceae | Urinary troubles | India |
| 126 | *Ficus religiosa* L. | Sacred fig | அரசமரம் | Not Evaluated | Moraceae | Uterus disorders | India |
| 127 | *Filicum decipiens* (Wight & Arn.) Thwaites | Fern tree | நிங்கல்மரம் | Data deficient | Sapindaceae | - | America |
| 128 | *Gmelina arborea* Roxb. | Beechwood | குமுளிதேக்கு | Near Endangered | Verbenaceae | Vital nutrients | India |
| 129 | *Guazuma tomentosa* H.B. & K. | Bastard Cedar | தேன்மரம் | Data deficient | Sterculiaceae | - | Central America |
| 130 | *Hamelia patens* Jacq. | Firebush | | Not Evaluated | Rubiaceae | - | Central America |
| 131 | *Hibiscus tiliaceus* L. | Sea hibiscus | காட்டுபூவரசு | Not Evaluated | Malvaceae | - | South East Asia |
| 132 | *Kigelia pinnata* (Jacq.) D.C. | Sausage tree | சிவன் கூந்தலம் | Not Evaluated | Bignoniaceae | Anti-cancer | South East Africa |
| 133 | *Lagerstroemia flos-reginae* Retz. | Queen's Crape Myrtle | பூமருது | Not Evaluated | Lythraceae | - | South Asia |
| 134 | *Lannea coromandelica* (Houtt.) Merr. | Indian Ash tree | ஓதிமரம் | Not Evaluated | Anacardiaceae | - | Bangladesh |
| 135 | *Mangifera indica* L. | Mango | மாமரம் | Data deficient | Anacardiaceae | Vital nutrients | India |
| 136 | *Millingtonia hortensis* L. | Tree Jasmine | மரமல்லி | Not Evaluated | Bignoniaceae | - | South East Asia |

**Table 4: Checklist of Flora with vernacular names, medicinal uses and nativity**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 137 | *Mimusops elengi* L. | Spanish Cherry | மகிழமரம் | Not Evaluated | Sapotaceae | - | Australia |
| 138 | *Morinda tinctoria* Roxb. | Indian Mulberry | நுணா | Least Concern | Rubiaceae | Fever | South Asia |
| 139 | *Moringa oleifera* L. | Drumstick | முருங்கை | Least Concern | Moringaceae | Skin disease | Africa |
| 140 | *Murraya exotica* L. | Orange jasmine | வெங்காரை | Least Concern | Rutaceae | - | Mexico |
| 141 | *Murraya koenigii* (L.) Sprengel. | Curry tree | கருவேப்பிலை | Least Concern | Rutaceae | Hair care | India |
| 142 | *Parkia biglandulosa* Wight & Arn. | Badminton ball tree | பந்துக்காய்மரம் | Least Concern | Fabaceae | - | Africa |
| 143 | *Peltophorum pterocarpum* (D.C.) Heyne. | Copperpod | பெருங்கொன்றை | Least Concern | Fabaceae | - | South East Asia |
| 144 | *Phoenix reclinata* Jacq. | Wild date palm | பேரீச்சை | Not Evaluated | Arecaceae | Blood purifier | India |
| 145 | *Phyllanthus acidus* (L.) Skeels. | Star gooseberry | அருநெல்லி | Least Concern | Euphorbiaceae | Blood purifier | South East Asia |
| 146 | *Phyllanthus emblica* L. | Amla | நெல்லி | Least Concern | Euphorbiaceae | Diabetes & Hair care | South East Asia |
| 147 | *Pisonia grandis* R. Br. | Grand devil's claws | சண்டிகீரை | Least Concern | Nyctaginaceae | Joint pains | India |
| 148 | *Pithecellobium dulce* (Roxb.) Benth. | Moneypod | கொடுக்காபுளி | Least Concern | Fabaceae | - | Trop. America |
| 149 | *Plumeria alba* L. | Frangipani | பெருங்கள்ளி | Least Concern | Apocynaceae | Eye troubles | Central America |
| 150 | *Polyalthia longifolia* Sonn. | False Ashoka | நெட்லிங்கமரம் | Least Concern | Annonaceae | - | India |
| 151 | *Pongamia pinnata* (L.) Pierre | Indian beech | புங்கை | Least Concern | Fabaceae | - | Asia |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 152 | *Pouteria sapota* (Jacq.) H.E. Moore et Stern | Sapote | சப்போட்டா | Least Concern | Sapotaceae | - | Central America |
| 153 | *Psidium guajava* L. | Guava | கொய்யா | Not Evaluated | Myrtaceae | Kidney care & Diabetes | South America |
| 154 | *Putranjiva roxburghii* Wall. | Lucky bean tree | புத்திரஜீவி | Not Evaluated | Putranjivaceae | - | South East Asia |
| 155 | *Roystonea regia* (Kunth) O.F. Cook. | Royal palm | பாக்கு | Not Evaluated | Arecaceae | - | Mexico |
| 156 | *Samanea saman* (Jacq.) Merr. | Rain tree | தூங்குமூஞ்சிமரம் | Least Concern | Fabaceae | - | India |
| 157 | *Santalum album* L. | Sandal tree | சந்தனம் | Vulnerable | Santalaceae | Skin care & cancer | India |
| 158 | *Sapindus saponaria* L. | Wingleaf Soapberry | பூவல்கொட்டைமரம் | Least Concern | Sapindaceae | - | North America |
| 159 | *Spathodea campanulata* P. Beauv. | Fountain tree | பட்டி | Least Concern | Bignoniaceae | - | Trop. America |
| 160 | *Sterculia foetida* L. | Java Olive tree | இலவம் மரம் | Least Concern | Sterculiaceae | - | South America |
| 161 | *Swietenia mahagoni* (L.) Jacq. | West Indies Mahogany | மகோகனி | Endangered | Meliaceae | Diabetes | South America |
| 162 | *Syzygium cumini* (L.) Skeels. | Jamun | நாவல் | Least Concern | Myrtaceae | Diabetes & tooth ache | India |
| 163 | *Tamarindus indica* L. | Tamarind | புளியமரம் | Least Concern | Fabaceae | - | India |
| 164 | *Terminalia arjuna* (Roxb.) Wight & Arn. | Arjuna tree | மருதமரம் | Near Threatened | Combretaceae | Astringent & Diuretic | India |
| 165 | *Terminalia catappa* L. | Country almond | நாட்டுவாதுமை | Near Threatened | Combretaceae | Liver diseases | India |
| 166 | *Washingtonia robusta* H. Wendl. | Mexican fan palm | பனைமரம் | Least Concern | Arecaceae | - | Mexico |
| 167 | *Ziziphus rugosa* L. | Wild jujube | தொடாரி | Least Concern | Rhamnaceae | Hypotensive | India |

# ELECTRICAL ENERGY AUDIT AND ITS IMPLICATIONS IN BISHOP HEBER CAMPUS

6

D.J.S. Anand Karunakaran, A. Alagappa Moses,
V. Anand Gideon and Sheela Mary,M.
*Bishop Heber College, Tiruchirappalli*

**Abstract**

*The governance of campus with need based energy in any form is the objective of this study.The Electrical Energy Audit(EEA) is a processes of conducting available/ requirement assessment, adaptability of alternate energy resources, survey and suggestions. A systematic audit has been conducted in the campus. Site survey and Space availability provides the platform for roof top Grid tied/ Off Grid solarization to substantiate and reduce the electric power consumption from regular mode. The PV panel type and arrangement, power output in KW, invertors, accumulator, convertors, connectivity and earthing with standard specification are mentioned. This audit also incite quantum of production and projective returns on investment in green energyover the period.*

**Key words:** *Energy Audit, Environmental audit, Energy Management, Solarization*

## Introduction

Energy management is the strategy of adjusting and optimizing energy to produce benefits and provide service with the least environmental effect. The sensible and effective use of energy is to make the most of profit byplaying down the costs and augment viable position.

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy and energy use to its discrete functions. It is an effective tool in defining and pursuing comprehensive energy management.

## Review of Literature

The need of environmental audit for energy management within a college campus is very essential. Most college and university campuses contain offices, classrooms, libraries, research labs, hospitals,

residential halls, food services, art studios, roads, parking lots, recreational and sports facilities, and wilderness areas. All campuses consume vast amounts of energy for lighting and various other purposes. The following literature review provides information on the extent of research done in the fields of energy management in various areas.

Energy Task Force suggested that incorporating passive solar building design and energy efficiency into future building plans such as the use of "day lighting" a means ofmaximizing the use of natural light in the design of a building[1]. In addition, planners may be encouraged to incorporate safe and renewable energy sources such as photovoltaic, cogeneration, wind and fuel cells into campus energy plans.

Heist, Eric et al[2] explained the way for increasing the efficiency of heating and cooling systems by looking at heating-and cooling- season temperature policies.

The above literature reveals that many authors have worked in the field of water, wastewater, flora and fauna, energy management with reference to educational institutions and other establishments. Very little work is available in the field of Campus Environmental Audit and Assessment addressing the issue in a holistic manner. Thus it is imperative to carry out a Campus Environmental Audit and Assessment for Bishop Heber College campus.

**Methodology**

Energy Audit can be classified into two types

**(i) Preliminary Audit**

It's a quick exercise to energy consumption, scope for saving, identification, setting reference point, study/measurement and assessment [3].

**(ii) Detailed Audit**

- Pre audit Phase

**Step.1**

- Plan and Organize
- Walk through audit
- Informal interviews

Step.2 Conduct meeting

- Audit Phase

Step.3 Primary data gathering

Step.4 Conduct survey and monitoring

Step.5 Trials and Experiments (pilot plant)
Step.6 Analysis of energy use
Step.7 Identification and Development (Opportunities)
Step.8 Cost benefit analysis
Step.9 Reporting and Presentation

• Post Audit Phase

Step.10 Implementation and Follow-up

**Energy Audit Team**

Managerial:

- Executive Summary
- Scope and Purpose
- Investments / operation Cost / savings

Technical:

- Energy Audit Options
- Measurements and Instruments
- Source / Distribution / usage / Substitution
- Recommendations

**The Out Come**

To Calculate

- Net Savings = Annual savings – Annual operating cost
- Payback period = Investments / net savings / year

**Data Collection**

It is impartment to plan additional data gathering carefully.
Measurement system: Information accuracy that is needed.
Measurement equipment can be inexpensive.
Quality of data to arrive correct conclusion
Data collection and design values should be accounted for process variations.

Model Data Sheet & Work Sheet are annexed

**Loss of energy:**

The amount of electrical energy loss is the difference in calculated and actual energy consumed

Loss factors

1. Heat and Hysteresis loss
2. Load distribution
3. Cable capacity laying (HT to LT)
4. Power distribution at LT
5. Grounding, etc..

**Measures to overcome energy loss:**

Ensure

1. Sanctioned and Required load
2. Distribution of load and cable laying (Distance and size for rate of flow to minimize Heat and Hysteresis loss)
3. Proper earthing
4. Fuse points to terminate over load condition.

## Electrical Energy Audit at BHC

**Source Information of main blocks**

| | | |
|---|---|---|
| Electric utility company | : | TNEB |
| Electric meter # | : | ER300P(L&T) |
| Potential Transformer details | : | 1100-110V |
| Main (Grid) Transformer details at campus. | : | Kirloskar 800KVA |
| Distance between Main LT & HT | : | 50ft (Approx) |
| HT Panel Details | : | Small Cubic for L&T meter & separate Cubic above this for CT &PT (Pfave =0.91) |
| Input feeder details 11KV or 66KV | : | 11KV |
| Service voltage from utility | : | 440V |
| Utility power available (apparent) | : | 440 X 20.5 = 9020W = 9.020 KW |

**Electrical Power Consumption:**

| | |
|---|---|
| Highest Power Consumption Sept-12 | 96332 units (96332 KW) |
| Electric rate per unit | Rs.7.00/- |
| Net payable amount | 96332 X 7 X 0.91(Pf) = Rs. 6,13,634.84 |

**Power back-up**

Generator connected to this Block 380 KVA, 125 KVA & 82.5 KVA, (Powerica&Kiroloskar)

Diesel consumption per month : Rs. 2,50,000/-

**Off mode**

| | |
|---|---|
| Power cuts in this Area | 1hours/day minimum |
| Load during Holiday | At this Block 1000W/hr,Pumps & Street Light will be Switched On as per requirement |

**Suggestion for alternate energy:**

Approximate Capacity of solar panels can be installed without Inter Row spacing for the

| | |
|---|---|
| 1. Administration Block | 100 KW |
| 2. P G Block | 100 KW |
| 3. Arts and Science Block | 100 KW |
| **Total required Capacity** | **300 KW** |

**Results and Suggestions**

This audit is to ensure the accuracy of the EB pay bill and to check the correctness of electrical system. Comparatively if the consumed and calculated electrical units are same the existing electrification by all means is perfect. Otherwise its need to check:

1. Power input/output across the main EB meter and fuse points
2. Load distribution
3. Control unit or MCB
4. Installation of proper earthing
5. Cabling or Wiring of electrical system

Considering the above factual data it is suggested that installation capacity of solar panels 300 KW is beneficial in both ways reduction regular power consumption and diesel consumption every month and will also pave way for investment on green energy resources.

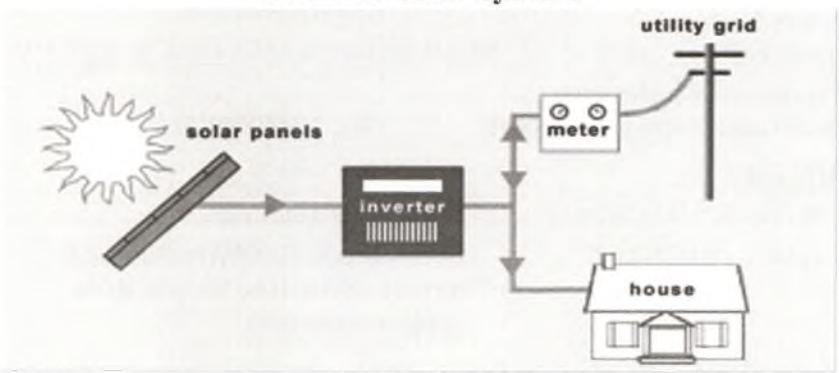
**Execution model of the Solarization:**

There are 3 type of solar systems in proactive

1. Grid line, 2. Off grid, 3. Hybrid solar

There are a few key differences between the equipment needed for grid-tied, off-grid and hybrid solar systems[4]. The suggested model is a Grid line or Grid –Tied Model

**Grid-Tied Solar Systems**




Grid-tied, on-grid, utility-interactive, grid intertie and grid back feeding are all terms used to describe the same concept – a solar system that is connected to the utility power grid.

**Equipment for Grid-Tied Solar Systems**

Standard grid-tied solar systems rely on the following components:

1. Grid-Tie Inverter (GTI) or Micro-Inverters
2. Power Meter.

The regular grid power and locally generated power are connected and synchronized and modified to have common phase and frequency[5]. But meets the power supply from the solar power first(leading current) and the rest by utility power grid[6].

**Advantages of Grid-Tied Systems**

1. Save more money with net metering
2. The utility grid is a virtual battery

**The scheme:**

| | |
|---|---|
| Title of the Project | Campus BHC Grid-Tied Solarization |
| Topic addressed by the project | 300KW Phase-1 PV Installation. |
| Background | Electrical Energy Audit- BHC Campus for Administration |
| Aim of the project | Provision of sufficient Solar power (300KW) |
| Objectives of the project | Installation of full set 3 Section of 100KW array of PV modules with interface peripherals. |
| Expected outcomes | Generation of 300KW peak output power. |
| Proposed activities | Site visit, layout sketches, Structural Design, PV modules matrix set up, cabling, Synchronizing invertors, accumulators and energy meters installation |
| Installation period | 4 – 7week |
| Target | Trial run testing, interfacing and commission of the project |
| Estimative budget | Total cost for 300kw @ Rs.85 per watt = Rs.2,55,00,000/- Capital subsidy @10% Rs. 25,50,000/- Investment from the customer Rs.2,29,50,000/- Maintenance Under AMC |

**Return on Investment**

Return on Investment calculation with interest @5% reducing balance according to IREDA rate and increase in tariff every 15 months @5% assuming there is no change in tax on EB Bill.

| | | |
|---|---|---|
| Total interest on the investment @ | | Rs. 52,00,000/- |
| Net Expected Returns | | Rs. 2, 81,50,000/- |
| Months | : | 0 – 95 |
| Daily Energy(KW) | : | 1400 |
| Monthly Energy(KW) | : | 42,000 |
| Tariff Rs. | : | 07.00 |
| Revenue Rs. | : | 2,94,000 |
| Total Returns Rs. | : | 2,79,30,000 |

**Conclusion**

Much of the world's required energy can be supplied directly by solar power and more requirements may still be provided indirectly[7]. The practicality of solarization will have to be examined, as well as the benefits and drawbacks. In addition, the advantages of solar energy and over the conventional energyare noted.

The campus Bishop Heber College (BHC) is well located in the central part of Tamil Nadu. Out spaced over 28 Acre of land, adequate building with sufficient roof top for solarization. The internal audit and survey conducted every year provided provisions for appropriatemodifications and relaying of electrical cabling for the avoidance of leakage. Additional load from the power grid is drawn to meet out the increasing demand. Thus this proposal is very appropriate in time to incorporate non conventional/green energy support for further requirement and to reduce the consumable electrical unit from regular power grid.

**References**


1. *Clark, Wilson; Energy for Survival: The Alternative to Extinction; Garden City, NY: Anchor Press; 1974*
2. *Hirst, Eric. "Recent Changes in U.S. Energy Consumption: Solar Dwelling Design Concepts; Washington, D.C. 1986*
3. *AIA Research Corporation; Solar Dwelling Design Concepts; Washington, D.C.*
4. *Solar Direct: Soalrdirect.com learning material online*
5. *Duffie, John A. & Beckman, William A.; Solar Energy Thermal Processes; New York, NY: John Wiley & Sons; 1974*
6. *O'Hanian, Hans C.; Physics; New York, NY: W. W. Norton & Co.; 1985*
7. *Kut, David & Hare, Gerald; Applied Solar Energy; New York, NY: Halsted Press; 1979.*

## Annexure IV

### A) Model Data Sheet:

- Name of the Institution :
- Location :
- Type of Connection :
- E B No :
- permitted Load :
- Consumed Load :
- Surplus Load :
- Demand in Load

1. Site Survey
2. Physical Data Collections
   - Name of the Buildings :
   - No of Blocks :
   - No of Floors :
   - No of Rooms :
   - Types of Section :
3. Builing Plans
4. Electrical Cabling Map
5. Electric Wiring Map

**Electrical Energy:**

- Power(P)= Voltage(V) X Current(I) in watt
- 1000watt/ 1hour = 1 Electrical Unit

**Loss of energy:**

The amount of electrical energy loss is the difference in calculated and actual energy consumed

Loss factors

1. Heat and Hysteresis loss
2. Load distribution
3. Cable capacity laying (HT to LT)
4. Power distribution at LT
5. Grounding, etc..

## B) Table.1: Model work sheet

| S.no | Name of the article | Quantity (1) | Power In watt (2) | Duration In hours/day (3) | Total Power Consumed/day (1)X(2)X(3)=(4) | Total Electrical Unit (4)/1000=(5) |
|---|---|---|---|---|---|---|
| 1 | Tube Light | 10 | 40 | | | |
| 2 | Ceiling Fan | 06 | 60 | | | |
| 3 | Washing Machine | 01 | 1000 | | | |
| 4 | Air Conditioner | 02 | 1800 | | | |
| 5 | Water Heater | 02 | 1400 | | | |
| Total electrical unit/day | | | | | | |

## Calculation

Net Unit : Total unit/day X 30 X 2
Net power consumed : Net units X Pf
Cost of Power : Net Unit X Tariff Cost (Follow TNEB Slab)

## Table - 2:Comparative electrical units consumed and calculated

| S.no | Month | Consumed Units | Calculated Units | Remark |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

PART- 2:

# COMMUNITY INITIATIVES

# COMMUNITY BASED ENVIRONMENTAL HEALTH INITIATIVES - A MULTIDISCIPLINARY SERVICE LEARNING APPROACH

7

Manorama Dhanaseeli and Priscilla A.S.
*Lady Doak College, Madurai.*

**Abstract**

*At the global level, World Health Organization found that most of the health problems are due to interactions with poor environmental factors. Sellur, a nearby neighborhood of Lady Doak College, Madurai, is a highly polluted, a deeply congested residential area with 13 streets with approximately 150 houses per street and people living there are at a greater risk of acquiring health setbacks by way of air and water contamination. Hence, it was envisaged that as an institution with extensive service learning programmes, it will be appropriate to apply the academic learning to promote quality life in the neighborhood.*

*A socio- environmental base line survey was conducted in the selected streets of Sellur with a main focus on water facilities, drainage and sanitation facilities, prevalence of diseases etc.,The density of garbage bins was found by geo-mapping. The survey data was statistically analyzed. The quality of air (in terms of mycoflora) and drinking water were investigated. The drinking water supplied to the community was found to have E. coli, a coli form bacterium, the biological indicator of faecal contamination. The most prevalent vector-borne disease was found to be Chikungunya, a viral disease. Based on survey, awareness on health and hygiene was created by conducting exhibition and medical camp. Awareness on segregation of biodegradable and non-biodegradable wastes and as a micro-enterprise, preparation of paper bags as an alternative to polythene bags was also conducted among local women. The outcome of such community service projects mutually benefitting the service providers and recipients are discussed.*

**Keywords:** *Contamination, Water quality, Polythene bags, Air quality, Environment health*

## Introduction

India has a long way to go to reach environmental quality similar to those enjoyed in developed economies. Pollution remains a major challenge and opportunity for India. Environmental issues are one of the primary

causes of disease, health issues and long term livelihood impact for India. Land and water are the most prime natural resources and improper management of such resources leads to severe environmental problem. The most common reason for the problem is the rapid population growth and unplanned urban expansion. Madurai city is expanding in all directions resulting in largescale urban sprawl and changes in land use. The spatial pattern of such changes is clearly noticed on the urban fringes, than in the city centre. Hence, the city fringe experience sudden growth but lacks in infrastructure facilities leading to various environmental issues.

## Methodology

### Geomapping- Image of Sellur Area Selected For Community Project

The settlements in the study area Sellur was mapped using the Geo mapping technique.

### Socio - Environmental Base Line Survey

A common questionnaire was prepared to collect the data. Data on their economic status, basic amenities, sanitation and drainage facilities and the prevalence of diseases in that area was collected from nearly 1430 respondents. Data analysis was done using SPSS software package.

### Physico-Chemical Analysis of Drinking Water at Sellur

Water analysis was performed for the samples collected from Ahimsapuram 1st to 8th streets. The parameters analyzed using water analysis kits were: total alkalinity, pH, phosphate, iron, calcium hardness, total hardness, residual chlorine, chloride, fluoride, nitrate, nitrite and ammonium. The results obtained were compared with the Bureau of Indian Standard (BIS) limits of drinking water (Apha, 1989).

### Bacteriological Examination of Drinking Water For Potability

Potability of water was tested using standard qualitative and quantitative procedures. (presumptive, confirmed and completed tests). MPN analysis was carried out to determine the number of coliforms in drinking water (Cappuccino, 2009).

### A Study on the air mycoflora at selected streets

Outdoor air mycoflora in selected streets of Sellur was studied by exposure plate method using Rose Bengal Agar (RBA) medium twice during the study period. The number of colonies formed in the plates and the spore types prevalent in the area were analyzed.

## Results

### A. Geo map of sellur area selected for community project

The selected area had 13 streets with not less than 150 houses per street. The survey covered a total of 13 streets (Ahimsapuram 2nd , 3rd,4 th, 5th , 6th , 7th , 8th streets, Ahimsapuram Mellatheru, Church street , AyyanarKoil 5th street and Manavallan 3rd , 4th streets).

### B. Findings from the survey data

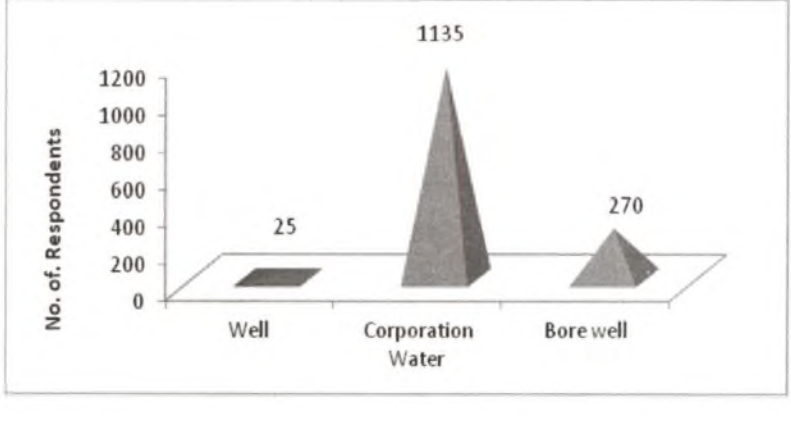
**Details of Economic Status:**

In the surveyed area, there were 244 thatched houses, 317 tiled houses and 869 concrete houses. Among 1430 respondents, 462 people live in their own houses and the remaining 968 live in rented houses and 417 respondents are in individual houses and the remaining 1013 people live in compounds/ apartments. Majority of the people live in concrete, rented, individual houses. Among 1430 respondents, 902 people come under the income group of less than Rs. 5000 and 361 people are under the income group Rs.5000-Rs.10000 and 167 people earn more than Rs.10, 000.

**Basic amenities:**

In Sellur, there were 1135 (79%) houses with water facilities, depend on corporation water. 1144 houses have television, 580 houses have radio, 264 houses have refrigerator. Nearly 972 people possess mobile phones. This statistical data depicts that television and mobile phones become basic amenities of the people.

**Drinking Water Facilities**



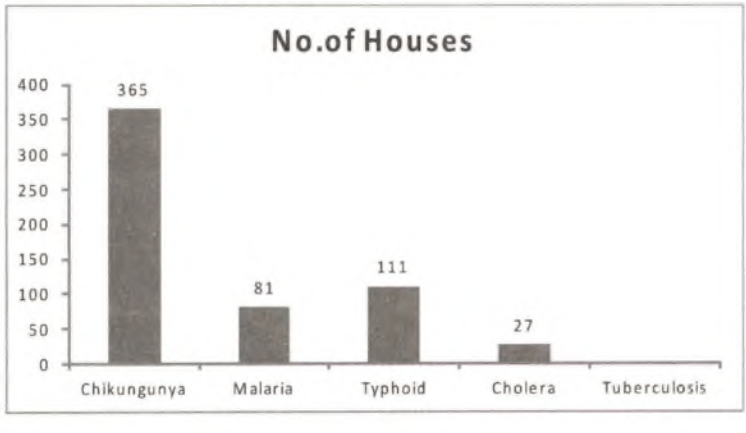
**Sanitation:**

In the selected area of Sellur, people in 408 (29%) houses use public toilets and 1001 (70%) houses have their own toilets and the remaining in open air (1 %). Most of the residents of Sellur use house toilets. 348 (24%) houses have open drainage facility and the remaining 1082 (76%) have closed drainage facilities. Though most of the houses have closed drainage, the area was unclean.

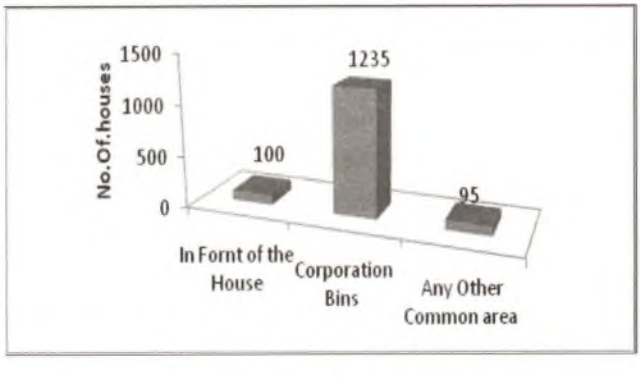
**Prevalence of Diseases:**

In the surveyed area, 365 people were affected by Chikungunya and 196 people had dental problems. The order of prevalence of diseases in Sellur was Chikungunya, Dental problems, Skin, Typhoid, Allergy, Malaria, Respiratory problems, Diarrhea, viral fever, Jaundice and tuberculosis.

**Disease Prevalence among Study Areas**




**Waste Disposal**



In the selected area of Sellur, 1235 houses dispose their solid wastes in corporation bins and there were nearly 20 bins in the 12 streets. 100 houses dispose their solid waste in front of the house and the remaining 95 dispose in any other common area.

**Improper disposal of Plastic bags in sewage canal at Sellur:**

Among the 1430 residents, 1204 agreed that the wastes are collected properly by corporation. Nearly 730 people in Sellur were unaware of plastics and the related environmental problems. Nearly 669 people were interested in taking hands on training in making value added paper products.

**Physico-Chemical analysis of drinking water at Sellur**

The water samples in Sellur showed alkalinity well within the BIS (Bureau of Indian standards) permissible limits (Table.1). Iron and Fluoride (permissible limit 1 – 1.5 ppm) was absent in all the samples collected from all the 13 streets. All samples were deficit in Calcium hardness and Total hardness. Phosphate was absent in all the samples except the sample from Ahimsapuram 4th street. All samples contained Chloride within the permissible limit (0 – 250 ppm). Residual chlorine was absent in all the samples (permissible limit 0.2– 0.5 ppm).

Nitrate was absent in all the samples except the sample from A1 b which has 5 ppm Nitrate (limit 0– 45 ppm). Nitrite was absent in all the samples except sample A-6 , A-7 & A-8 which have 0.5 ppm Nitrite(permissible limit 0 – 10 ppm). Nitrite and Nitrate are forms of the element Nitrogen. Nitrite is unstable and easily gets converted into nitrate which is seen in

sample A1-a containing 5 ppm. Ammonia was also absent in all the samples. Thus the physico-chemical parameters of all the water samples in Sellur showed parameters within the permissible limits of BIS.

**Table :1 Physico-Chemical Analysis of Drinking Water at Sellur**

| S.No | Estimation | A-1b | A-1c | A-2 | A-3 | A-4 | A-5 | A-6 | A-7 | A-8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total alkalinity (ppm) | 155 | 235 | 185 | 175 | 265 | 175 | 210 | 175 | 215 |
| 2 | pH | 8.0 | 8.0 | 7.0 | 7.0 | 7.0 | 8.0 | 8.0 | 8.0 | 7.0 |
| 3 | Iron (ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Calcium Hardness (ppm) | 70 | 55 | 65 | 60 | 70 | 55 | 60 | 55 | 60 |
| 5 | Total Hardness (ppm) | 118 | 170 | 116 | 136 | 194 | 154 | 184 | 168 | 140 |
| 6. | Phosphate (ppm) | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 |
| 7. | Fluoride (ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8. | Chloride (ppm) | 60 | 80 | 70 | 60 | 50 | 70 | 60 | 70 | 50 |
| 9. | Residual chlorine (ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. | Nitrate (ppm) | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. | Nitrite (ppm) | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 |
| 12. | Ammonium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Ref.:- [WHO, Indian Standard, National Primary Drinking Water Regulations

**Table-2: Determination of Coliform numbers By MPN Method**

| S.No | MPN index/ 100ml | EMB Agar | Gram stain |
|---|---|---|---|
| S1 | - | Metallic sheen was present | Gram negative |
| S2 | ≥2400 | Metallic sheen was present | Gram negative |
| S3 | - | | - |
| S4 | - | | - |
| S5 | 79 | Metallic sheen was present | Gram negative |
| S6 | 79 | Metallic sheen was present | Gram negative |
| S7 | - | | - |
| S8 | - | | - |
| S9 | - | | - |

Most Probable Number (MPN) index is an index of the number of coliform bacteria that, more probably occurs in 100ml of water sample. The MPN index is determined by comparing the pattern of positive results (the number of tubes showing growth at each dilution) with statistical tables. The tabulated value is reported as MPN per 100 ml of sample. (Table-2)

E.coli is a normal bacterial flora present in our intestine and it will be present in fecal matter and hence it is used as an indicator organism to detect the potability of water. E.coli was found to be present in the water samples collected from four streets. (1Ahimsapuram -1, Ahimsapuram -2, Ahimsapuram-5 and Ahimsapuram-6. Presence of E.coli indicated the possibility of the presence of other pathogens in the drinking water, further confirmed by IMVIC test. (Table-3).

**Table-3: IMViC Test**

| ORGANISM | INDOLE | METHYL RED | VOGES PROSKAUER | CITRATE TEST |
|---|---|---|---|---|
| Escherichia coli | + | + | - | - |
| Enterobacter aerogenes | - | - | + | + |

Fecal coliform and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems. (IS 10500: 2012 Indian standard of drinking water specification & WHO, 1996)

**Air mycoflora at the selected streets of Sellur, Madurai**

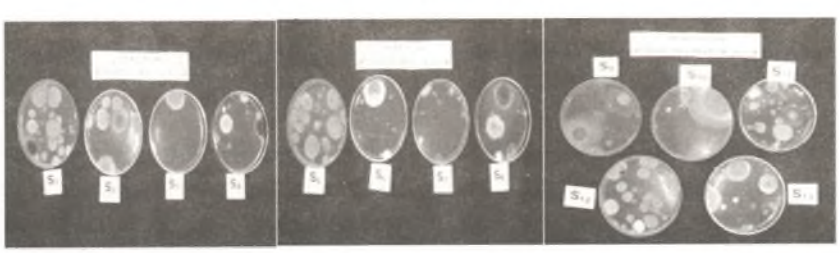
The outdoor air at Sellur was found to have normal fungal flora. Maximum numbers of fungal colonies were observed in the atmospheric air of church Street and Iyanarkovil Street. Minimum number of fungal colonies was observed in the atmosphere air of Ahimsapuram III and Manavalan IV street. Maximum number of colonies was obtained in the month of December than January (Table 4). Fungal spore types obtained were Aspergillus spp., Curvularia, Mucor, Penicillium etc., Aspergillus was found to be the dominant fungus.

**Table -4: Number of Fungal Colonies Found in the selected Streets of Sellur**

| Street | Total no of colonies | | *Aspergillus sp* | | *Alternaria sp* | | *Cladosporium sp.* | | *Curvularia sp.* | | *Mucor sp.* | | *Penicillium sp.* | | *Trichoderma sp.* | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan | Dec | Jan |
| Ahim I | 17 | 9 | 10 | 5 | - | - | 2 | 1 | 1 | - | 1 | - | - | - | - | - | 3 | 3 |
| II | 10 | 7 | 3 | 6 | - | - | 1 | - | - | - | - | - | - | - | - | - | 6 | 1 |
| III | 7 | 6 | 3 | 4 | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 2 |
| IV | 10 | 8 | 5 | 7 | - | - | - | - | - | - | 1 | - | - | - | - | - | 4 | 1 |
| V | 15 | 11 | 8 | 2 | - | - | - | 7 | - | - | - | - | - | - | - | 1 | 7 | 1 |
| VI | 11 | 5 | 6 | 1 | - | - | - | 3 | - | - | - | - | - | - | - | - | 5 | 1 |
| VII | 16 | 7 | 7 | 1 | - | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 7 | 1 |
| VIII | 14 | 11 | 7 | 8 | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - |
| Church St | 20 | 6 | 12 | 1 | - | 1 | - | 4 | - | - | - | - | - | - | - | - | 8 | - |
| Mana 3rd | 16 | 8 | 8 | 1 | - | 2 | 1 | 1 | - | - | - | - | - | - | - | 1 | 7 | 3 |
| 4th | 6 | 8 | 2 | 5 | - | - | - | 2 | - | - | - | - | - | - | - | - | 4 | 1 |
| Melatheru | 19 | 11 | 11 | 5 | - | - | - | 2 | - | - | - | - | - | - | - | - | 8 | 4 |
| IyanarKovil | 21 | 12 | 14 | 7 | - | - | - | 3 | - | - | - | - | - | - | - | - | 2 | 2 |

**Culture Plates showing fungal colonies isolated from air at Sellur**
(December, 2011)

(January, 2011)



**Followup Initiatives**

**a) Awareness programme on "Environment and Health"**

An awareness exhibition on 'Environment and Health' was organized for the school students at Manohara Middle School, Sellur. The exhibition highlighted on complete and balanced diet, nutritional deficiency diseases, food spoilage, infectious diseases, herbal medicines, environmental pollution, global warming, best hygienic practices, water conservation, waste management, recycling of wastes, mushroom cultivation, eco-friendly city etc., Various school children from Sellur and its surroundings about 3000 of them participated and benefited from it.

**b) Medical Camp**

As a follow up of the survey on Socio – environmental baseline survey, a free medical camp was organized for the public dwelling in Sellur at Manohara Middle School. Team of doctors rendered their service in the conduct of the camp. Free medicines and spectacles were distributed to the needy people. About 2000 residents were screened.

**c) Awareness On 3RS – REDUCE, REUSE and RECYCLE**

Plastics are petroleum products and non-biodegradable. Though these can be recycled, they give out dioxins during the process of burning. These dioxins destroy the environment and cause serious health problems such as cancer. Plastic products can persist in the landfill for centuries which was the major problem faced in the study area. Paper bags do not pollute the environment the way plastic bags do and their convenience and biodegradability was highlighted by student volunteers.

**d) Faculty Workshop on Environmental Research**

A faculty workshop on environmental research was conducted on 10th and 11th of March 2011. About 50 faculty from various disciplines participated. Eminent resource persons handled the various sessions on Eco criticism, Environmental Research, Environmental Audit and Environmental Health and Safety. The participants prepared research proposals for inter disciplinary environmental research.

**Challenges encountered and solutions attempted**

Improper disposal of polythene bags in sewage canals by local people
Awareness on proper methods of disposal and segregation and disposal of degradable and non-biodegradable wastes was given to the public.

Use of paper bags as an alternative to polythene bags was introduced and hands on training on paper bag making was given to the women using students under service learning programme. The above attempt was also a solution to reduce vector borne diseases by minimizing mosquito breeding in the sewage canal.

**Prevalence of dental problem**

A free medical camp was conducted in collaboration with selected local hospitals. Three dental surgeons were involved in the camp and more than 200 people with dental problems were benefitted. The analysis of water sample indicated absence of fluoride in drinking water which can lead to dental caries in the population. Attempts were made to improve the water quality by linking with the local Water Board authorities and Corporation officials.

**Fecal contamination of drinking water**

The issue was presented to the Corporation commissioner and City Health Officer for taking suitable action.

**Conclusion**

The community at Sellur were sensitized on various environmental and health problems that prevailed in that area. A few key environmental problems were identified through interdisciplinary projects carried out by students and faculty. Attempts were made to improve human health by conducting awareness programmes for school students, distribution of pamphlets and medical camp to the general public.

Students involved in the project learnt to apply their knowledge to promote quality life in the neighborhood. They learnt to prepare models, display and explain the requirements for healthy living during awareness programme. They interacted with the community and realized the importance of serving the community. They carried out environment related projects in the community and analyzed the problems prevailing in the selected community. More collaborative works with the local government departments for further clean up and work for improvement of water quality and sanitation facilities can be carried out

**Recommendations**

Most of the women in the area were house wives. Special campaigns may be organized and importance must be given in teaching them

entrepreneurial ventures that can be performed in households and which helps them to earn more. In Sellur, only few people are using public toilet and so posters demonstrating the infections in the public toilets can be displayed in the area. People in the surveyed area suffer from some type of diseases, the medical students can be given opportunity to find reason and diagnose it and more clinical studies can prove the cause and prognosis of the disease. Proper awareness regarding problems of plastic can be given and motivate people to use less of plastics and recycle them. Awareness to be created among people through rallies, posters regarding cleanliness and proper disposal of solid wastes.

**Acknowledgments**

This research was carried out under financial assistance from United Board for Christian Higher Education in Asia. The authors also acknowledge with gratitude the support given by Manohara Middle School, Aravind Eye hospital, Saravana Hospital and Madurai Corporation for their respective contribution towards the success of the project. Sincerely acknowledges the involvement of Mrs. P. Sakthieswari, Asst. Professor, Dept. of Botany & Microbiology , Mrs. S. Mahalakshmi, Asst. Professor, Dept. of Chemistry; Mrs. Padmaja, Asst. Professor, Dept. of Physics & former faculty in Geoinformatics Lab in carrying out the project / field study and the support received from the team of faculty & students of Science and Humanities Departments enrolled in Elective course Human Environment & Society and Service learning programmes, and faculty members from centre for environmental studies.

**References**

* *APHA.1989. Standards methods for the examination of water and waste water. 17th edition, American public health association, Washington, D.C*
* *James G. Cappuccino, 2009, Natalie Sherman, Microbiology-A Laboratory manual, Pearson publication, 7th edition, 323.*
* *Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes, 1996, Edited by Jamie Bartram and Richard Balance, Published on behalf of United Nations Environment Programme and the World Health Organization.*

## Educating The School Children

## Medical Camp

## Faculty Training

## Geo Map of Sellur area selected for community project

# ENVIRONMENT AND HEALTH AWARENESS THROUGH SERVICE LEARNING

8

Leonilla Menezes (Sr.M.Clare, A.C.) and Sharmila L. Mascarenhas
*St. Ann's College of Education, Mangaluru*

**Abstract**

*St. Ann's College of Education (Autonomous), Mangaluru, Karnataka organized "An Environment and Health Awareness Programme through Community Based Activities in rural areas by the In-service Teachers and School Students of Dakshina Kannada District, Karnataka, adopting Service-Learning Approach", with the financial assistance from United Board for Christian Higher Education in Asia. The goals or main objective of the programme was to provide an opportunity to 100 in-service teachersand 1000 students to identify and learn the needs related to the prevailing environmental and health conditions covering 25 urban and rural areas provide related awareness and find suitable solutions to these problems. The outcome of the project is discussed at length.*

**Keyword:** *Service Learning, Environment and Health problems, Environmental Education, Solid Waste Management*

## Introduction

Mangaluru is facing a challenge of managing increasing volumes of waste in an environmentally sustainable and fiscally responsible manner. If the waste is not managed scientifically, it results in serious damage to human health, economic losses and damage to eco system. Therefore there is a need to create awareness among the public about environmental problems. Schools have an important role in environmental education. Teachers have considerable influence over the children they teach. When teachers are well trained in environmental and health related skills and values, they will be the best personnel in leading their students to build a safe and healthy environment. Solid waste managerial skill and values are important and should be imbibed in every individual to promote a healthy environment. Hence, St. Ann's College of Education took a challenge to carry out a project on "An Environment and Health Awareness Programme through Community Based Activities in rural areas by the In-service Teachers and School Students of Dakshina Kannada District, Karnataka through Service-Learning Approach", focusing on Solid Waste Management.

In this project, the training received by the service teachers is transferred to their students. The students in turn move to the community along with the assistance of the NGO's to carry out the planned projects. The evaluation of the project is done through presentation of the projects and reflection on all the executed activities.

**General Objectives**

The main objective was to provide with an opportunity to the in-service teachers and school going students to identify and learn the needs related to the prevailing environmental and health related conditions of a particular rural area and to provide related awareness to the common people.

*Specific Objectives:*

* To enable the in-service teachers and school going students to acquire the knowledge of environment, its importance and significance to humankind.
* To equip the teachers with the necessary environmental and health related skills and values with focus on Solid Waste Management.
* To prepare action plans and to implement the same.
* To share and evaluate the project undertaken through group sessions.

**Methodology**

The activities of training the in service teachers were conducted in phases and were as follows:

**Phase I: Orientation to the Project:**

* Introduction to Environment and its natural processes.
* Orientation to environmental and health related skills and values.
* Selection of projects to develop environmental and health related skills and values.
* Preparation and presentation of an Action Plan based on environment and health.

A one day workshop on Environment and Health related skills and values with special focus on solid waste management for the promotion of health was organized with the above objectives for thirty in-service teachers of High Schools and P.U. Colleges. The participants (teachers) were guided to prepare action plans concerning solid waste and promotion of health. The teachers of each institution prepared and presented the Action Plans.

**Phase II: Implementation of Action Plan involved the following:**

* In the second phase,these trained teachers conducted a similar training programme for their colleagues and selected students of their respective institutions.
* An awareness programme was developed and implemented involving the school going children of that particular area through street plays on proper waste disposal, collection of waste plastics and management of the same and displays on health awareness.
* Input sessions were arranged through lectures and mimes on solid waste management, herbal garden/ medicinal plants. These activities were carried out in collaboration with School Development and Management Committee (SDMC), the Parent Teachers Association (PTA), local NGOs and environmental scientists.

Rural areas were identified and a survey of all the families of that area, such as details of prevalent diseases, waste management, eco friendly life styles and sanitation measures was carried out. Eleven schools of Dakshina Kannada District of Karnataka were involved in the project.

*The following activities were carried out as a part of the project by the schools:*

* Input sessions to the students of the school on environment and nature.
* Organization of rallies on various Environmental aspects.
* Awareness to the local people about the use of plastics and how it decreases fertility of soil, being non biodegradable. Distribution of pamphlets to the public by the students specially to parents and the people in the neighbourhood
* Maintaining an Eco garden.
* Preparation of burnt soil using method of Onken and Ossner. Burnt soil thus obtained was used as compost for plants for the Eco Garden.
* Educating the students on decentralizing garbage processing and understand the role of earthworms in increasing the fertility of the soil, students were trained to convert biodegradable waste into rich humus by using earthworms-Vermicomposting.
* Students were informed about rain water harvesting and need of it in present situation, where water can flow downwards and settle

down thus increasing ground water percentage. Conducted activities such as segregation of waste, slogan contest, skits, preparation of cloth carry bags, using dust bins to dispose waste, cartoon drawing and Slogan writing competitions, Yakshagana (a local folk art- Dance Drama) on unmanaged garbage

* Field trips to places of Environmental interest.
* Administration of an Attitude test towards Environment on the students on a three point scale before and after the implementation of the project.
* Administration of a questionnaire on the students to know their awareness on waste management.
* Converting the school campus into a plastic free campus and bring awareness in the students about management of solid waste.
* Skits were composed and enacted on the themes related to waste management, use of leaves and plastic articles. A Street play was conducted with posters and slogans.
* Preparation and use of paper and cloth bags.
* Preparation of Bio Water Heater using low cost material and demonstration of the method of preparation and use of the same to the public. The principle behind this is, when cow dung decomposes, it produces heat. This heat may be utilized to heat water which is a natural process and does not cause any pollution and hot water may be obtained throughout the year without any cost. The bio water heater works without electricity and the initial investment is very minimal.
* Collecting the waste papers and obtaining information about the process of preparing paper pulp.
* Preparation of fish manure using waste fish from the nearby sea shore. Training students to create awareness on solid waste management among their classmates and schoolmates using captions, slogans, pictorial charts, stories etc.
* An awareness programme titled 'Garbage to Garden' was conducted to the local fishermen, distributed handouts to neighbouring fishermen to keep their environment clean.

**Phase III: Presentation and Evaluation of the project:**

After the completion of the Project, the institutions were invited to St. Ann's College of Education for the presentation of the report and for the evaluation of the project activities. The implemented projects were presented and critical evaluation of the projects was done through group sessions and opinionaires. It was an enriching learning experience for all those involved who were present.

**Learning outcomes and Benefits to the Community**

*The in-service teachers,*

* Acquired the knowledge of environment, its importance and significance.
* Developed the necessary environmental and health related skills and values.
* Prepared action plans to undertake projects on Solid Waste Management.
* Worked towards students and community welfare in terms of promoting safe and healthy environment and in return train their students and members of the society where this project will be implemented using similar skills.
* Incorporated environmental and health related issues in their core school subjects' i.e, Literature, Science, Social Science etc.
* Accepted their responsibility of training the student community who are the future citizens in the protection of environment, and in turn the public, on various aspects of Health Awareness in general, and Waste Management in particular.
* Acquired skills of solid waste management as means for promotion of heath in the society and to create a clean physical environment for themselves and for others.
* Strengthened their skills of conducting and organizing projects that reach out to the community in the form of Service Learning and presenting project reports effectively.

About hundred in-service teachers and about one thousand students of High Schools and P.U. Colleges of 13 institutions of Udupi and MangaluruDisticts, Karnataka participated in this project. About 25 urban and rural areas also benefited from the various activities of this project.

**The School Students**

* Realized the need to identify, segregate and find measures to manage the solid waste and thus learnt the process of collection and dumping of waste.
* Developed skills and values of active participation, team spirit and commitment to the cause. Since it was an action based project personal involvement was noticed. Social values such as cooperation, unity, mutual sharing, enthusiasm, adjustment, belongingness etc. were cultivated and practiced. A sense of responsibility in minimizing the non bio-degradable waste was created in the students.

* Learnt the skills of carrying out projects successfully assigned to themby making it educational as well as service oriented

**The Public**

* Developed individual responsibility in managing the waste and concern towards environment and health. People recognized personal actions can either worsen or improve the Environmental quality.
* Came to a conclusion to reduce the use of materials that become a hazardous waste and its disposal and studied the methods employed in the management and disposal of suchwaste.
* Became aware of the ill effects caused due to garbage disposal.
* Recognized the need of organizing a compost bin in the garden and use it for the plants, thus reduce the use of fertilizers.
* Acknowledged to organize small community a meeting with the assistance of NGO'S to discuss positive approaches to manage waste, and thus work in collaboration with the local Municipal Corporation.
* Accepted to have community composting and motivate other people to join in the management of waste.

In general, the teachers, students and the public became more aware of the adverse effect of lack of proper management of waste on health and learnt the skills of managing domestic waste very constructively to prevent health hazards.

**Reflection of the Project Activity**

This project created awareness in the local public regarding the need to segregate waste at the source and its effective management. People also were enlightened to know the various measures of preparing wealth from waste. They learnt that personal and community health can be promoted through effective management of solid waste. The consequences of wrong ways of disposal of waste were highlighted.

The in-service teachers from the selected schools of the project effectively presented the project reports. During the presentation, they highlighted upon the actual activity carried out during the project. They mentioned that the students and the local community supported and co-operated with them in the successful completion of the project. It was

also reported that local people were more enthusiastic and motivated towards the protection of environment. Discussion and clarification on the projects were done after presentation.The process of the activities carried out by one school was an insight to the other participants.

**Conclusion**

The institution had a 'felt need' to conduct a programme on Health Awareness and Solid waste management. With the financial assistance from the United Board, this project was carried out. The organizers reflected upon the activity mentioning that, it was a need of the hour to conduct such an activity focusing on Solid waste management. The activities carried out as a part of the project was not mere institutional, but care was taken to see that it reached out to the community through the in service teachers and students. Thus, the meaning and significance of Service Learning is continued and sustained. Therefore, it was a rich and enlightening experience to the organizers, in service teachers, students and the local community.

**Acknowledgement**

We are extremely grateful to the United Board for granting funds towards the execution of the project. We thank all the in service teachers, the student community and the local public for their interest, constructive outlook and active participation towards the successful completion of the project.

**References**

* *Bharucha, Erach, Text Book of Environmental Studies, Universities Press India Pvt. Ltd., Hyderabad, 2005.*
* *Chandrabanu, T.K., Environmental Management, First Edition, Global Publications, New Delhi, 2010.*
* *Pruthi, R.K., Towards Sustainable Development, First Edition, Rajat Publications, New Delhi, 2005.*
* *Ranga Reddy, A. Ethics and Environment, First Edition, Mittal Publications, New Delhi, 2009.*
* *Ravindranath, Shailaja, Environmental Education: A Resource Book for Teacher Educators, National Council for Teacher Education, New Delhi, 2007.*
* *Sinha, B.K., Environment, Pollution and Health Hazards, APH Publishing Corporation, New Delhi, 2008*

## Awareness Campagin

## Awareness Campagin

## Waste Segregation

## Vermi Composting

# THE PUBLIC HEALTH IMPACT AND CARBON FOOTPRINT OF AN OPEN AIR CREMATORIUM

9

Priscilla A.S, Manorama Dhanaseeli and Joy Marjorie Annal.D,
*Lady Doak College, Madurai*

**Abstract**

*Traditional open air cremation of corpses is associated with gaseous emissions in the form of CO2, CO, etc., that are associated with global warming and climate change. In Madurai, Thathaneri is a congested and heavily populated residential area (Ganesapuram) with a biggest cremation ground in Madurai and very near to Vaigai river. An interdisciplinary study was undertaken in and around this cremation ground.*

*A questionnaire based socio-environmental and health baseline survey was undertaken at Ganesapuram, Thathaneri. Study area was geo-mapped using ArcGIS and reference map was created with different data such as, settlements, green cover and energy consumption. Water, soil, and air quality around the cremation area were analyzed for physical, chemical and microbiological factors. Based on the analysis health and environmental awareness campaigns were conducted to benefit the community living in that area. Our study indicates lowering of air quality and increased incidence of respiratory disorders among the residents of the area. The findings of the present pioneer study at Thathaneri have been reported to Madurai City Corporation and Public Health Officer for necessary action. Awareness campaign was also conducted as a follow up.*

**Key words:** *Carbon footprint, cremation, heavy metals, air quality*

## Introduction

India's open air cremation adds ashes and leaves a carbon footprint. According to United Nations estimation 10 million people die in India every year and about 84% of India's populations being Hindus, majority of them are cremated. The ritual produces half a million tons of ash and also releases 8 million tons of greenhouse gases or carbon dioxide. About 50-60 million trees, covering 1,500-2,000 sq. km of forest land, are cut every year to burn the dead in India (Narain, 2016). Madurai is renowned the world over, for its temples. Thathaneri is a congested and

heavily populated residential area (Ganesapuram) with a biggest cremation ground in Madurai. Burning of corpse near the residential area causes health effects which seeks attention of many environmentalists.

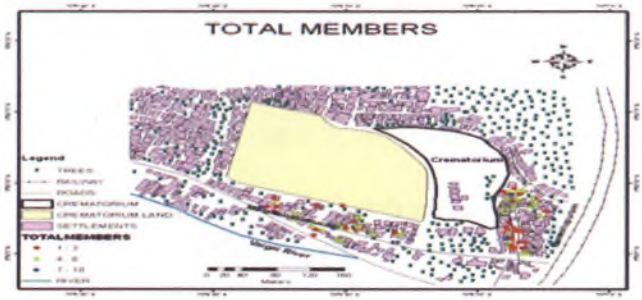
**Methodology**

1. Geomapping of Thathaneri and Ganesapuram using GIS: The Google Earth image is used as a base map. The raster images were geo-referencing and vectorization using ArcGIS 9.0. The layers were linked with the created spatial and non – spatial database.
2. Socio Environmental Baseline Survey : GIS based study on socio-economic status using tools such as ARC GIS, ARC MAP, ARC CATALOG, ARC TOOLBOX, RASTER, VECTOR. Data collection: Questionnaire based survey on economic status, settlements, occupation, annual income sanitation, health problems, energy usage, number of electrical appliances, electricity consumption etc. was undertaken and data was compiled.
3. Collection of secondary data from the crematorium office: Data on number cremations carried over a period, and other details were collected.
4. Study on Air Quality:
   * Assessment of air quality with special reference to CO2 & CO: NDIR (Non Dispersive Infra Red) absorption method was used for measuring the carbon di-oxide (Measurement range 0 ppm to 4000 ppm).
   * Carbon monoxide was analyzed using carbon monoxide analyzer (Measurement range 0 ppm to 1000 ppm).
   * Lung capacity was measured using Peak flow meter ( Normal Reference values of Peak Expiratory Rate – EU Scale for Men – 480 to 580 L/Min; Women – 380 to 420 L/Min, Age 15 to 85 yrs) (Miller, 2004)
5. Study on prevalence of Respiratory problems: A Survey was conducted to find out the health problem (350 respondents) of the people residing at Ganesapuram, Thathaneri using a questionnaire.
6. Study on concentration of heavy metal in and around Crematorium: Soil samples were analyzed for the presence of heavy metals (lead, chromium & mercury) using Atomic Absorption spectrophotometry. Survey was done to analyze the symptoms of heavy metal toxicity.

## Results & Discussion

### Geo Map of Study Area


### SOCIO Environmental Baseline Survey

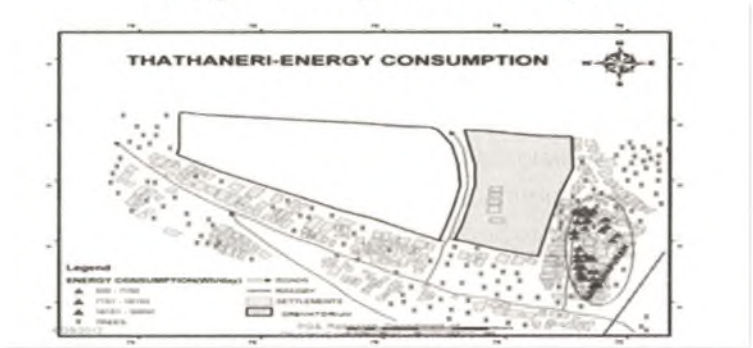



Majority of the residents belong to Hindu religion. Lack of basic amenities was prevalently seen among the residents of Ganesapuram. 90% of the people work as daily wagers. Women work as domestic helpers. Some of the children are also working as labourers to financially support their family. Houses are very small, even without doors. Many houses are in a damaged condition, so they live in a constant fear that it may fall at any time. Lack of proper drainage system and toilet facilities leads to various health problems. People are unaware of the consequences of CO2 emission from crematorium. Due to the unclosed drainages, the ditch water is stagnant before the houses which may cause various health problems.

### GIS based study on electricity consumption in Ganesapuram Area

The details about number of electrical appliances and the electricity consumption in Ganesapuram area were analyzed. The data for number of settlements, electrical energy supply were collected using GPS receiver. This mapping will clearly show the settlements, population density and total energy consumption in Ganesapuram area.

**Energy Consumption in Ganesapuram**




In the geomaps, trees are indicated as point data, roads, railway line, streets are indicated as line feature and settlements, crematorium, crematorium lands are indicated as point feature. Red point in the geomap indicates that 600- 7390 watts/day, pink approximately indicates that 7–16 kwatts/ day and blue approximately indicates that 16-34 kwatts/day consumed by the people in Ganesapuram area.

**Secondary Data Collected from the Crematorium Office**

**Table-1: Number of Cremations**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Cremations | 360 | 478 | 498 | 521 | 545 | 460 | 415 | 434 | 347 | 356 | 375 | 434 |

**Table 2: Calculation of CO2 released per year based on Cremations / Year**

| Year | No. of cremations | Fire wood used (Kg) | Kg of $CO_2$ released / kg of wood | Kerosene used / cremation (L) | Kg of $CO_2$ released / L of kerosene |
|---|---|---|---|---|---|
| 2010 | 5232 | 3,13,920 | 5,96,448 | 2,616 | 6,540 |
| 2011 | 4054 | 2,43,240 | 4,62,156 | 2,027 | 5,067.5 |

*1Kg of wood releases 1.9 kg of CO2*

*1 L of kerosene releases 2.5Kg of CO2*

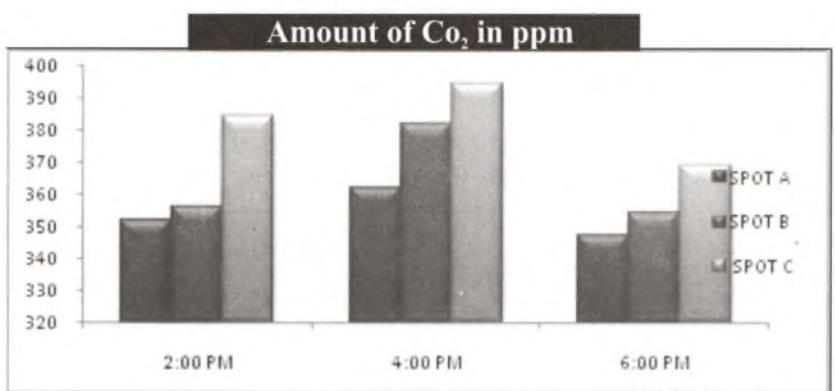
*Total amount of CO2 released from the cremation ground / yr = 535 tonnes (approx.)*

The secondary data obtained from the crematorium indicated that on an average the number of cremations done per year ranges from 4000-5000. About 5-20 cremations were found to be performed each day taking about 5-6 hours for complete burning of one carcass using fire wood (60kg), cow dung cake ( approx. 100 cakes) and kerosene (½ L). The left over ash is disposed by landfilling posing other environmental problems. The total amount of CO2 released from the cremation ground per year was calculated to be 535 tonnes approximately.

**4. Study on Air Quality**

Assessment of Air Quality with special reference to CO2:
Air quality in and around Thathaneri crematorium was assessed through measuring carbon dioxide emission during cremation and from the vehicles that pass through the bridge which is about half a kilometer away from the crematorium at different time intervals (2:00pm, 4:00pm and 6:00pm) over a period of a month. Cremation is done all through the day and night at Thathaneri crematorium. Ganesapuram is a highly populated area close to the crematorium and it often receives the contaminated air from the crematorium grounds due to cremation of carcasses.

**Carbon Dioxide Level in the bride and at Ganesapuram**




* Spot A – Far away from the crematorium only vehicular emission

Spot B – Little bit near to the crematorium with both vehicular and crematorium emission

Spot C – End of the bridge near to the crematorium

**Table-3 : $CO_2$ Level in ppm at Ganesapuram**

| Area | 2:00 PM | 4:00 PM | 6:00 PM | 8:00 PM |
|---|---|---|---|---|
| 1 | 393 | 389 | 416 | 454 |
| 2 | 392 | 404 | 403 | 435 |
| 3 | 390 | 437 | 469 | 450 |

*Area 1 – Entrance of Ganesapuram (far away from crematorium)

Area 2 – Middle of Ganesapuram (parallel to crematorium)

Area 3 – Terminal of Ganesapuram (diagonal to crematorium)

The range of carbon dioxide on bridge and Ganeshapuram was found to be between 340 -390ppm and 390 – 469ppm respectively. The level of carbon dioxide emission was very high at 4:00 pm on the bridge which might be due to more number of vehicles passing the bridge during that time. Carbon dioxide level was very high after 4:00 pm at Ganeshapuram. This could be due to more number of cremations that take place during that time.

Carbon Monoxide (CO) Level at Ganesapuram and Thathaneri

**Table-4: Average Carbon Monoxide levels in Bridge at different timings**

| Thathaneri Bridge | Maximum (4.00pm) In ppm | Minimum (2.00pm) in ppm | Ganeshapuram | Maximum (6.00 pm) in ppm | Minimum (2.00 pm) in ppm |
|---|---|---|---|---|---|
| SPOT A | 352 | 85 | Area 1 | 316 | 68 |
| SPOT B | 323 | 110 | Area 2 | 328 | 106 |
| SPOT C | 366 | 93 | Area 3 | 371 | 98 |

The level of carbon monoxide is higher at 6.00 pm. Maximum carbon monoxide level was found to be between 365 – 375 ppm, which can induce serious headaches and drowsiness. Carbon monoxide emission was found to be high at 4:00pm on the bridge whereas at 6:00pm in Ganesapuram which could be due to heavy transport and burning of carcasses.

At the time of cremation the air quality was analysed and it showed that carbon dioxide emission was 2280ppm and carbon monoxide emission was 249ppm.

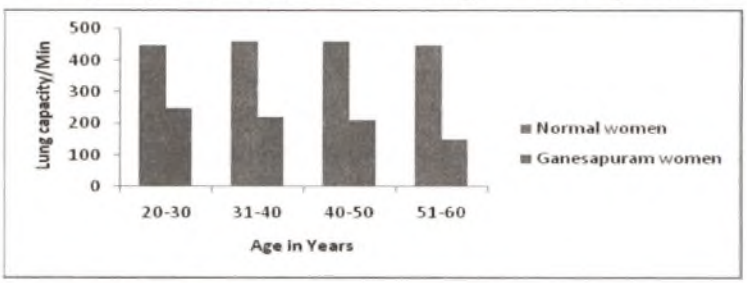
**Table-5: Lung Capacity of Cremation Assistant**

| Age | Years of Experience | Lung capacity L/Min |
|---|---|---|
| 36 | 20 | 275 |
| 58 | 40 | 215 |

The lung capacity of the crematorium assistants was found to be very poor which could be due to constant exposure to the high emission of carbon dioxide and carbon monoxide.

Similarly, the lung capacity of women between 40 and 60 years was very poor when compared to women between 20 and 40 years of age because most of the elderly women remain at home.

**Lung Capacity of women residing at Ganesapuram**




**Study on prevalence of Respiratory Problems**

A questionnaire was used to investigate the prevalence of respiratory problems in people residing at Ganesapuram near Thathaneri crematorium (350 respondents). Survey results revealed that children (0-10 yrs) and elders (above 60) were highly affected. 56% of respondents were hospitalized during a period of 5 yrs, out of which 33% of people were treated for Asthma, 12% of them were treated for wheezing. Nearly 23% of the people reported that they cannot sleep due to shortness of breath (Table:6). Based on the survey report, it was concluded that, people living in Ganesapuram are most affected y respiratory problems.

**Respiratory tract problems prevailing at Ganesapuram**

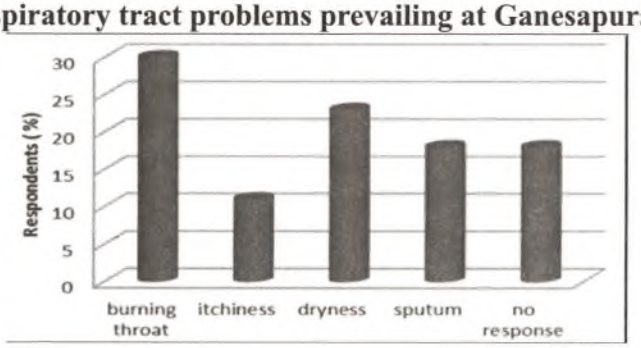


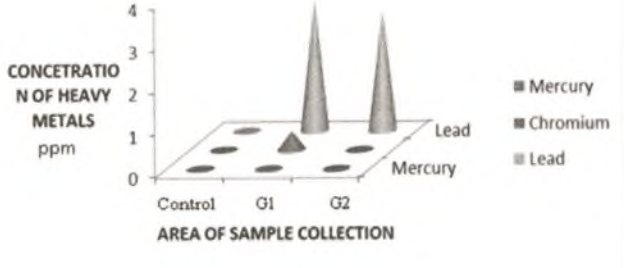
**Table-6: Survey details on respiratory health problems**

| S.No | Health Problem | Percentage of Occurrence |
|---|---|---|
| 1 | People hospitalized for the past 5 years | 56 |
| 2 | Treatment for Asthma | 33 |
| 3 | Shortness of breath | 23 |
| 4 | Cough | 43 |
| 5 | Smothering in chest | 7 |
| 6 | Wheezing | 12 |
| 7 | Chest tightness during night | 4 |

**Study on concentration of heavy metal in and around Crematorium:**

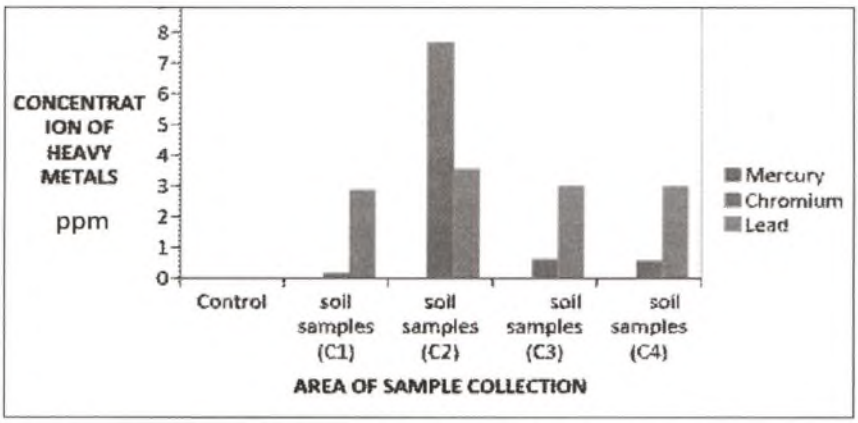
Crematories have been identified as sources of various environmental pollutants like dioxins, heavy metals like mercury as they are released during incineration of corpses. Studies and scientific information concerning their potential health risks to humans is very limited. Present study was undertaken to assess the level of heavy metals in soil of the open air crematory in Thathaneri, Madurai and the neighbouring densely populated Ganesapuram settlement, who are completely exposed to its effects. Lead levels were found to be high even further away from crematorium at a distance of ten metres. Mercury and chromium values were found to be comparatively less than the standards as proposed by Environmental Protection Agency India (EPAI)

**Concentration of Heavy Mentals in Ganesapuram area in soil samples**



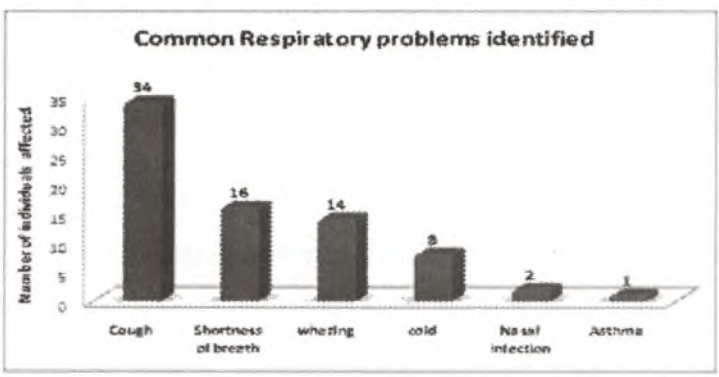

*G1 Within the radius of 10 meters; G2 – Within the radius of 20 meters

**Concentration of heavy metals in Thathaneri Crematorium Area**




*Within the radius of: C1 – 5meters; C2 – 10 meters; C3 – 15 meters; C4 – 20 meters

Survey results revealed burning throat, frequent headaches, insomnia, muscular tremors, wheezing, cough and skin itching which are the common symptoms of toxicity due to heavy metals.




**Educational Environmental Initiatives**

A carbon footprint is a measure of the impact our activities on the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day life through burning fossil fuels for electricity, heating, transportation etc. As every individual has the responsibility to maintain the sustainability of our environment, it becomes essential to sensitize the younger generation on current environmental issue 'the climate change and its impact and the ways to reduce one's carbon foot print'.

An **'Awareness Exhibition'** was organized in the college premises by the Centre for Environmental Studies, Lady Doak College, and Madurai, on 13th & 14th December 2011. Exhibition focused on Carbon foot printing, Global warming, causes and impacts of climate change. Book marks with 'Tips to reduce the carbon foot print' were distributed to all the students and the faculty. Feedback from the students was overwhelming and they showed keen interest in knowing about carbon foot printing and its management.

**Conclusion**

Impact and Implications:

The pioneer study on 'Carbon foot printing at Thathaneri' was a real time experience for students & faculty involved in a community affected by smoke from a crematorium and they learnt to apply their knowledge to promote quality life in the neighborhood. It helped the students to **internalize the concept of carbon foot printing and suggest measures to reduce carbon footprint**. They learnt to interact with the community and realize the importance of serving the community. Initiated to do carbon foot printing related projects and take an attempt to bring changes by suggesting solutions societal problems.

**Recommendations**

People of Ganesapuram are not aware of the ill effects of crematorium smoke because of which there is an urgent need to create awareness among the public. Smoke from cremations could be avoided by using dry woods for burning. Increasing vegetation by planting more number of trees around cremation ground which could serve as sink of all kind of emissions. Government has to take initiative to evolve strategies for safer methods of cremation by using electrical furnaces to improve the health status of the people at Ganesapuram. Recently the non functioning electric crematorium in Thathaneri has been made functional but still open air cremation goes on because it needs an attitudinal change among Madurai residents to completely avoid going for open air cremation which needs more awareness.

A detailed clinical study on the present health state of people in that area and potential ecological responses in the study area is worth doing as a follow up. Such study should carefully investigate the anthropogenic causal factors which have induced the current situation. A proper intervention to mitigate the health problems and protect the people can

only be designed based on these investigations.

As a follow-up of the project Ecological foot print of Lady Doak Community and fine Particulate matter present in Gorripalayam, Mattuthavani and Periyar Bus Stand were carried out.

**Acknowledgements**

This research was carried out with financial assistance from **United Board for Christian Higher Education in Asia.** The authors also remember with gratitude the support given by **Madurai Corporation** for obtaining data and analysis. Acknowledgements are due to the faculty guides, **Ms. C. Usha,** Assistant Professor in Dept. of Zoology; **Mrs. Padmaja & Mrs. Arockia Shyamala**, Asst. Professors in Dept. of Physics and team of students of Science and Humanities Departments enrolled for Environmental Awareness Programme, Departmental Service Learning Programmes and Undergraduate student projects, Lady Doak College, Madurai- 625 002, Tamil Nadu, India.

**References**

* *Jayant Sathaye, Doug Barnes, 1998, Urban household energy use in India: efficiency and policy implications, Manzoor Alam, Institute of Energy and Environmental studies, Hyderabad.*
* *Martin R. Miller, 2004, Peak expiratory flow meter scale changes: implications for patients and health professionals, The Airway Journal 2(2):80.*
* *Michael N. Derners, 2002, Fundamentals of Geographic Information system, II edition, New Mexico State University, John Wiley & Sons Publications, New York,*
* *Mitchell, A. [1999] The ESRI Guide to GIS Analysis. Volume 7: Geographic Patterns & Relationships, Redlands, California.*
* *Narain,2016,India's burning issue with emissions from Hindu funeral pyres www.cnn.com/2011/09/12/world/asia/india-funeral-pyres-emissions/*
* *Reindl J. 2009, Mercury emissions from crematoria. Presented at the 9th International Conference on Mercury as a Global Pollutant, June 7–12, Guiyang, China.*
* *Bernhardsen, Tor, 2002, Geographic Information systems An Introduction – III Edition, John Wiley & Sons Publications, New York.*

Open Air Crematorium at Thathaneri

Awareness Exhibition on Carbon Foot Printing

# SOLID WASTE MANAGEMENT BY SALESIAN COLLEGE, SILIGURI CAMPUS

10

Samar Thapa and Sandeep Sundas
*Salesian College, Sonada, Darjilling*

**Abstract**

*Solid waste and its handling is a burning problem of any urban area especially in developing countries. The principle effects include the degradation of land, ground water contamination and obnoxious smell. This paper discusses about the Solid Waste Management and the efforts made by Salesian College, Siliguri Campus in this respect to deal with the open dumping ground of the Siliguri Municipal Corporation.*

**Key words:** *Solid Waste Management, pollution, awareness programme*

## Introduction

The change in the physical and chemical quality of environment has undergone dramatic changes in the world. Even the world community is thinking seriously about it and the environmental concern is global. The condition of the environment and the changes that are taking place because of the anthropogenic activities are quite the same everywhere, irrespective of the country or state we belong to.

Solid wastes are generally all the discarded or useless wastes arising from human and animal activities that are in solid in nature. They are of three broad categories, Municipal waste, Industrial waste and Hazardous waste. Municipal Solid Waste (MSW) contains food wastes (animal, fruit or vegetable residues), rubbish (combustible and noncombustible solid waste including paper, plastics, textiles, rubber, and leather wood), and demolition and construction wastes [1, Peavy et al, 1985].

Salesian college, Siliguri campus is located at the Don Bosco Road, Jyoti Nagar, in the district of Jalpaiguri. It shares a common boundary with the solid waste dumping ground of the Siliguri Municipal Corporation (SMC). In this paper the solid waste management project (SWMP) 2010 – 2011 funded by the United Board is discussed as a model project to show how Christian Higher Education Institutions could possibly promote social concern and civic responsibility through environmental action and activism in academic community.

**The Problem**

The Siliguri campus of Salesian College shares a boundary on its west, with the dumping area of Siliguri, an up growing town in North Bengal. This has resulted in the visual pollution and spread of obnoxious smell in the vicinity [Figure 1]. On the other hand, the government has also granted permission to several schools in the vicinity. This has resulted in the deterioration in the health standards of the children and of the locals nearby.

**The Objective**

As a leading educational institution in the region, Salesian College Siliguri made a proposal with the United Board for a project with a goal to create awareness among the college students and through them among the other student population surrounding the college neighborhood about the bio-degradable and non-biodegradable substances of the daily use in Kitchen and at home along with their possible segregation and treatment.

**The Effort**

Keeping in mind the 'Corporate Social Responsibility' as the institution of higher learning and also the victims of the above, Salesian College, Siliguri Campus, seeing the immediate need, conducted an awareness programme to the eighty plus college students and parents through 'Parent Teacher Student Association" forum to educate them about the management of solid waste.

**The Practice**

The following were the follow up of academically sound best practices that were carried in the institution during the years 2010 – 2015.

a) Guest Lectures – Several interactive sessions of guest lecture were conducted, the prominent being

* Mr. Rohin D'Souza, MSW, Director of Darjeeling based Non-Governmental Organization named "PRERNA", delivered a guest lecture on the need of managing the waste at home, in the public and the role of every individual towards the disposal of the same in the places like we co-habit with.

* Fr. (Dr.) Robert Athickal, SJ, Taru Mitra, Patna presented a guest lecture in Salesian College Sonada Campus on the above.

b) Power Point Presentation Competition – Every year the college organizes college week packed with cultural, literary & sports events and one of the events being the power point competition. In the following year of the project, the students of different clubs

were asked to prepare the PPTs on 'Solid Waste Management' in order to imbibe and inculcate the concept, need and technical knowhow of the matter.

c) New Set of Janitors – The College has procured four janitors made in Germany with the brand name Sulos to facilitate the disposal of bio-degradable and non-biodegradable wastes [Figure 2].

d) Water Testing – The College in collaboration with the Department of Microbiology, University of North Bengal, conducted analysis for bacteriological quality and with the Department of Chemistry, University of North Bengal for its chemical analysis of water from open bore wells of the vicinity of the Siliguri Municipal Waste Dumping site. As per the report on four water samples collected on February 22, 2011, all were unsafe for drinking purpose with a total coli form count as high as 1800 and faecal coli form as high as 350 per 100 ml (Acceptable level for drinking water < 1 coli form/ 100 ml) of the samples [Annexure I]. The pH was also low of 6.04 (acceptable level: 6.5 – 8.5) at 22°C [Annexure II]. Water is considered to be acidic, soft and corrosive when the pH < 6.5 and have a potential for containing elevated levels of toxic metals like iron, manganese, copper, lead and zinc [2].

e) Filling & leveling of low lands – The Principal, Salesian College, Siliguri vide his letter dated 21/ 02/ 2014 authorized M/s Subrata Poddar, Contractor (Siliguri Municipal Corporation) Conservancy, Siliguri to fill up, dump materials (solid) in the low lying lands of the college compound [Figure 3] [Annexure III].

**The Outcome – Impact**

A Cr. P.C. u/s 133 Misc. Petition Case No. 746/ 2012 dated 16/10/2012 was filed before the Sub Divisional Magistrate, Jalpaiguri by Smt Champaswari Roy against the Mayor, Siliguri Municipal Corporation in this respect, alleging the change in the nature and character of land without permission and thereby causing loses and damage to life and property in the nearby [Annexure IV]. The applicant also prayed for an issuance of an order to restrain the opposite party from dumping garbage in the area for reducing of public nuisance. The shifting of the Municipal dumping ground is the next enterprise that the college will be instrumental and is contemplating along this line already.

**Conclusion and Lessons Learnt**

Salesian College Siliguri Campus took up the project titled, "Prevention of Health Hazards Due to Water & Air Pollution in Jyoti Nagar" in the year 2012 - 13 as a follow up to the above project on the pollution caused

by the garbage ground near Jyoti Nagar and areas adjacent to the College which falls under the jurisdiction of Siliguri Municipal Corporation (SMC) wards No. 38, 39 & 41. The sample survey and practical field study report shows that the low Oxygen, high carbon and ammonia content in the air reported various health hazards, pulmonary, respiratory, and bronchial diseases. It is undoubtedly, a major cause of concern for the people of these localities. During the first phase, twenty members including faculty members, students and the locals were divided into 3 groups. These groups went for survey, sampling and the practical research in the area, SMC Ward No. 38, 39 and 40 the adjacent Paresh Nagar and BSF Road were sample wise surveyed by the members, conscientization meetings were held, face to face interviews were organized and the report was collected.

With all these activities the members and the locals felt the need for greater awareness and persisting with the demand for their rights. Frequent request to the officials through meetings and several dialogues were attempted [Annexure V]. Some solutions were proposed as a result and the local administration has come forward and constructed a wall around the site. The activists in the area have requested the administration to relocate the dumping ground and come out with a concrete action plan to restore a clean, healthy living condition so as to protect the present and future generations.

**Acknowledgments**

I would like to express my deep gratitude and thanks to Fr (Dr) George Thadathil, Principal, Salesian College for his motivation and direction in writing this paper and to the College Administration for providing me with the necessary data for the write-up.

**References**

*[1] Peavy Howard S., Rowe Donald R., Tchobanoglous George, "Environmental Engineering", McGraw-Hill Book Company, 1985, p.573.*

*[2] Source: Internet, http://www.water-research.net/index.php/ph*

**Figure 1: The Siliguri Municipal Dumping Ground at Jyoti Nagar, Siliguri**


**(I) The Solid Waste Dump,**

**(ii) The Dumping Ground**



**(iii) Tractor pulling solid waste bin for dumping**

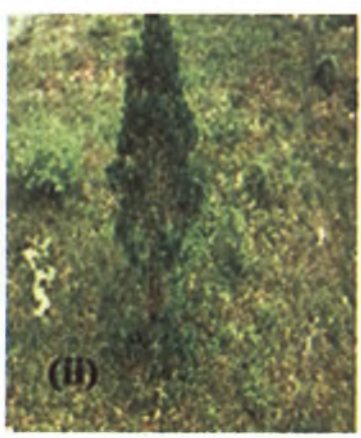
**(iv) a blocked drain**


**New Set of Janitors**

**(I) & (iii) leveled low lying area around college campus leveled after filling up with solid waste;**



**(ii) Plantation**



Annexure-I:

Bacteriological Quality of Water

**UNIVERSITY OF NORTH BENGAL**
**DEPARTMENT OF MICROBIOLOGY**
SILIGURI-734013, INDIA Phone : +91-353-2776319, Fax : +91-353-2699001

Ref.: Micro/2010-11/281 dated 7.3.2011

**REPORT ON ANALYSIS OF BACTERIOLOGICAL QUALITY OF WATER**

Reference : Letter No. TAG/084/011 dated 20.1.2011 of Fr. (Dr.) George Thadathil, Principal, Salesian College, Siliguri Campus, Siliguri-734 001

Sample : Four water samples collected by ourselves

Date of Collection: February 22, 2011

Results:

| Sample No. | Sample description / source | MPN / 100 ml sample | | Quality* (for drinking purpose) |
|---|---|---|---|---|
| | | Total coliform | Faecal coliform | |
| 1 | Hand pump fitted with a well in a house located ~30 m away from the dumping area near Salesian College, Siliguri | 920 | 2 | Unsafe (of low risk) |
| 2 | Hand pump fitted with a well in a house located ~15 m away from the dumping area near Salesian College, Siliguri | >1800 | 23 | Unsafe (of intermediate risk) |
| 3 | Well, located near Brothers' Hostel inside Salesian College campus (~100 m away from the dumping area) | >1800 | 350 | Unsafe (of high risk) |
| 4 | Hand pump, located near Staff Room inside Salesian College campus (~200 m away from dumping area) | 920 | 350 | Unsafe (of high risk) |

* As per W.H.O. Guidelines for Drinking Water Quality (1997).

Note: Since all the four samples contain <2000 MPN of faecal coliforms per 100 ml, the sources are safe for recreational purposes.

Countersigned

Dr P.K. Sarkar
Professor & Head
Microbiology Department
North Bengal University

Sarita Kumari

Ms Sarita Kumari
Lecturer
Lecturer
Dept. of Micro Biology

Annexure-II:

Chemical Analysis of Water


# UNIVERSITY OF NORTH BENGAL

HEAD OF THE DEPARTMENT
DEPARTMENT OF CHEMISTRY

P.O. NORTH BENGAL UNIVERSITY,
Raja Rammohunpur, Dist. Darjeeling,
West Bengal, India, PIN - 734013.
Tel.: 0353 - 2776 381
Fax: 0353 - 2699 001


Ref. No. .....

03.05.2011

Dated .....20.....

The following tests were conducted with a water sample collected and supplied by the Principal Salesian College, Siliguri Campus – 734001, as per the letter from the Principal of the College mentioned above, Ref. No. TAG/083/011, dated 20.01.2011 as well as note to the Head, Department of Chemistry, North Bengal University by Honorable Vice-Chancellor, North Bengal University, Ref. No. F-117/VC-II/148, dated 02.02.2011:

| | Sample-1 | Sample – 2 | Sample-3 | Sample-4 |
|---|---|---|---|---|
| pH | 6.85 (22°C) | 6.15(22°C) | * | 6.04 (22°C) |
| Conductance | 0.04 mS $cm^{-1}$ (24°C) | 0.50 mS $cm^{-1}$ (24°C) | * | 0.10 mS $cm^{-1}$ (24°C) |
| Iron | 0.30 ppm | 1.80 ppm | * | 0.65 ppm |
| Zinc | BDL | 0.11 ppm | * | BDL |
| Total hardness | | | | |
| Calcium | 4.810 mg/Lit | 19.328 mg/Lit | 11.575 mg/Lit | 4.48 mg/Lit |
| Magnesium | 2.917 mg/Lit | 4.885 mg/lit | 3.010 mg/Lit | BDL |

N.B.: * =Test not performed due to sample misplacing. BDL= below detection limit.
Results may very depending on the time lag between sample collection and tests performed.

The tests mentioned above were conducted without any pre-treatment of the sample. On the basis of the results it may be inferred that the result are within permissible limits.

A. K. PANDA
HEAD
Head,
DEPARTMENT OF CHEMISTRY
UNIVERSITY OF NORTH BENGAL

B. SINHA
Analysis done by
Assistant Professor
Department of Chemistry
University of North Bengal

Annexure-III:

Filling & Leveling of low lands with solid waste

SALESIAN COLLEGE
UGC Certified College of Excellence &
Accredited by NAAC with A Grade
Affiliated to University of North Bengal
P Box - 73, Don Bosco Road,
SILIGURI - 734001, West Bengal
Email : principal@salesiancollege.net
Phone 0353-2545622 / 27

21/02/2014

To
M/s Subrata Poddar
Contractor (SMC) Conservancy
Siliguri

**Sub: Work Order for Filling & Levelling with Dumping Ground in the Low Lands of Salesian College Compound.**

**Ref: Quotation and bilateral discussion.**

Dear Sir,

With reference to the above and in receipt of your submitted quotation for the aforesaid work, the undersigned, hereby authorize you to fill up, dump materials (solid) in the low lying lands of the College compound

Therefore you are directed to start the filling operation at your earliest taking adequate safety for the smooth completion of the task delivered upon.

Thanking you,

Yours truly,

Fr. (Dr.) George Thadathil
Principal
THE PRINCIPAL
SALESIAN COLLEGE
SILIGURI - 734001

Revival Poddar
21/02/2014

Annexure - IV:

CRPC Case filed against the dumping ground

W.B FORM NO. 3890
H.C.:– CRIMINAL FORM NO. (M) 20
Dist.:– JALPAIGURI

ORDER SHEET FOR
MAGISTRATE RECORDS
= In the court of:=

REFERENCE :- Ptn/R. No. 746/12, dt. 16.10.12. u/s. 133 Cr.P.C.

THE SUB- DIVISIONAL MAGISTRATE (S) JALPAIGURI

THE EXECUTIVE MAGISTRATE (S), JALPAIGURI
Misc. case No
.....20

NAME OF THE PETITIONER/STATE= VERSUS-NAME OF THE O/P/ACCD-PERSON

Champaswari Roy. W/O. D.N. Roy.
Of Baikuntha Pally, W.No. 41,Sevok Road.
P . 9hktinagar, Jalpaiguri.

Vs

The Mayor,
Siliguri Municipal Corporation.
P.S. Siliguri, Darjeeling.

| Sl. No. | Date | Order with Signature of the Magistrate | Note of action taken on order & date |
|---|---|---|---|
| | 16.10.12. | Perused the petition U/S 133 Cr.P.C. Ld. Advocate for the Petitioner appeared. Heard him. He submits that Siliguri Municipal Corporation used the scheduled below land as "Dumping Ground" without obtaining any legal permission from the pollution Board or any necessary permission from any competent authority . This damping ground causes herm the petitioner along with the adjacent people and as well the children of nearby schools, and they are facing serious difficulties. On several requests, the OP men refused to clear the "Damping Ground" . Ld. Advocate argues for draw up a proceeding U/S 133 Cr.P.C. against the Ops.<br>Considered.<br>The commissioner , SMC to look into the matter with an intention to this court.<br>To 27.11.12.<br>Dictated & corrected<br>By me<br>Executive Magistrate<br>Jalpaiguri | |

Process No. 1207 Dated. 17/10/12

Copy forwarded for information and necessary action to :-

1. The Commissioner , SMC

Executive Magistrate.
Jalpaiguri

Annexure - V:

Minutes of the Meeting held on 2nd Feb, 2014

To

.....

.....

.....

Feb 17, 2014.

Dear Sir/Madam,

Subject: Report of the meeting held at Conference Hall, Salesian College at 3.00 p.m. on Sunday, the 2nd February, 2014.

Pursuant to the meeting held on Sunday, Feb 2, 2014 at Salesian College, as advised, I sent here the minutes of the meeting along with Draft of a letter which you may use when you prepare your letter to be addressed to the Mayor, SMC with copy to the Minister of North Bengal Development Department, Government of West Bengal.

Kindly do the needful and keep two copies of letters ready duly signed by you in-order that one of our representatives can call on you to collect the same before Feb 20, 2014.

Thanking you

Yours faithfully

SD/-

Sujit Biswas

(The Convener of AAA)

**Minutes of the Deliberations at the meeting held at 3.00 p.m. on Sunday, Feb 2, 2014 at Salesian College.**

Members Present

1. Mr. S N Chatterjee
2. Sr. Pakumala Elizabeth
3. Fr George Thadathil
4. Sr. Baiju George
5. Mr. Bijon Chakraborty
6. Mr. Sujit Biswas

The persons present in the meeting introduced themselves to one another. Fr George opened the discussion by giving a background of the activities in relation to combating the Environmental Pollution arising from the Dumping Ground. He stated that institutions way back in 2009, voiced concern which helped initiate the organization which espoused the cause of the suffering humanity and the institutions plagued by the emission of polluting gases belched out by the Dumping Ground.

Mr Bijon Chakraborty dwelt on initiatives taken by people in different places to deal with environmental hazards. He emphasized the urgency of consolidating the action and reaching out to the people of different walks of life to make it an on-going and sustainable movement and added that the College had conducted survey on water which proved that the locality used contaminated water. Mr. Chatterjee observed that while core group with heads of institution and important personalities should be consolidated peoples belonging to different layers have got to be reached by multiplying the initiative of the members of the core group who will in the process of induction inspire confidence in others emphasizing the urgency of pursuing the cause seriously. He also suggested an action plan which after considerable deliberations by the members present was accepted unanimously.

The action plan is as under-

1. The heads of each institution shall address a letter to Mayor of Siliguri Municipal Corporation with a copy to the Minister of North Bengal Development, West Bengal, high lighting the menace of environmental pollution arising from the Dumping Ground demanding relocation of the same in accordance with decision taken by the Corporation, to Puttimari, at the earliest

   A draft for the same will be made available in order that the heads of the institutions can take this draft as a guide line for preparing the letter. The letter, thereafter, shall be collected by a representative of AAA in order that all these letters together can be handed over to the mayor and the minister on an appointed date by the members of the

core group.

2. The members of the core group shall find out from the mayor the plan of action the SMC proposes to take to alleviate the sufferings of the people and in what manner SMC proposes to implement its plan of action.
3. The members of the core group will in the mean time take the initiative through various methods to make the people not only of the area around to the Dumping Ground but also in general of the city of Siliguri at large the virulence of the situation emphasizing the point that with the advent of this year's monsoon the situation will go out of control.
4. Media both electronic and print should be activated so that in the meantime possibilities of action to be initiated by the sufferers may be highlighted in order to prevent deterioration of the law and order problem in the area.
5. Such other action as would be approved by the core committee in its meeting to be held after submission of the letters to the mayor and the minister.
6. The venue of the meeting of the core committee should rotate and that the next meeting would be Goodrike School provided the principal of the said institution approve of it. There being no other business the meeting ended with thanks to the principal of Salesian College for providing the premises for the meeting.

**Letter to Mayor**

To
The Mayor
Siliguri Municipal Corporation
West Bengal
Feb 21, 2014

Dear Madam,

Subject: **Environmental Pollution vis-à-vis the Dumping Ground**

We would like to tell you that on several occasions during the past three years, the seriousness of situation arising out of environmental pollution caused by the unauthorized Dumping Ground situated in ward no 42. Our institution located in its vicinity with our boys and girls and the members of teaching and non-teaching staff are being perilously exposed to the increasing pollution. The objections from Pollution Control Board, West Bengal regarding the Dumping Ground are known to you and the possibility of relocating it to Puttimari has been given as the way to its resolution.

Unless some positive action to alleviate our sufferings are taken and your action plan made known, we, in order to save ourselves, shall be compelled to take action as you would deem appropriate to restore to ourselves the right to a decent living as per provision Article 21 of the Constitution of India which the inaction of SMC consistently is to our detriment.

We shall look forward to your positive action as to reinstall in ourselves the faith in SMC.
Thanking you,
Yours Sincerely,

Copy to the Minister of North Bengal Development Department

# PLASTIC BAG MENACE – ASSESSMENT, SENSITISATION AND MITIGATION

11

Mary Pearl Ravikumar and Betsy Selvakumar
*Women's Christian College, Chennai.*

**Abstract**

*Chennai, a coastal metropolitan city has been reeling under tonnes of plastic waste. Plastic bags if not disposed properly find their way into all possible areas such as oceans, play grounds, window sill of offices, soil, intestines of animals, etc., posing a great threat. Its impact is felt in all the three spheres of the environment-physical, biological and social. The upsurge of news reports on the innumerable health hazards of plastics provided an impetus and the sense of urgency to create awareness first to our own 'oikos' which we are assured will have a ripple effect in the community at large in the long run. An attempt is made to sensitize the target groups of the project, the College Community and two local communities towards the risk and health hazards of plastic carry bags, with the specific aim of bringing in a change in the existing convenience- over-concern-for-the-environment attitude. The success of the project is the definite change in attitude and behavior of the college and local community participants as revealed by the post campaign survey.*

**Key Words:** *Plastic carry-bag menace, sensitization, awareness, white Pollution, Mitigation*

## Introduction

Chennai city with a total area of 216Km2, a population of 5.9 million, vast land cover and reserve forests in the heart of the city is an ecologically sensitive area. In spite of Chennai Corporation's (civic body in charge of Chennai city) best efforts to beautify the metropolis, it is still reeling under tonnes of plastic waste. The all-pervasive and indiscriminate use of plastic has contributed to "white pollution", thus tilting the ecological balance and posing health hazards. Plastics pose health risks and of principal concern are endocrine-disrupting properties, as triggered for example by bisphenol A and di-(2-ethylhexyl) phthalate (DEHP) (Halden, 2010).

The quantum of plastic waste is ever increasing forming a significant portion of the total municipal solid waste (MSW). It is estimated that approximately 10 thousand tons per day (TPD) of plastic waste is generated i.e. 9 percent of MSW in India. 8 to 15 percent of garbage by weight is plastic. But in terms of volume, the amount of plastic would be 20 to 30 percent as it occupies a lot of space (Joseph, 2009). The plastics waste constitutes two major categories of plastics-Thermoplastics and Thermoset plastics. Thermoplastics (recyclable plastics), constitute 80 percent of total post-consumer plastics waste generated in India and includes the plastic carry bags. Plastic shopping bags are usually made of Low Density Poly Ethylene (LDPE) with a resin identification code 4. (Parivesh, Central Plastic Control Board)

The magnitude of the plastic carry bag menace that is challenging the city can be understood by a simple calculation – if on an average one carry bag is disposed per individual per day, then the city of Chennai will be generating 6 million bags per day. Plastic carry bags are used for containing and transporting goods such as foods, powders, ice, chemicals, drinking water and waste. Plastic bags if not disposed properly find their way into all possible areas – oceans, play grounds, window sill of offices, soil, intestines of animals, etc.- posing a threat. Its impact is felt in all the three spheres of the environment- physical, biological and social.

**Impact on the physical environment**

* Being light, they are easily blown by the wind and strewn all over the place, spoiling the beauty of the city. Plastic debris causes aesthetic problems, and it also presents a hazard to maritime activities including fishing and tourism (Moore 2008; Gregory 2009).
* They go airborne after they are discarded—getting caught in fences, trees and even the throats of birds. Sometimes they pose a threat to motorcyclists.
* Their disposal in the soil could arrest the recharging of ground water aquifers.
* Recycled /coloured plastic bags may contain certain chemicals, which can leach into the ground and contaminate soil and sub-soil water.
* They alter the texture of the top soil and obstruct penetration of light, thus preventing growth of soil biota.

* Accumulated plastics choke municipal sewer lines and storm water drains, and clog the bar-screens of sewage treatment plants, often resulting in water logging and flooding.
* Garbage mixed with plastics interferes in waste processing facilities and may also cause problems in landfill operations.
* Unscientific disposal of plastic waste also causes landslides in the hills.

**Impact on Biological Environment:**

* Lying in the garbage, plastic bags find their way into gut of cattle causing internal injury, intestinal blockage, starvation and asphyxiation of the animals.
* Postmortem of dead turtles have revealed that they had been choked by the plastic carry bags.
* Garbage containing plastics when burnt emit gases causing air pollution.

**Impact on Social Environment:**

Because of the non-biodegradable and impervious nature of plastics, they create vector breeding grounds, leading to the outbreak of epidemics. Discarded plastic carry bags lying in water bodies became the ecological equivalents of natural, tree hole environment, attracting the forest-dwelling species of Aedes mosquitoes, leading to an outbreak of Chikungunya fever in the city in the recent past (As of August 2006, nearly 100,000 people were infected in Tamil Nadu).

Recent studies have shown that Aedes mosquito needs only 2ml of water for breeding and human beings are providing for such breeding grounds by littering the city with plastic carry bags. The upsurge of news reports on the innumerable health hazards of plastics to humans is alarming. All these have developed a deep concern and the urge to create awareness first to our own 'oikos' which we are assured will have a ripple effect in the community at large in the long run.

**Methodology**

**Target Groups:** The target groups of the project were the College Community and two local communities –Thideer Nagar and Thousand lights. The project was carried out in four Phases.

**1. Pre Project Survey:** A pre project survey tool – a bilingual Questionnaire - was designed & prepared in consultation with CARE EARTH (NGO). Questionnaires were distributed through various departments for staff and students; and through various offices for

administrative staff, collected after 2 or 3 days, giving sufficient time for them to fill it. 20 percent of questionnaires could not be traced.

Majority of local community participants were not available during week days. Pre project survey was therefore, conducted during weekends to the convenience of both students and the participants. In spite of all the hurdles door-to-door survey was a huge success.

**Data analysis**

80 percent of the college community responded by giving in the filled in questionnaire. The data of the College community and the local communities was pooled and analysed using MS Office Tools. There was 100 percent response in the local communities that we surveyed, as it was a door to door survey.

**Sensitization**

**Awareness Campaign:** Sensitization programme titled **'White Pollution - an awareness campaign'** was planned for the different target groups as shown below.

**Table 1: Schedule for White Pollution - an awareness campaign**

| S.No. | Date | Place | Participants |
|---|---|---|---|
| 1 | 11.07.11 | College Auditorium | Aided Section Students |
| 2 | 20.07.11 | Mc. Dougall Nursery School, Thousand Lights | Students of the School, Parents and people of the neighbourhood |
| 3 | 25.07.11 | Thideer Nagar Community, Greames Road. | 100 Families from the community |
| 4 | 21.09.11 | College Auditorium | Self Financed Section Students |

**Training the support staff:** 22 support staff involved in collection of wastes on campus will be trained.

**Post Campaign Survey**

A Post Campaign survey tool - a bilingual Questionnaire - was designed & prepared. The Data collected from the College Community and the local communities were analysed.

**Mitigation**

**Collection bins:** (1.6x1.6x2 feet) exclusively for plastics were made.

**Disintegration bins:** (3x3x3feet) were made.

**Paper bags:** Enviro Club members will make paper bags and donate to the canteen for packing food items.

## Results and Discussion

### Table 1: Results of the Pre Project Survey

| S.No. | Details | Percentage of Respondents | |
|---|---|---|---|
| | | College Community | Local community |
| 1. | No. of plastic carry bags used per day | | |
| | • 1-5 | 94.4 | 78.3 |
| | • 5-10 | Negligible | 14.1 |
| | • 10-15 | Negligible | 07.1 |
| 2. | Use Plastic Carry bags for | | |
| | • Wrap tiffin boxes | 51.4 | 27.8 |
| | • Carry goods | Negligible | 62.6 |
| 3. | Get Plastic carry bags from | | |
| | • Super markets | 36.2 | 11.1 |
| | • Stationery | 32.5 | 47.5 |
| | • Textile | 23.1 | 17.7 |
| | • Eateries | Negligible | 23.2 |
| 4. | Preference factor for use of PLASTIC Carry bags | | |
| | • Easy availability | 36,4 | 43.9 |
| | • Use & discard | 30.8 | 29.3 |
| | • Convenient to carry | 17.9 | 21.2 |
| | • Light Weight | 10.6 | 03.5 |
| 5. | How do they discard Plastic Carry Bags | | |
| | • Throw in dustbin | 72.9 | 83.3 |
| | • Reuse | 18.6 | 04.0 |
| | • Segregate and give to an agency | 06.5 | 11.1 |
| 6. | Feeling when they see Plastic carry bags strewn around | | |
| | • Desire to reduce its use | 57.2 | 32.3 |
| | • Saddened by the sight | 22.6 | 28.8 |
| | • Indifferent | 09.5 | 04.0 |
| | • Not bothered | 09.2 | 11.1 |
| 7. | Plastic Carry Bags are made of | | |
| | • Polyethylene | 71.7 | 17.6 |
| | • Poly urethane | - | - |
| | • PVC | - | - |
| | • Not sure | 20.2 | 73.2 |
| 8. | Nature of Plastic Carry Bags | | |
| | • Non degradable | 89.8 | 51.0 |
| | • Degradable | 04.7 | 40.4 |
| | • Biodegradable | 04.7 | 08.0 |
| 9. | Permissible thickness of Plastic Carry Bags | | |
| | • 20 microns | 49.4 | 18.2 |
| | • Less than 20 microns | 27.0 | 18.2 |
| | Do not know | Negligible | 55.5 |
| 10. | Physical effects of plastic carry bags | | |
| | • Choking Water ways | 76.2 | 31.8 |
| | • Spoiling the beauty of the city | Remaining | Remaining |
| | • Arrests recharge of ground water | | |
| | • All of the above | | |
| | • Any one of the above | | |
| 11. | Biological Effects | | |
| | • Consumed by grazing animals | | 45.5 |
| | • Chokes marine organisms | 75.7 | 27.3 |
| | • Causes air pollution | | |
| | • All of the above | | |
| 12. | Social Effects | | |
| | • Breeding site of Mosquitoes | 74.2 | 48.5 |
| | • Outbreak of epidemics | | 36.4 |
| | • Outbreak of Chikungunya | | |
| | • All of the above | | |
| 13. | Have you made a conscious effort to reduce plastic bag usage | | |
| | • Yes | 57.0 | 51.0 |
| | • No | 42.4 | 46.9 |
| 14. | Interested to learn more about ill effects of Plastic Carry Bags | | |
| | • Yes | 77.2 | 69.7 |

**Highlights of the pre project survey**

* Irrespective of the educational status and life styles of the respondents, plastic carry bags have become an integral part of everyday life of the college and local communities
* There is a difference in the use of plastic carry bags, the college community using it mainly to wrap tiffin boxes and the local community to carry goods.
* In the opinion of the college community, plastic carry bags are mostly acquired from supermarkets, while the local community gets a good number of them from eateries
* Knowledge regarding the composition of plastic carry bags, their permissible thickness, nature of degradation and their physical, biological and social effects was high in the college community.
* The attitude of being indifferent and not bothered to plastics being strewn around is high in the local community
* Members of both communities have expressed desire to know more about the ill effects of plastic carry bags.

**Sensitisation**

White Pollution: The awareness programme for the college community and the local communities included the following components. (Plate I: 2)

* Introduction of the theme White Pollution.
* At the campaign site there was a display of posters disseminating information about the menace of plastics. Plastic carry bags categorised according to thickness were on display. Ecofriendly alternatives for plastic carry bags such as cloth bags, paper bags, jute bags, banana fiber bags were also displayed.
* Depiction of the conflict between plastic carry bags and their ecofriendly alternatives through MIME.
* **Choreography** bringing out nature's win over the invasion of plastic carry bags.
* 'Screen R presentation' on the ill effects of plastics, giving the audience an awareness of the resin codes 1-7 imprinted on plastic containers.
* **'Villupattu'** – a traditional folk art used as a powerful medium for disseminating a social message.
* Taking a **Pledge** to avoid the use of plastics.

*"We WCCites solemnly pledge to make a conscious effort to reduce the use of plastic carry bags & adopt ecofriendly alternatives especially cloth bags to make the campus, community, city & country a cleaner & greener place to live in."*

**Training the Support Staff**

22 support staff who are involved in collection of wastes on campus, were trained on 15th July 2011 by Dr. Ranjit Daniels & Dr. Mary Pearl Ravikumar on segregation of plastics at source and transferring them to the disintegration bins. The ill effect of Plastics was brought home to the support staff in the local language through a power point presentation. Methods for reuse of the existing plastics were also taught.

**Post Campaign Survey**

**Table 2: Results of the Post Campaign Survey**

| S.No. | Details | Percentage of Respondents | |
|---|---|---|---|
| | | College Community | Local Community |
| 1. | What did you learn from the Campaign<br>• Plastic Bags are Harmful<br>• Alternatives to plastic bags are available<br>• Both | 97.1 | 94.2 |
| 2. | Steps which will be taken to reduce plastic bag usage<br>• Take cloth bag while shopping<br>• Carry vessels while going to an eatery | 77.4<br>8.2 | 84.4<br>13.6 |
| 3. | Response if shopkeeper offers a plastic bag<br>• I will return it | 62 | 76 |
| 4. | After taking a decision to reduce Plastic carry bag usage how long will you abide by it<br>• Always | 72.0 | 80.5 |
| 5. | Difficulty they will face to carry out the decision<br>• Forget to take a bag<br>• Shopkeepers insist<br>• Easy to buy fish meat etc. in Plastic carry bags | 40.1<br>15.5<br>28.9 | 44.2<br>20.8<br>22.7 |
| 6. | Inform friends & relatives about ill effects of Plastic Carry Bags<br>• Yes | 68.3 | 92.9 |
| 7. | Which of the programs did you like<br>• Villu Pattu<br>• Mime | 39.0<br>23.7 | 65.0<br>16.2 |
| 8. | Rating of the program<br>• Interesting<br>• Informative | 32.5<br>39.4 | 39.6<br>52.0 |

**Highlights of the post campaign survey**

* The respondents learnt that plastic carry bags are harmful and alternatives to plastic carry bags are available
* The spontaneous response of the audience was that they will take a cloth bag and refuse the plastic bag when offered.
* They also said that they'll always abide by this decision of saying NO to plastics.

**Mitigation**

**a. Collection bins:** Five Bins (1.6x1.6x2 feet) are placed in strategic positions on campus exclusively for plastics. The support staffs empty the contents of the collection bins into disintegration bins once a week. Number of disposable water bottles was reduced from 540 as on 12th August 2011 to 320 on 30th September 2011.

**b. Disintegration Bins:** Five Disintegration bins (3x3x3feet) were made and are placed on the terrace of one of the academic blocks. The plastics mainly PET bottles collected on campus are now placed in disintegration bins for Photo degradation.

**c. Paper Bags**

As a first step towards reduction of Plastic carry bags on campus, students of the Enviro- Club made 1000 paper bags and donated them to the college canteen for packing food items.

**Conclusion**

**a. Overall Impact of the project**

Involvement of the students of the department of Advanced Zoology & Biotechnology in the project has enhanced their teaching learning experience. Students made a conscious effort to carry ecofriendly alternatives after the initiation of the project. Data collection in the local communities gave an opportunity for our students to observe their living conditions, simple life style, friendly attitude, and interact with them in a positive way. This helped students learn lessons for life. The 'White Pollution' awareness program was entirely planned and executed by the students. This enabled them to showcase their talents, for many of them it was a discovery of their innate potential, which gave them a sense of confidence, satisfaction and accomplishment. It has paved way for an overall reduction of the use of plastics on campus and the residence of the participants as revealed by the reduction in the numbers of plastics in the collection bins. There is a definite change in attitude and behavior of the college and local community participants as revealed by the post campaign survey. Almost 90% of the respondents have said that they have made an attitudinal/behavioural change after the White Pollution Campaign. Some of the responses are given below.

**b. Attitudinal Response:**

'I arrived at a desire not to use plastic carry bags'

'I changed my attitude & decided never to use plastics'

'There is definitely some change in my attitude. When I happen to use plastic carry bags I feel guilty'

'After the campaign, I have decided to completely let go of plastic bags and move on to other alternatives like Jute bags & cloth bags'

**c. Behavioural Response:**

'I have started using my own bags while shopping and refuse plastic bags offered by the

shopkeeper'

'I started making sure that I would carry a cloth bag while going to shop'

'I started saying 'no' to plastic when shopkeepers give the stuff in a plastic cover. I

prefer to take my own bag while I go for shopping'

'I have stopped using plastic bags, I have also started passing this info to others also'

'I refuse plastic bags at stores and insist on putting things into my handbag rather than encourage the use of plastic'

**References**


1. *Gregory M. R. 2009 Environmental implications of plastic debris in marine settings entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Phil. Trans. R. Soc. B 364, 2013–2025.*
2. *Halden RU. 2010 Plastics and health risks. Annu Rev Public Health. 2010; 31:179-94.*
3. *Joseph, Kurien 2009 http://timesofindia.indiatimes.com/city/-chennai/40-tonnes-plastic-waste-each-day/articleshow/4908375.cms*
4. *Moore CJ 2008 Synthetic polymers in the marine environment: a rapidly increasing, long-term threat. Environ. Res 108, 131–139*
5. *Parivesh, Central Plastic Control Board. ()*

White Pollution - Awareness Campaign

Collection & Disintegration Bin

White Pollution - Street Campaign

White Pollution - Awareness Campaign




White Pollution - School Campaign

# PART- 3:

# NOVEL INITIATIVES

# MICRO-HYDEL PROJECT OF SALESIAN COLLEGE, DARJEELING

12

Samar Thapa
*Salestian College, Sonada*

**Abstract**

*Falling water as a source of energy is known from ancient times. Vertical fall of water may be natural due to topographical features or may be artificially prepared by dams. If the available water energy is utilized properly, then the efficiency of hydropower plant would be more or even double than the conventional thermal power plant with an added benefit of being environmentally clean. This paper discusses the 25 kVA micro hydel power plant of Salesian College, Sonada.*

## Introduction

The major use of energy in a building includes lighting, heating, cooling, ventilation, running of various gadgets, etc. Energy is also consumed for the production of materials used to construct the building which is known as embodied energy and also the energy required to transport the construction materials from where they are produced to where they are used. With the increase in the global concern for energy and environmental issues, the building sector holds a tremendous potential for energy savings [1, Thapa et al, 2015, p. 112].

India's building energy consumption increased by about 13.6 % during the years 2004 – 2010. It was 196.04 million tons of oil equivalents in 2011. In commercial buildings, about 42 – 58 % of the total energy is used for air-conditioning, heaters, fans and air coolers. India has an ever-widening energy supply-demand gap. The national level energy deficit in the year 2014 – 2015 is 5.1 %, while the regional grids are facing a shortage of 3.1 – 17.4 %. This has increased significantly in the last few years [2, Indraganti et al, 2015, p. 284].

## About the institution

Salesian College is a minority educational institution of the Catholic Church, run by Salesians of Don Bosco, Kolkata Province and affiliated to the University of North Bengal. The college was established in Shillong, in 1933 and was shifted to its present location in Sonada, Darjeeling in 1938. In 1935, it received affiliation to the Calcutta

University for I.A., and in 1948 for B.A. course in English History and Latin followed by Economics in 1950. In 1962 its affiliation was transferred from Calcutta University as one of the founding colleges of University of North Bengal, where today nearly 1500 students do their undergraduate courses in various streams of humanities, commerce and science and over 5000 students in various IGNOU courses. The college presently houses two campuses, the first in the sub Himalayan region of Sonada, Darjeeling (established in 1938) and second, an extension in the plains of North Bengal at Siliguri in 2009.

The Sonada Campus of the college where is the concentration of this paper is situated in latitude 27° 57' 10" N and longitude 88° 17' 6" E and at an altitude of 1950 meters above mean sea level (MSL).

**The Problem**

The region faces cold and cloudy type of climate with pleasant and overcast summers and cold winters. The average yearly temperature variation is less than the daily variations. Daily variation range is more pronounced in winters (about 15° C), than that during the summers or monsoons (about 5° C) [3, Thapa, 2011, p. 124]. In the earlier study, simulations were done to find yearly energy (electrical) requirement for heating the college building, considering the various factors like occupancy, periodic fluctuation of heat flow through the wall considering the sol-air temperature, etc [3, Thapa, 2011, p. 133]. The annual number of degree days with a base temperature of 18°C is 1150 and amounts to 90,000 kWh of electrical units for heating [4, Thapa et al, 2010, p. 15-16]. In addition energy may be required for other utilities like computers, lightings, geysers, etc which are unaccounted and all the electrical energy is supplied from the grid, i.e. West Bengal State Electricity Distribution Corporation Limited.

The contribution of hydroelectric power to the installed capacity in India was around 40 % for the first 25 years after independence. However subsequently, it has gradually declined to 25.2 % in 2005. Though India's reserves of coal are high, there are a number of problems, like high ash content, limited amount of coking coal, etc as a result as over 24 million tones are imported annually. Whereas, if the available water energy from source is utilized properly, then the efficiency of hydropower plant would be more or even double than the conventional thermal power plant, not to say the added benefits of no GHG emission.

## Hydro Energy in Darjeeling

Falling water as a source of energy is well known. The golden age of hydropower was the first half of twentieth century, before the oil took over. Dams and hydropower stations were built in Europe and North America. Vertical flow (which is known as head) of water may be natural due to topographical features or can be artificially achieved by means of dams. Being in the sub Himalayan region with natural gradient for water flow, Darjeeling district also offers good potential for hydel energy, with the country's first hydro electric power station with 2 x 65 kW capacity at Sidrabong, near Darjeeling town, commissioned on 10th November 1897 by Sir C.C. Stevens, the then Acting Lieutenant Governor of Bengal. The table 1 below gives the various hydro power stations with their installed capacity in the Darjeeling District.

**Table : Various Hydel Power Station in Darjeeling and their installed capacity**

| *S.No.* | *Name of the Hydro Power Station in Darjeeling District* | *Installed Capacity* | |
|---|---|---|---|
| 1 | Teesta Low Dam III hydel | | 132 MW |
| 2 | Teesta Low Dam IV hydel | | 160 MW |
| 3 | Teesta canal fall hydel project | 3 x 3 x 7.3 | = 67.3 MW |
| 4 | Rammam Hydel Project | 4 x 12.73 | = 31 MW |
| 5 | Jaldhaka Hydel Project (Stage I & II) | (3 x 9) & (2 x 4) | = 35 MW |
| 6 | Rinchington Hydel Project | (2 x 2) | = 4 MW |
| 7 | Mungpoo Kalikhola Hydel Project | (1 x 3) | = 3 MW |
| 8 | Sidrabong Hydel Project | (3 x 110 kW) | = 0.6 MW |
| 9 | Fazi Hydel Project | (2 x 0.4 + 1 x 0.448 + 1 x 1110) kW = 2.448 MW | |

## The Practice: 25 kVA Hydel Power Station at Salesian College, Sonada Campus

The campus being situated in the natural hilly terrain, with an adjacent Batasiya Khola (a small rivulet), a tributary of Balson provide potential for harnessing the exergy drop of the river water. About 30 LPS (liters per second) flow is available during the dry months of March and April. For the rest of the month over 100 LPS flow is available [5]. The catchment area is about 3 Km2. The important part was no trees of any kind were cut for this project as natural inclination provides the head.

**The Weir:** The weir is about 6 m wide with rock bed. The height of the weir is 1 m. The top width of the weir is 1 m and bottom width 1.5 m. The weir is of concrete gravity type. The stream at weir site is about 5 m wide with rock bed. The bottom level of the weir is at an altitude of 2030

MSL. A fore bay tank of 2 m x 2m x 2m is about 3 m from the weir. A 30 cm pipe is used for connecting the fore bay tank and the weir. A surge shaft of length 4 m is at a distance of about 100 m from the weir site.

The bed slope of the stream at weir site is about 1.5. Due to the construction of the weir at 1.5 m height no submergence of useful land occurred. The water storage in the weir is about 7.5 m length, 5 m width and average depth of 0.75 m.

**The Penstock:** Penstock starts from a height of about 30 cm from the bottom level of the tank. The length of the penstock is about 900 m. The inside diameter is about 150 mm. Weld able high density G.I. pipe with wall thickness of 15 mm and pressure withstanding capacity of 10 kg/ cm2 is used.

**The Power House:** The powerhouse is located near the road gutter at an altitude 1950 MSL, 27° 10' N, 88° 20'E. The inner dimension of the power house is 4m x 3m x 3m. Aluminum sheet roof over brick walls with necessary doors and windows on 2 sides are present.

**Tail Race:** The water coming out of the turbine is sent to the road gutter through a PVC pipe. The water flows back to the stream through the gutter and the nearby culvert.

**Flow Details:** About 100 LPS flow is available during the months of May to December. During January and February a flow of about 50 LPS is available. During March and April the flow is about 30 LPS.

**Head:** The bottom level of the weir is 2030 m above MSL. The height of the weir is 1.5 m. So the top level of the reservoir is 2031.5 m above MSL. Hence the head available is (2031.5 – 1950) = 81.5 m. The penstock length is about 900 m with an internal diameter of 150 mm. The calculated head loss is 24.5 m and a minor loss is 2.5 m. Hence the net head available is (81.5–24.5–2.5) m = 54.5m.

**Power Potential:**

G = 9.81 m/ s2; H = 54.5 m; Q = 50 LPS (average); ρ (efficiency) = 0.75

Power in watts, PW=ρgHQ = 0.75 x 9.81 x 54.5 x 50 = 20049 W=20 KW (1)

**Installed Capacity:**

Horizontal shaft pump is used as Turbine synchronous generator. The ac generator has the following Power Rating – 25 kVA; potential – 415 volts, phase - 3□, no of revolution – 1500 rpm clockwise from drive, excitation – 25 V.

**Outcome:** Power Generation:
The generators work for about 10 months at full load at a load factor of about 70 %. The annual production of the power station is over 135 MWh (See Annexure I).

**Project Cost:** The capital cost of the project was over Rs 13.5 lacks INR (See Annexure II). The cost per kW (Rs 1363148/ 25 kW) is Rs 54526 per kW.

**Payback:** The entire power generated could not be used due to miss match between the supply and demand. Hence, pay back is calculated in terms of the electrical energy purchased from the grid prior to the installation, which was around Rs 18000/- per month or Rs 216000/- per year. Hence payback (capital cost/ yearly savings, i.e. Rs 1363148/ Rs 216000 per year) comes to be 6.31 years or 6 years 4 months which is feasible in such type of projects.

The energy obtained from the project is used in the college premises through the cables which are connected to the campus main switch. The distance between the powerhouse and the main switch board of the college is only 150 m. No grid connection is done at present.

**Legislation Aspect**

Permission for diversion of 0.075 hectares of forest land for laying of pipeline through the forest land was accorded vide letter no. 5-WBB012/2008-BHU dated May 21, 2008 of Deputy Conservator of Forest (Central), Ministry of Environment & Forests, Eastern Regional Office addressed to the Principal Secretary, Forest & Environment, Government of West Bengal with one of the condition that the legal status of the forest land shall remain unchanged. In fact, no trees of any kind were cut for this project. Also the fact verification team who visited the spot in the year 2015 endorsed the project for the same.

**Hydro- A Green Energy**

The average efficiency of coal based thermal power plants in India is 32.8%, way below the global standards in terms of efficiency. The study which was conducted by the Center for Science and Environment (CSE) claimed that average CO2 emission was 1.08 kg per kWh, i.e. 14 % higher than that of China [6]. So, in realm of the above, the micro hydel power plant in the Salesian College Sonada, not only provides economic benefits of saving electricity bill worth INR 216000/- per

year, but is also instrumental in saving the global carbon dioxide emissions by saving approximately 135000 kWh x 1.08 kg/ kWh = 145800 kg, i.e. 145.8 tonnes of CO2 annually, thus qualifying itself for carbon credits (CERs) under the Clean Development Mechanism (CDM) of Kyoto Protocol.

Furthermore, the project being in a hilly terrain with a low height weir on a perennial rivulet, the head available was natural and as there was no construction of dams or other reservoir of large impact, there was no submergence of any kind and also was without any deforestation.

**Conclusion - Lesson Learnt**

Hydropower is one of the most established renewable sources of energy for electricity generation. Energy in falling water is converted into mechanical and then electrical energy, with a prime mover being the hydraulic turbine. India is facing severe power shortage with load shedding and power cut being common in many states. Though, no environmental problems are seen in micro hydel projects as such, due to the mismatch between the supply and the demand, such isolated power plants often faces difficulty during operation. This problem can be overcome by either of the two methods, first effectively managing the load. In this process, the excess production during the high flow rate period can be used for alternate purpose, i.e. some other consumption other than the college requirements. Secondly, the problem can be solved effectively by grid connection which facilitates two way metering, i.e. during the time when the generation (supply) is more than the demand, the additional electricity can be sent to the grid while the same can be taken in from the grid during the period of higher demand than generation. However the need for syncronisation with the grid power arises as the amplitude and direction of ac change with time. Synchronization is the process of matching the speed and frequency of the generated electricity to that of the grid. There are five conditions that must be met before the synchronization process takes place. The generated electricity must have equal line voltage, frequency, phase sequence, phase angle and waveform to that of the system (grid) to which it is being synchronized [7]. Waveform and phase sequence are fixed by the generator and its connections to the network, while voltage, frequency and phase angle must be controlled each time a generator is connected to the grid which can be achieved by using automatic synchronizing relays. Also, the flexibility of the local electricity board to include such private players is required.

**Acknowledgements**

I would like to express my deep gratitude and thanks to Fr (Dr) George Thadathil, Principal, Salesian College for his motivation and direction in writing this paper.

***References***

*[1] Thapa Samar, Panda G, Energy Conservation in Buildings – a Review, International Journal of Energy Engineering, 2015, vol. 5, issue 4, p. 95 – 112, DOI: 10.5963/IJEE0504001*

*[2] Indraganti Madhavi, Ryozo Ooko, Rijal HB, Thermal comfort in offices in India: Behavioral adaptation and the effect of age and gender, Elsevier: Energy and Buildings, 2015, vol. 103, p. 284 - 295*

*[3] Thapa Samar, Comfort Zone Calculation & Climatic Condition for Typical Building located in Darjeeling Hills, Salesian Journal of Humanities and Social Science, 2011, vol. II, issue 2 p. 123 – 133*

*[4] Thapa Samar, Singh S.P., Mukhia Pravin, A major project on Solar Passive Heating for the proposed new campus at Salesian College, Sonada, 2010, School of Energy and Environmental Studies, Devi Ahilya University, Indore (Unpublished)*

*[5] Gupta Sandeep, Report on Hydrogeological Study for Ground Water at Salesian College, Sonada, 2011, (Unpublished)*

*[6] http://articles.economictimes.indiatimes.com/2015-021/news/59363102_1_plant-cse-national-thermal-power-corporation*

*[7] Source: Internet, en.wikipedia.org/wiki/synchronization*

**Annexure - I**

***Annual Power Generation***

| Sl. No | Month (no of days) | Flow volume LPS | Power rating at given flow rate (KW) | Calculation (power rating x 24 hours x no of days x lf) | Output in (KWh) |
|---|---|---|---|---|---|
| 1 | May - Dec (245) | 100 LPS | 25 KW | 25 x 24 x 245 x 0.7 | 102900 |
| 2 | Jan – Feb ( 59) | 50 LPS | 20 KW | 20 x 24 x 59 x 0.7 | 19824 |
| 3 | Mar – Apr (61) | 30 LPS | 12 KW | 12 x 24 x 61 x 0.7 | 12297 |
| | TOTAL PRODUCTION ANNUALLY | | | | 135021 kWh |

## Annexure - II

### Project Cost

| Sl.No | Specification | Details | Cost (INR) |
|---|---|---|---|
| 1 | Earth work in foundation (weir, fore bay, de silting tank) | (6 x 2.5 x 0.5)+(2 x 2 x 1) = 11.5 $m^3$ @ Rs 500/- per $m^3$ | 5750/- |
| 2 | RCC works including materials | | 113398/- |
| 3 | Penstock – GI pipe with 150 mm internal diameter | 950 m @ Rs 900/- per m | 855000/- |
| 4 | Penstock laying, alignment, excavation valve, surge shaft, etc | | 120000/- |
| 5 | Power House with brick wall and GI sheet | 12 m @ Rs 3000/- | 36000/- |
| 6 | Generator, Turbine & control system | | 125000/- |
| 7 | Tail race arrangement | | 10000/- |
| 8 | Erection & commissioning | | 25000/- |
| 9 | Power Evacuation Arrangement | | 10000/- |
| 10 | Design & consultancy | | 50000/- |
| 11 | Contingency | | 13000/- |
| | **NET COST** | | **Rs 13,63,148/-** |

**The Salesian College Power House showing the penstock**

**The Penstock, the turbine and the ac generator**

# A STUDY ON SUSTAINABLE RESOURCE MANAGEMENT AT LADY DOAK COLLEGE

13

Priyatharsini Rajendran, Akshaya Mu and Gunaseeli,R.
*Lady Doak College, Madurai*

**Abstract**

*The combined effects of population growth, consumption, overuse, wastage and misuse of resources has strained the capacity of the earth to sustain life. Hence awareness regarding the eco footprint is very important. Ecological foot-print analysis is an accounting tool that estimates the resource consumption and waste assimilation of a defined human population. An Eco footprint analysis was done in Lady Doak college campus to make the community aware of their resource utilization and to take necessary steps in reducing the same.*

*Carbon foot-print which is also similar to ecological foot printing, helps to analyze the amount of green house gas emission. Carbon neutrality occurs when energy and resources are used in a way that does not increase the net amount of carbon dioxide or other greenhouse gases (GHG) in the atmosphere over time. A study undertaken to assess the individual foot print of Lady Doak College Community members reveal that it is well below national average. The implications and outcome of this study is discussed proposing some steps for mitigation.*

**Keywords:** *Ecological footprint, Carbon footprint, GHG, Carbon dioxide, Carbon sink, Climate change*

## Introduction

Ecological foot-print analysis is the means of comparing consumption and life styles and checking this against nature's ability to provide for the consumption. Ecological foot-print analysis was initially developed by Rees and Wackernagel in 1990's [1]. For leading a basic life natural resources are vital. The users have to be cautious about the utilization of resources. Ecological footprint analysis compares human demands on nature with the biosphere's ability to regenerate resources. It represents the amount of biologically productive land and area necessary to supply the resources that a human population consumes and to assimilate the associated waste [2]. This analysis will create awareness of our consumption and the pressure exerted on the natural resources and when realized by individuals it alters their personal behavior.

The concept of Carbon foot-print originates from Ecological foot-print. Carbon foot-prints are more specific than Ecological foot-print since they measure direct emissions of gases that cause climate change. An individual's or nation's foot-print can be measured by undertaking a green house Gases emission assessment or by other calculative activities. The main influences of these foot-prints include population, ecological output and energy. Carbon foot-print means Carbon dioxide emissions. Carbon dioxide is released when carbon-based fuels are burnt. Almost all fuels are carbon-based, including Petrol, diesel, Gas, oil, coal and Jet fuels. Carbon dioxide is greenhouse gas-it traps the sun's heat and keeps the earth warm. But too much of carbon dioxide leads to climate change, known as global warming [3]. Other greenhouse gases such as Methane, also contribute to climate change. The most common way to reduce this ecological foot-print of humans is to "REDUCE, REUSE, RECYCLE". The mitigation of carbon foot-prints can be achieved through the development of alternative energy, such as solar or wind energy or restoration reduction of fossil fuels. Carbon foot-print analysis is often known as Carbon offsetting. The present work was done to sensitize the members of Lady Doak Community, that the footprint can be related to the carrying capacity concept, which facilitates the linkage of individual and collective life style to the global environment, and to make the environment carbon neutral by the year 2025 by focusing on the following objectives:

* To identify the resources that are utilized by the members of the LDC community
* To calculate the ecological footprint of Lady Doak College Community
* To calculate the green house gas emission at Lady Doak College campus as ton equivalents of Co2
* To create awareness on the need for the reduction of resources usage and green house gas emission
* To measure the progress towards sustainability by using ecological foot printing as a tool and mitigation strategies for carbon foot printing.

## Methodology

### Calculation of Ecological Footprint

The Ecological footprint analysis was done using a Ecological footprint Calculator (which was available online with minor modification). The questionnaire was designed so as to get data regarding the individual's consumption of energy, food, fuel, clothing and assimilation of waste. The questions were allotted scores as per the options **(Annexure I)**. LADY DOAK COLLEGE COMMUNITY is the target group which included 749 residents' students, 2860 non - resident's students, 206 teaching faculty, 87 non-teaching faculty and 31 housekeeping staff member. Questionnaire was distributed to all the members of Lady Doak College and the data collected was analyzed. Ecological footprint is calculated by dividing the grand total ecological footprint of the college community divided by 100 = _x_ global hectares (gha) [4].

### Calculation of Carbon foot printing:

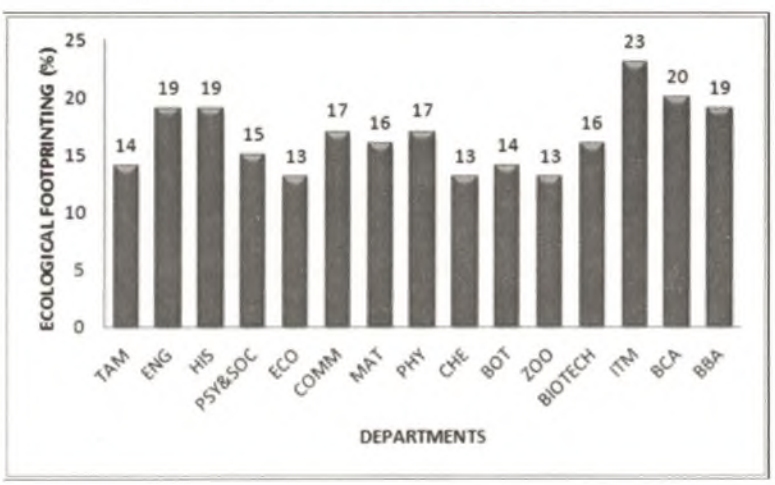
Carbon foot printing is calculated by GHG accounting which is based on the five different principles such as relevance, completeness, consistency, transparency and accuracy [5,6]. The organizational boundary in the college was set up within which the GHG accounting was done. The operational boundaries includes GHG emission sources and removals associated with operations which are categorized into scope1/direct emissions [7] , scope 2/ indirect emissions [8] and other Scope 3 indirect emissions. All the relevant emission sources and activities within the chosen inventory boundary are considered for accounting. GHG emissions by the vehicles are calculated using CA-CP Calculator based on fuel usage data. GHG emissions associated with purchased electricity are calculated using the following equation: GHG Emissions (Metric tons $CO_2e$) = Purchased Electricity (Kwh) × Grid Emission factor

## Result and Discussion

The personal Ecological Footprint of a person is calculated by considering all of the biological materials consumed, and the biological wastes generated, by that person in a given year. The ecological footprint is a resource management tool that measures, in terms of equivalent area (global hectares, gha) how much land and water a given population requires for its current way of life [9].The materials and wastes demand ecologically productive areas, such as cropland to grow crops, or forest

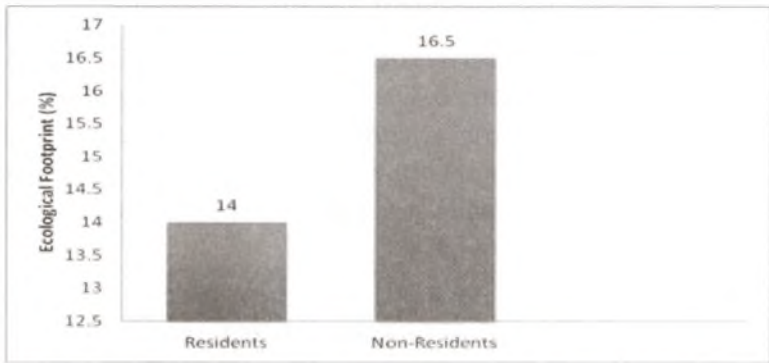
to sequester fossil carbon dioxide emissions. All of these materials and wastes are then individually translated into an equivalent number of global hectares. To accomplish this, an amount of material consumed by each person (tons per year) is divided by the yield of the specific land or sea area (annual tons per hectare) from which it was harvested, or where its waste material was absorbed. The number of hectares that result from this calculation are then converted to global hectares using yield and equivalence factors. The sum of the global hectares needed to support the resource consumption and waste generation of the person gives that person's total Ecological Footprint.

**Fig.1: Ecological footprint of Departments**



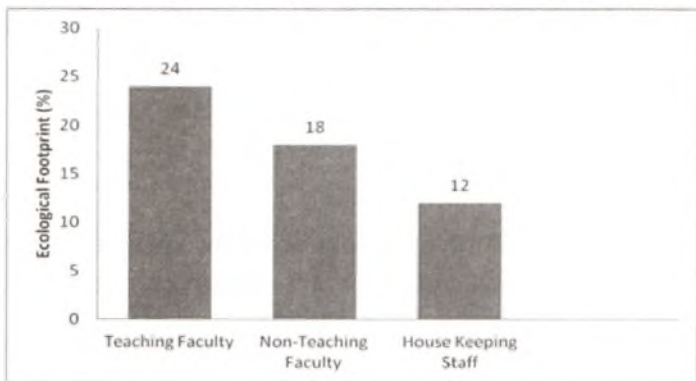

The personal ecological footprint values as shown in Figure 1 shows that the maximum ecological foot-print was observed in students of the department of Information Technology and Management (23%) followed by students of Department of BCA (20%) and BBA, History and English (19%). Ecological foot-print of Students of Zoology, Chemistry and economics was found to be the least (13%). The reason for the above observation could be that the students of the departments which showed higher footprint belong to the self-financed stream and many of the students come from families of higher income group. More than 65% of the student's families annual income is > Rs.3 lakhs which reflects the lifestyle of the students with reference to consumption of resources and waste generated.

**Fig.2: Ecological footprint of Residential and Non-Residential students**



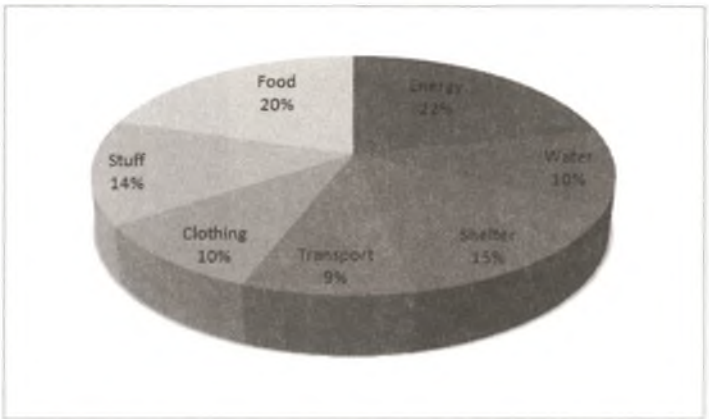

The comparison was done between residential and non residential students in which the result revealed that non resident students possessed the higher foot-print value of 16.5% compared to the resident students. The higher value could be mainly due to the means of transport used by non-residents students, which is related to the footprint on usage of fuel apart from varied food habits and life styles etc. (Figure 2)

**Fig.3: Ecological footprint among working members**




In the data collected from the working class namely teaching faculty, non- teaching faculty and housekeeping staff, the foot-print clearly shows that the economic status of an individual influences the footprint he or she leaves (Figure 3). The house keeping personnel had a very low footprint (12%) when compared to the overall college community that might be due to their minimum requirements for livelihood. So house keeping records the minimum eco foot-print of 12%.

**Fig.4: Ecological footprint on using different resources**



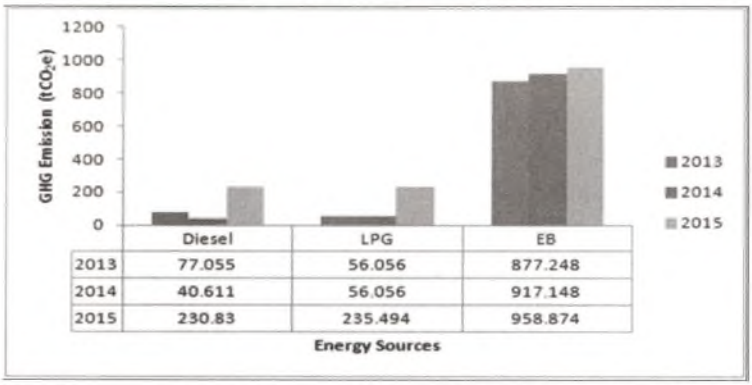

The calculation of footprint on usage of water, food, shelter, transport, energy, clothing and stuff has been done and the collected data revealed that the largest footprint was for energy utilization which was 21.62% followed by food (20.30%). The other footprint values are shelter (14.90%), stuff (14.13%), water (10.29%), clothing (9.80% ) and transport (8.98% ) (figure 4). The higher values for energy and food is assumed to be because of the unmitigated footprint of the college community due to the behavioural atitude of the people living in urban localities, traveling to the college and the improper management of the waste generated.

**Table 1: Overall ecological footprint of the college community**

| S.No | Ecological footprint of college community | Global hectare (gha) |
|---|---|---|
| 1 | Non- resident students | 16.53 |
| 2 | Resident students | 14 |
| 3 | Teaching faculty | 24 |
| 4 | Non-teaching faculty | 18 |
| 5 | House-keeping staff | 12 |
| 6 | Total Ecological Footprint | 84.53 |

Overall ecological footprint for the college community is found to be 84.53 gha. Thus the average individual footprint is calculated for the members of Lady Doak College community to be 0.16gha/cap.(Table-1)

**Fig.5:Comparative GHG emission for the years 2013, 2014 & 2015**




| | Diesel | LPG | EB |
|---|---|---|---|
| 2013 | 77.055 | 56.056 | 877.248 |
| 2014 | 40.611 | 56.056 | 917.148 |
| 2015 | 230.83 | 235.494 | 958.874 |

There is increase in the usage of diesel in the year 2014 because of increase in usage of generator for online test conducted for the undergraduate students. The emission of Co2 from electricity is also found to be increased for the year 2015, because of purchase of more lab equipments, fridges, air conditioners etc., (Figure 5).

**Fig.6: GIS Analysis of vegetation at LDC for the Year 2015**

**GHG Removals and Sinks:** Trees remove carbon dioxide from the atmosphere through the natural process of photosynthesis and store the carbon (C) in their vegetative tissues such as leaves, branches, stems, bark and roots. Trees in forests (including plantations), if well-stocked, typically sequester carbon at a maximum rate between about age 10 and age 20–30. As an indication, at age 30 years about 200 to 520 tonnes CO2-e are sequestered per ha in forests with productivity ranging from low to high [10]. LDC campus has trees, shrubs and herbs as part of the green campus. About 1100 trees are present within the campus.

Vegetation in LDC is calculated to about 71,576 sq. meter land through GIS mapping system [11] (Figure 6), available in the department of Physics, LDC, and is used to calculate the carbon dioxide sink/ sequestration [12]. (Table 2)

**Table-2: The amount of CO2 sequestered through the vegetation is given below.**

| S.No | Description | Details |
|---|---|---|
| 1 | Total persons in Lady Doak College | 4738 |
| 2 | Total annual CO2 emission | 8528.4 $tCO_2e$ |
| 3 | Total monthly CO2 emission | 710.70 $tCO_2e$ |
| 4 | Number of trees required to offset the CO2 emission per year | 42,642 |
| 5 | Number of trees required to offset the CO2 emission per month | 3553.5 |

Solar panel installed in the College hall (6kWA) and Pandian Hostel (5kWA) generated the electricity unit of about 18,000. Thus the renewable energy generated from solar panel helps in the reduction of CO2 emission which accounts to about 21.02 tCO2e.

**Conclusion**

Based on the study undertaken the average individual footprint calculated for the members of Lady Doak College community is 0.16 gha/cap, which is well below the national average. Even though the individual footprint is very small, this should not lead one to think that we are doing well with sustainability. With the campus growing by leaps and bounds, it will not be far off when the resource use will overshoot the resource availability. With respect to Green house gas accounting, the amount of tCO2 e was increased for the year 2015 than the inventory study year 2013 & 2014.

**Various mitigation strategies were proposed such as Energy Star procurement Policy:**

1. Purchase of energy star certified appliances in all areas for which such ratings exist and wherever practical.
2. Possible energy efficiency strategies:
   i. Routing the electricity generated by solar plant in Pandian hostel to the administration block for the month of May and June.
   ii. Fixing up off sub-meters in the hostel blocks, administrative block and college blocks.

iii. Maintaining the temperature of the air conditioners at 240 C in all the places within the college.

iv. Increasing the carbon sequestration by planting more number of plants.

v. Awareness creation regarding energy saving and GHG emission, among the campus community.

3. Installation of solar panels
4. Exporting excess electricity generated on campus to the common grid.
5. Installation of methane captures systems for sewage treatment plants and solid waste.
6. Installation of windmills / purchase of wind energy.

**Table-3: Mitigation strategies followed in LDC campus for the reduction of GHG emission during the year 2015.**

1. Energy Star procurement Policy: Replacement of energy star certified appliances in all areas wherever practical. Below is the list of replaced electronic items.

| Sl.No | Star rated Electronic items replaced | Quantity |
|---|---|---|
| 1 | Air conditioner | 19 |
| 2 | Fridge | 2 |
| 3 | Tube lights (36W & 28W) | 280 |
| 4 | Fan | 13 |

2. Awareness campaigns for energy conservation was conducted such as rally by the students, Guest lecture by the experts, **"NO"** vehicle day, competitions for the students on energy conservation.
3. Display of stickers for saving natural resources on college campus.

Awareness programs on energy conservation and energy efficiency were conducted among the LDC campus community to bring behavioral change with reference to usage/ wastage of energy. Even though mitigation strategies were followed for the calendar year 2015, due to the increase in the population of student's community, there is greatly demand for the usage of electrical appliances which in turn increases green house gas emission. Thus the college has initiated tangible actions towards carbon near neutrality campus by implementing the offsets for efficient energy usage for the forthcoming year such as installation of more number of solar panels in the college campus, increasing the

carbon sequestration by planting more number of plants, fixing up off sub-meters in the hostel blocks, administrative block and college blocks. We have also implemented climate change policy for the Institution (Annexure II).

**Follow Up:**

* Regular conduct of awareness programs on energy conservation, water conservation, and waste management and take steps to implement them on campus.
* Display of stickers for saving natural resources on college campus.

**Acknowledgement**

We acknowledge the financial support received from United Board for Christian Higher Education in Asia that enabled us to carry out this project. We express our gratitude to Lady Doak College, Madurai, India for the help and support extended to us in pursuing this pilot study. We wish to acknowledge the work done by Pushpa.T, Sivagami Alias Sindhu. S and Sofika Begum .P, in collecting the data through questionnaire for personal ecological footprint calculation. We also would like to thank Mrs.M.Lakshmi, M.Sc., Assistant Professor, Department of Physics, for assistance in calculating carbon sink using GIS. We express our sincere thanks to maintenance team of LDC and hostel for providing necessary data.

**References**

1. *Ewing et al. 2001. Global Footprint Network. Retrieved 25 February 2001.*
2. *Data Sources. Global Footprint Network. 2010-02-05. Retrieved 2060-02-05.*
3. *The Royal Society. Climate change: A Summary of the Science. London: The Royal Society Science Policy Centre, 2010.*
4. *www.deq.state.ok.us*
5. *Baseline Protection Initiative. 2002. Baseline Protection Initiative—Reference Manual. National Climate Change Process, Government of Canada, April 2002.*
6. *Bosi, M. 2000. An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study. OECD and IEA Information Paper, June 2000.*
7. *http://cdm.unfccc.int/methodologies/PAmethodologies/tools/ -am-tool-03-v2.pdf.*

8. *http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf*
9. *Thattai. D. 2007, Ecological footprint calculation for a college campus in South India. . Journal of Environmental Researh And Development Vol. 2 No. 2.*
10. *Australian Greenhouse Office (2001). Growing Trees and Greenhouse Sinks. An overview for landholders. AGO in the department of Environment and Heritage. 14 pp.*
11. *Introduction to ArcGis for Arcview, Arceditor, Arcinfo: United states, ESRI educational services, 2003.*
12. *http://www.nature.org/greenliving/carboncalculator/*

# SERVICE LEARNING STRATEGY FOR SOLID WASTE MANAGEMENT

14

Jaba Priya,T.
*Madras Christian College,Chennai.*

**Abstract**

*Chemical science offers the strongest justification for the adoption of pro-environmental practices and policies. In this context, service learning model creates the need for scientific knowledge to address a genuine environmental problem perceived by the students. This paper describes the success story of one such model program conducted by students of Chemistry Department at Madras Christian College. It involves the interaction with informal recyclers and the chemical recycling of polyethylene terephthalate (PET) waste. The stakeholders of the project were the students, informal recyclers, residential population, and an NGO. The widespread application and non-biodegradability of PET bottle creates a huge amount of waste to dispose of, causing a serious problem in solid waste management. Indiscriminate disposal of PET bottles used in the packaging of soft drinks and drinking water creates a need for recycling and reprocessing the PET waste. This work involves participatory waste management with the help of informal recyclers, which will contribute to the social cohesion. This real-life working environment lead to excellent learning outcomes and strengthened the individual social responsibility of the students.*

**Key Words:** *Informal recyclers, chemical recycling, service-learning; waste management, PET bottles*

## Introduction

Service-learning is a method of teaching and learning which offers a unique opportunity for young people to use the experience of community service projects to enhance classroom learning, to use what they learn in the classroom to solve real-life community problems, and to develop real-world services which benefit mankind (Betsy & Ling, 2012; Demb & Wade, 2012). Well-designed and well-implemented, service-learning experiences can result in students' learning to become producers of knowledge and services, not just consumers of information (Banerjee & Hausafus 2007 ; Bowen & Kiser 2009 ; Dauenhauer et al 2010).

The populace of the city of Chennai and its neighborhood generate about 3500 tons of garbage every day. This garbage, also known as "municipal waste", is comprised of organic waste, plastic, packaging waste, paper, metal, glass, construction debris and other components like ash, sand and grit. This mounting solid waste, increases each day and threatens the health of human being and hence managing these wastes, is essential.

**Study on the Solid Waste Management Methods**

**Biodegradable waste**

The solid waste management methodology implemented in the Lakshmipuram, Tambaram (suburb of Chennai) was thoroughly studied from the periodical discussions with the Municipal Councillor Mr. D.K. Ramamoorthy and Mr. Ravikumar, Assistant Project coordinator, Hand in Hand (NGO), SEED, Environmental Division, Tamil Nadu. The students were exposed to segregation of domestic solid waste into biodegradable and non-biodegradable materials. They visited composting and vermicomposting units and found out that there are well established methods for converting the biodegradable material into manure and bio-gas. The bio-gas was used to produce electricity which lights up street lights.

**Non-biodegradable wastes**

However, they found that the non-biodegradable waste, particularly plastics, posed a greater challenge. These plastic wastes including PET bottles were simply sent to dump yards and informal recyclers (so called rag pickers) collected them and sold them to scrap dealers. No proper unit for the recycling of PET bottles existed and the process of recycling followed an unscientific method, resulting in unauthorized bottling by unscrupulous people. Further these informal recyclers work under unhygienic conditions and remain marginalized and ineligible to receive social welfare schemes of the Government. Hence there arises a need to integrate them into the mainstream.

As a part of curriculum, Green Chemistry is taught both at the undergraduate and post graduate levels in the Department of Chemistry. Apart from learning the theoretical explanations of the principles of Reuse, Reduce and Recycle, students carry out experiments based on these principles. One such experiment is the chemical recycling of polyethylene terephthalate (PET) bottles (Raed et al, 2011). The

depolymerized product can be used as a raw material for the preparation of polyester fibers.

These challenges led the students of Department of Chemistry to carry out Service Learning Program with the following aims:

- To systemize the collection of the waste materials like PET bottles, recycle them and as a result decrease their effects on health of general public particularly the informal recyclers, our surroundings and the environment.
- To use classroom knowledge to develop simple and novel recycling techniques to recycle PET bottles.
- To develop participatory waste management which will contribute to the social cohesion.
- To bridge the gap between `school science' where the notion of truth possession and certainty would seem still to dominate the prescribed curriculum and the world of `real science', where risk, uncertainty and limits to knowledge are increasingly regarded as the norm (Susan, 2008; Donaghy et al, 2012).

**Methodology**

**The one-year Service Learning program involved the following stages:**

1. A group of 25 post graduate chemistry students were the participants. The students learned in the laboratory, the basis of recycling and conservation of the natural resources, along with the process of converting waste PET bottles into polyester fibers through depolymerization of PET bottles using phase transfer catalysts. They were also taken to the factory which carried out the conversion of post consumer PET bottles into terephthalic acid and then converting it into fiber. They were amazed at the large quantity of PET bottles used for this purpose. They found that though enough PET bottles are available locally for recycling, the firm imported most of their requirement from abroad. They understood the need to have a formal PET bottle collection system at the local level.
2. The students then visited the waste dumping yard where all the solid waste including the biodegradables was thrown. They interacted with informal recyclers who did the great job of collecting PET bottles. Many of the recyclers were illiterates but

they could still make a distinction among various recyclable products using their experience and local wisdom.

3. The students were struck by the unhygienic work conditions of these informal recyclers. Handling and processing recyclable materials exposed the informal recyclers to unhealthy and dangerous conditions. Despite the visibility of informal recyclers in the streets, their working conditions are hardly recognized and they generally remain without a voice. It is not widely recognized that the people collecting recyclables are providing an important environmental service to the public. Students were pained by the social exclusion of the recyclers and understood the need for recovering their citizenship.
4. The students realized that waste management is not solely about technical solutions to waste disposal but is more so about social and environmental concerns. They recognized the need to introduce co-management practices of recyclables, which will allow for the participation of organized recycling groups and the public in waste management. Hence a bottom up initiative involving neighborhood community in recycling was attempted. The students wanted to utilize the knowledge gained in the laboratory for the benefit of the informal recyclers. Hence they obtained the used PET bottles collected by them and produced the raw material for fiber making through depolymerization process. This involved the assembly of simple all-glass equipment which is readily available in our chemistry laboratory.
5. Depolymerization: The depolymerization reaction was carried out in around-bottom reactor equipped with a reflux condenser using a mechanical agitator. 10 mL of 2.5M solution of NaOH (10% wt.) was added into the glass reactor of 250mL capacity fitted with a reflux condenser. The system was then placed in a heated oil bath and the reaction temperature was maintained at 900C. 0.5g of PET flakes and the catalyst namely Benzalkonium chloride (BKC) were then added to the reactor. Continuous stirring was done with the use of magnetic stirrer in order to keep the mixture homogeneous. The reaction mixture was allowed to react for 2 hours, at desired reaction temperature (90-1100C).At the end of the reaction, the reaction mass was neutralized to pH 7 with concentrated sulphuric acid and filtered. The terephthalic acid

(TPA) in the mixture was precipitated by the addition of concentrated sulphuric acid and the pH was brought down to 2.5-3.0. The final solid TPA produced was dried in a vacuum oven at 12000Cand weighed. The unreacted PET that remained was washed with water, dried in a vacuum at 1200C.The final unreacted PET was weighed and PET degradation was calculated.

The depolymerized product was handed over to the recyclers so that it could be sold in the market. If the recyclers sold the PET bottles as such, they would be earning only one fifth of what they earned through the sale of depolymerized product.

**Building Social Capital with Recycling**

A formal group of recyclers was formed and the residents in the area were advised to hand over the recyclables to these recyclers when they approach them for collection. A Non-Governmental Organization (NGO), "Hand in Hand" was partnered with in this program and they assisted in organizing the groups. They ensured effective liaison between the public and the students. Twenty two recyclers were part of this initiative. They learned about the quality and efficiency of selective collection and separation, health and risk protection, financial administration and group organization. Recycling was used as a vehicle to draw public attention to the deprived living conditions in the neighborhood and it was hoped it might pave the way for the social inclusion of the informal recyclers. In the present study, most of the local residents who collaborated with the formal recycling proposal recognized the advantages of the project for their community.

**Threats**

There is an increasing trend towards privatization of this sector with a dominance of large-scale enterprises and multinational corporations controlling this sector. They have begun to play a central role in the recycling business. These developments may have serious effects on the informal recycling sector. These private actors prioritize incineration and landfill as waste management techniques. Incineration helps produce energy but has problem of emission of toxic fumes and gases due to the decomposition of polymer chain molecules and particular additives present. Land filling of plastics is not preferred because of space constraints and land pollution.

**Academic impact of the project**

This project enriched the students and faculty to explore and relish the pedagogy of "learn and serve" & "serve and learn" (Hegeman et al 2010 ; Jordan et al 2012 ; Lambright & Alden, 2012). From the reflection exercises done during and after the project, the students have shared that they have realized that 'recycling' of anthropogenic and xenobiotic materials occupies a central position in preservation of our environment.

The students were able to publish a technical paper based on conventional method of depolymerization (Priya et al 2013). This publication, in turn, motivated some students to study the process of depolymerization thoroughly and further improvement was made in depolymerization of PET bottles using microwave radiation. The resulting product was very pure and the reaction time of depolymerization was reduced to a few minutes. This work was also published in academic journals (Priya et al, 2014; Priya & Sugumar, 2014).

**Reflections and Lessons Learnt**

As we followed "What?- So what ? - Then What? "model in this study, 'reflections 'formed a part during and at the end of this project. Reflections during the project allowed us to make certain mid course corrections. On the other hand, end of project reflections helped us to get the feedback about the whole programme. Such reflections helped us to obtain qualitative outcomes such as student satisfaction, student narratives, and student end-of-course comments.

Overall, students perceived the entire service learning experience as positive.. They felt they had benefited significantly in terms of personal development and civic responsibility and hence acquired the real world skills. Majority of the students regarded such experience as a lesson in life and issues they need to be aware of in the neighbourhood. Moreover, they were appreciative that such opportunity allowed them to realize the way in which the informal recyclers operate. For some it was an eye opener to observe informal recyclers with a different view. They were surprised by the local wisdom of recyclers in gathering the right type of plastics which can be recycled. This led them not to look down on people who were not as fortunate as them. Students also developed a greater understanding for the role of non-profit organizations.

This study had some limitations too. As it was not a compulsory module,

the ratio of staff to students was 1:11. Hence, the sample size was not big enough to conduct a large-scale quantitative research. Communities were eager to count on partnerships with long-term commitments and wanted us to provide student support regularly, may be each semester. We need to build new programs and strengthen service delivery.

Two main challenges to using service learning were identified by participants in this study: the time commitment required and the lack of recognition of service learning activities toward tenure and promotion.

**Conclusion**.

Through this project the following viewpoints emerge: though recycling is not the ultimate environmental solution, it does provide an opportunity for reducing the secondary carbon footprint. It is an activity that already involves the most excluded people from the society who pick up the waste and send to recycling. Organized recycling provides the possibility of recovering citizenship of those marginalized people involved in waste recovery.

Further action in this direction for sustainability of the program should focus on:

I. Inclusion: formatting inclusive waste management programs with organized recycling groups and facilitating their articulation.

ii. Equity: guaranteeing fair pay and social benefits for the service of resource recovery and assuring gender equity.

iii. Eco-health: addressing all levels of health from protecting the health of the workers to improving environmental health

iv.Eco-efficiency: reducing waste at the source, introducing co-responsibility for producers and consumers and intensifying resource recovery.

**Acknowledgements**

I thank the authorities of United Board for Christian Higher Education in Asia for the financial support extended to me to carry out this project. I also record our sincere thanks to the former Head, Department of Chemistry, Dr. R. Wilfred Sugumar and other colleagues in the Department of Chemistry for their support and advice in implementing the project. The laboratory assistants of the Department of Chemistry certainly deserve praise for the dedication shown during the tenure of the project.

**References**

*Banerjee, M., & Hausafus, C. O. Faculty use of service learning: Perceptions, motivations, and impediments for the human sciences. Michigan Journal of Community Service Learning, 2007, 14(1), 32–45.*

*Betsy Ling-Ling NG, The application of community service learning in science education, Asia-Pacific Forum on Science Learning and Teaching, 2012, Volume 13, Issue 2, Article 15, p.2*

*Bowen, G., & Kiser, P. Promoting innovative pedagogy and engagement through service-learning faculty fellows programs. Journal of Higher Education Outreach and Engagement, 2009, 13(1), 27–44.*

*Dauenhauer, J. A., Steitz, D. W., Aponte, C. I., & Faria, D. F. Enhancing student gero-competencies: Evaluation of an intergenerational service learning course. Journal of Gerontological Social Work, 2010 , 53, 319–335.*

*Demb, A., & Wade, A. Reality check: Faculty involvement in outreach and engagement. Journal of Higher Education, 2012, 83, 337–366.*

*Donaghy, Kelley,J, Saxton, Kathleen, J. Service-Learning Track in Chemistry: Giving" Students a Choice", Journal of Chemical Education, 2012, vol89, No.11, 1378-1383,.*

*Hegeman, C. R., Roodin, P., Gilliland, K. A., & O'Flathabhain, K. B. Intergenerational service-learning: Linking three generations: Concept, history and outcome assessment. Gerontology and Geriatrics Education, 2010, 31, 37–54.*

*Jordan, C., Jones-Webb, R., Cook, N., Dubrow, G., Mendenhall, T., & Doherty, W. Competency-based faculty development in community-engaged scholarship: A diffusion of innovation approach. Journal of Higher Education Outreach and Engagement, 2012, 16(1), 65–96.*

*Lambright, K. T., & Alden, A. F. Voices from the trenches: Faculty perspectives on support for sustaining service-learning. Journal of Education Outreach and Engagement, 2012, 16 (2), 9–44.*

*Priya,J. T., Kannadasan, K. and Sugumar R.W., 'Recycling of PET waste by depolymerization using Phase Transfer Catalysts', International Journal of Chemistry, , 2013 ,2 (1), 86 – 91.*

*Priya J.T., Subramee Sarkar , Shamili G. and Sugumar, R.W., 'Microwave Assisted Depolymerization of Post Consumer PET Waste Using Phase Transfer Catalysts', The Chemical Educator, 2014,19, 61–63,.*

*Priya J.T. Sugumar R.W. Service Learning Approach to Recycling, International Journal for Service Learning in Engineering 2014, Vol. 9, No. 1, pp. 108-116, Spring*

*Raed K. Al-tamimi , Moayad N. Khalaf , May Sabri , Luma Sabri, 'Post consumer poly(ethylene terephthalate) depolymerization by waste of battery acid hydrolysis' Journal of Materials and Environmental Science 2011, 2 (2) 88-93,.*

*Susan Sutheimer, "Strategies to Simplify Service-Learning Efforts in Chemistry", Journal of Chemical Education, 2008, Vol 85, No 2, 231-33..*

**Interaction with formal and informal recyclers.**

**Biodegradable waste management**

**Biomethanation plant**

**Interaction with the NGO**

**Vermicomposting**

**Experimental Set up**

# LOCAL KNOWLEDGE – REVISITING THE PAST FOR A SUSTAINABLE FUTURE

15

Priscilla Jebakumari and Sathya Bama, S.
*Stella Maris College, Chennai*

**Abstract**

*Ethnobotany is the study of the relationship between people and plants. This interdisciplinary field includes studying plants and people in the context of cultural myths and religious ceremonies of Irula Tribe. The Research topic deals with the role of traditional knowledge, indigenous knowledge and local knowledge in sustainable development. The focus of the project leaned towards ethnographic and ethnobotanical studies for which data was collected from the Irular tribal group. The participants also interacted with women belonging to various self-help groups on the concepts of Vata, Pitta&Kapha and daily dietary routine at the Stella Maris College Extension Project Centre at Tirupachur village, Thiruvallur District. As a result the information was collated and documented. Then this traditional knowledge was disseminated among students, community and the public and thereby making it sustainable. Repository of Seedsand setting up medicinal plants as "Irula Corner" in the herbal garden at Stella Maris College was an outcome of the sustainable development.*

**Key words :** *Ethnobotany, traditional knowledge, Indigenous, Irula Tribe, Sustainability*

## Introduction

The Departments of Botany (UG), Public Relations (PG) and Social Work (PG), Stella Maris College, Chennai, Tamil Nadu, executed a project supported by the United Board of Christian Higher Education in Asia (UBCHEA) on **"Local Knowledge – Revisiting the Past for a Sustainable Future"** for the academic year 2014-15.

This interdisciplinary project dealt with traditional knowledge, indigenous knowledge andlocal knowledge in sustainable development. They have been defined as forms of intellectual property that generally refers to the long-standing traditions and practices of some regional, indigenous or local communities.

The focus of the project leaned towards ethnographic and

ethnobotanical studies for which data was collected on people and plants, their habits and habitats, culture, social living and occupational changes that have affected the life of the Irular tribal group. The project also included documenting the traditionalknowledge, disseminating the information among students, community and the public and thereby making it sustainable.

Ethnobotany includes studies concerning mutual relationships between plants and traditional people. It provides the linkage and interface among plants, people, technology for crop improvement etc. Significance of ethnobotanical studies involving knowledge collection is manifold, especially with reference to local medical knowledge, food, cultural practices and sustainable practices,conservation of biodiversity and discovery of new medicines.

**Irular Tribes**

'Irulas' are a tribal community, which lives in south India in the states of Tamil Nadu and Kerala. Their traditional occupation is snake catching,but now, due to the Animal and Wildlife Protection Act and ban of snake skin industries imposed by the Government their livelihoods were hindered. Along with snake catching, the Irula women, are involved in processing of medical plants and providing herbal treatments. They still do practice herbal medicines and are good herbal doctors (Vaidyars) and an asset to our society. They have treatments for the diabetes, snake-bites, filariasis, skin ailments etc.

The Irula Tribal Women Welfare Society (ITWWS) was initiated in the year 1986, five years after the foundation of Snake-Catchers society. It was founded by an Animal Herpetologist, Ron Whitaker, to educate people about snakes and its value in the environment.

They possess an extensive knowledge about the trees and plants in Tamil Nadu, it's seeding and flowering cycles, soil and water needs and medicinal properties. Thus, ITWWS was formed with the primary aim of developing the herbal skills of the women and commercializing it for their income and sustenance. This helped ITWWS start a nursery consisting of medicinal plants and a Herbal Centreto protect natural resources and to educate future generations. TheHerbal Center prepares 14 varieties of herbal products which includes herbal teas, herbal oils and medicines for arthritis, diabetes and indigestion. These herbal products are marketed by the society.

Out of the 40 Aadivasi communities in South India, the most distinctive are the Irulas or Irular. They master forest skills that include tracking, hunting, fishing and the collection and processing of medicinal plants. They have been using these skills to their livelihood until modern laws and restrictions posed threat to them. The institution of 'Wildlife Act 1972' put an end to their traditional source of income, particularly catching snakes for the snake skin industry.

**Objectives of the Study**

* To promote and practice Inter disciplinary Teaching and Learning Processes
* Capacity building of faculty and students
* Building a repository of traditional knowledge
* Dissemination of findings and Documentation of local knowledge

**Methodology**

Ethno methodological techniques included open and semi – structured face to face interviews with the Irular women of the age group between 45 – 80to collect information on traditional knowledge. Other methodologies adopted were field visits and local information collected by the students from secondary sources such as books on Ayurveda, Siddha and traditional medicine practioners. This information were collated, printed and distributed as handouts. The leaflets were printed in vernacular language (Tamil)and afew in English. The information centered on simple remedies such as uses of Neem for medicinal purposes, the importance of indigenous green leafy vegetables in diet and collection of popular adagespertaining to good health practices, through generations.

A workshop on Ethno methodology, data collection and documentation prior to the visits, prepared the participants with the required expertise on mapping of layout, ways of gaining the confidence of Irula women and finally methods of interviewing. The participants also went to the Stella Maris College Extension Project Centre at Tirupachur village, Thiruvallur District to interact with women belonging to various self-help groups on the concepts of Vata, Pitta&Kapha and daily dietary routine. A workshop on preparation of Herbal Medicine and the importance of Acupressure was conducted by an Indian Medicine Practitioner. Handson training was provided to the self-help groups on preparation of herbal shampoo, pain relief balm and herbal oils.

## RESULTS

The study on Ethnobotanical aspects of Irulas involved individuals residing in Thandarai, Chengalpet, Kanchipuram District of Tamil Nadu. They are identified by different names such as Villiyan, Vedans and Kattukaran. They speak a dialect of Tamil. They are popularly known as thaenpillaiyars (collectors of honey). Their profession includes catching snakes, rodents and collecting of rice from rat holes.They also trap reptiles rodents and winged termites for food. Their rat catching techniques include snaring, netting, digging and smoking out the rats from their holes.The nets are made out of Aloe vera fibers. They are also very skilled in collecting rice from rat holes, sometimes as much as five kilograms from each hole.

Enumeration of Plants

Ethno-medicinal information of few plants species was collected and are enumerated as follows:

| | | |
|---|---|---|
| Naiyuruvi | (Achyranthusaspera) | Juice of the leaf with palm jaggery given to new born babies for, fever and cough. |
| Sirukurunjan | (Gemnemasylvestre) | Leaves are used for diabetes, for scorpion and rat bites. Leaves of this plant are regularly used in several of the dishes prepared by Irulas at least once a week even though leaves add a bitter taste to the meal. |
| Vettukkaayathalai | (Tridaxprocumbens) | Juice of this plant arrests bleeding from wounds. |
| Sarakkondrai | (Cassia auriculata) | Leaves, flowers, fruits, stem and roots are used for protecting skin from infections. |
| Kuppaimaeni | (Acalyphaindica) | Decoction of leaves are used for snake bites, ear pain and scabies. |
| Poongamaram | (Pongamiapinnata) | The paste of the seeds are applied externally for joint pain. |
| Elumu-ottiillai | (Ormocarpumcochinchinensis) | The leaves are beneficial for bone health. Leaves are dried, powdered. One teaspoon of the powder mixedin a cup of milk helps repair of bones. |
| Thoodhuvalai | (Solanum trilobatum) | The leaves of this plant are boiled and made into a decoction for relief from chest congestion, cough and cold. |
| Chembarathi poo | (Hibiscus rosa- sinensis) | Herbal tea made from flowers are given to adolescent girls to strengthen their reproductive system and relieve menstrual problems. The leaves are used asa herbal hair cleanser in combination with Aaciaconcinna. |
| Nilavembu or siriyanangai | (Andrographispaniculata) | Leaves are used for blood purification, allergies and snake bites |
| Nirnochchi | (Vitexnegundo) | Leaves are used for eczema, ringworm, liver disorders, rheumatic pain. |
| Sirupeelai | (Aervalanata) | Leaf juice is the traditional medicine for snakebites, treatment of bladder and kidney stones. |
| Sirukattukodi | Cocculushirsutus | Leaves are used for poisonous bites, leprosy, piles and fever. |

| | | |
|---|---|---|
| Mallaivembu | (Melia azadirachta) | Leaves are a natural insecticide to keep with stored food, and has antibacterial properties. |
| Chittrarathai | (Alpiniaspeciosa) | Leaves have diuretic, antihypertensive and antifungal properties. |
| Pirandai | (Cissusquadrangularis) | Heal broken bones, injured ligaments and tendons, obesity and diabetes. |
| Nannari | (Hemidesmusindicus) | Coolant and a blood-purifier, treatment for anemia. |
| Kollungi | (Tephrosiapurpurea) | Leaves have anthelmintic, antipyretic properties. It is also used for asthma, and tumors. |
| Vallarai | (Centellaasiatica) | Leaves are used for leprosy, lupus, psoriasis, diarrhoea, fever, amenorrhea. |
| Vetpaalai | (Wrightiatinctoria) | Leaves of this plant are used for treatment of diarrhoea, piles and skin diseases. |
| Karisalai | (Eclipta alba) | Leaves and flowers are used ashepato-protective and as a tonic for the hair. |
| Sembaruthi | (Hibiscus rosa-sinensis) | Flowers and leaves are used in hair oil preparation. |
| Pavettai | (Pavettaindica) | Leaves are used for visceral obstructions and haemorrhoids. |
| Tazhutazhai | (Clerodendrumphlomidis) | used as avermifuge and for rheumatism and measles |
| Cikkanan | (Albiziaamara) | Leaves are used for diarrhoea, cough, gonorrhoea and leprosy |
| Karudenkizhangu | (Corallocarpusepigaeus) | Root used for treatment eye diseases and diabetes. |
| Adathodai | (Justiciaadhatoda) | The leaf juice of this plant is used as an expectorant.It is believed to improve the quality of voice. |
| Mudakathankeerai | (Cardiospermumhalicacabum) | The leaves are used to prepare a decoction to relieve joint pain. |
| Ulunthu | (Phaseolus mungo) | seeds of this plant along with pepper is roasted and ground into powder. This powder is mixed with one egg and some gingely oil. Adolescent girls are given this drinkto maintain a healthy reproductive system. |

Other then plants, Mother's milk is used as eye drop to prevent infection during eye injury.

### Diet during pregnancy and lactation

Foods such as fish, chillies, papaya liquor, and excess salt are avoided as these aggravate body heat and may accuse to abort the fetus. Foods with strong odour are also not included in the regular diet as they could cause nausea. Twined fruits and tubers are avoided with the belief of having twins if one consumes such deformed fruits. Soon after delivery women are preferably given porridge atleast for initial seven days. Jaggery, ghee and coconut are added in their diet to make them more energetic.

### Skills as snake catchers

The poisonous snakes that are commonly seen in Tamil Nadu are NallaPaambu (Indian Cobra), Kattuviriyan (Banded krait),

Kannadiviriyan (Daboia krait) and SuruttaiPaambu (Saw-scaled viper). Irulars are experts in catching these snakes and they are aware of plants used to cure snake bites. They are experts in identifying the signs of particular snake bite,such as Cobra bite appears as a pluck mark, viper bites appear as cut mark and krait bite as puncture mark.

**Cultural Practices**

They celebrate the Tamil month Aadi(during the month of August) as auspicious month. They celebrate the month by preparing porridge and offering it to their deity Kanniamman.

Dance, singing songs, beating drums during weddings, when girls attain puberty and child births are some of their cultural recreational practices.

**Interaction with self- help group at Thirupachur**

The feedback from the respondents of the workshop revealedapprecia - tion for the honest attempt to achieve the success of the project objectives.

The traditional local knowledge gathered through visits and interactions was disseminated in a few schools at Tirupachur. Information on traditional foodand practices, good eating habits and use of herbal medicine were imparted to the teachers and students who attended the sessions. They expressed their view that these values be inculcated in the minds of young adults to help them lead a healthier and better life.

"Parambariyam" an exhibition was organized as part of the process of disseminating the local knowledge to the urban population. It was held at the Industrial Trade Fair Exhibition organised by the Government of Tamil Nadu. More than 1500 people visited the stall. They were enlightened on local knowledge with specific reference to traditional food, medicine, games, cultural practices, significance of including all six tastes (Arusuvai) in regular diet. It was appreciated by both young and old. The public appreciated our efforts revive the knowledge on traditional food and methods of living. A fifty two year old gentleman remarked that the presentation on food and medicine by the college students was on par with a doctor's advice.

The exhibition was also organized in Stella Maris College in February 2015, where the students were informed about good traditional food, medicines, games and other traditional practices. They were encouraged to play a few traditional games which are believed to contribute significantly in the coordination of reflexes.

All the data collected through interactions, workshops and training have been complied into a booklet on local knowledge for sustainable future.

**Outcome of the Project**

Cultural diversity in terms of ethnic groups gives us knowledge on the value of plant resources. The knowledge of the ethnic groups on the cultural, spiritual, social and economic values of plants can be of immense use to the entire humankind. It can equip the humankind with several new chemicals for combating many human ailments (Ravishankar, 2003). Accordingly the local community and school students were involved in a process of social learning through the transmission and sharing of knowledge. The initiative of collection and dissemination of Traditional knowledge by the students of the Departments of Botany, Public Relations and Social Work provided rich learning experiences both to the Knowledge recipients and disseminators. Therefore the learning outcome compasses knowledge, skills and attitudes that are linked to positive participation in society.

Tapping of Ancestral knowledge would help in strengthening cultural integrity and its continuity. The traditional knowledge about goodness of neem, greens, importance of tastes in food, use of spices and millets, etc., gathered by the students through secondary resources were printed as handbills and distributed to schools and community. This was found to be an effective methodology to develop, transmit and preserve ethnic identity and ancestral knowledge for future sustainability of traditional knowledge.

The importance of this traditional knowledge for the protection of biodiversity and the achievement of sustainable development is being recognized internationally. This fact finds place in the article 8 of the convention on biological diversity. Practices like sacred groves as observed by Irulars leads to a self regulated community based conservational initiative.

Conservation of natural resources, including medicinal plants implies the development of local communities and creates a forum for research on the potentials of natural resources for medicinal purposes. Similarly the income generating activity of Irular community, where in, growing medicinal plants and supplying the same for the purposes of herbal medicine preparation and research, enhances in-situ conservation of biodiversity

The gene rich traditional varieties seeds and cereals are crucial to food security. The tribal communities practice a unique method of preserving seeds in traditional granaries in which the seeds would remain viable and thus conserve the genetic strains for a long period. Irular at Irular Tribal Women Welfare Society, Chengalpet collect seeds from trees in neighboring forests and make it available to institutions for setting up seed banks. An attempt has been made to setup a Seed Bank Repository comprising of 40 different seeds from medicinally important plants. Thus the seed bank set at Stella Maris College would serve as a convenient means of long term storage of genetic diversity as the samples are small in size, easily handled, requiring low maintenance and frequently remaining viable for long periods. Eventually the storage of material in the form of seeds is one of the most widespread and valuable ex situ approaches to conservation and sustainability. This repository also facilitates transfer and dissemination of Ethno_botanical knowledge.

**Conclusion**

This study was an excellent opportunity to explore the lifestyle of theIRULA tribal community and gathering local knowledge from secondary sources. The present study observed that Irular tribe of Thandarai have a good knowledge on traditional medicine which after documentation could help pharmacological research in various dimensions. Documenting the indigenous knowledge through ethnobotanical study is important for the conservation and utilization of biological resources.

Due to lack of interest among the younger generation, as well as their tendency to migrate to cities for jobs there is possibility of losing the wealth of knowledge in the near future. It thus becomes necessary to acquire, preserve and document the traditional knowledge of Irulars and indigenous knowledge from various communities and secondary sources. Above all the study was a real eye opener for the students who underwent the study. The study also enthused few students to take up group projects on antimicrobial studies of few medicinal plants.

**Acknowledgement**

The interdisciplinary approach coupled with the experiential learning process facilitated students and faculty of the Departments of Botany(UG), Public Relations (PG) and Social Work(PG) to gain a

hands on experience to conduct live field observatory studies and to transfer theoretical knowledge into practical experience. Our sincere thanks are due to theUBCHEA for providing us this opportunity. We also acknowledge the Principal and the Management of Stella Maris College for the successful conduct of this project.

**References**

*T. Ravishankar, Traditional Knowledge and Conservation of Biodiversity for Sustainable Livelihood by tribal Communities in Southern India. The original unedited version of a paper submitted to XII World Forestry Congress, 2003, Canada.*

*Pradeep M and G. Poyyamoli, Ethnobotany and utilization of Plant Resources in Irula Villages (Sigur Plateau, Nilgiri Biosphere Reseve, India), J. of M. plants research, 2013. Vol. 7(6).Pp267-276.*

*Agarwal A, Gibson CC. Enchantment and Disenchantment: TheRole of Community in Natural Resource Conservation(1999). World Dev.27(4):629-649.*

*Arul PN, Jayendran M, Rajasekaran CS. Study of Plants used as Anti diabetic agents by the Nilgiri aborigines. Anc. Sci. Life(2006), 25(3&4).*

*SharadiniDahanukar and Urmila Thatte, Ayurveda Unravelled (2013), National Book Trust, India.*

*Pravin Chandra Trivedi, Medicinal plants traditional knowledge (2006). I. K International Publishing house Pvt. Ltd. New Delhi.*

*Ahuja, Ethnobotany – The Renaissance of traditional Herbal Medicine(2012).Abhijeet Publications, New Delhi.*

*.Duraidasan.G.Siddha Principles on Sound and Preventive Medicine(1989).*

**Workshop on Ethnomethodology**

**Interaction with IrulaTribal woman**


**Dissemination of traditional knowledge to schools and community**

**Dissemination of traditional knowledge to public and college students**

**Dissemination of traditional knowledge to schools and community**

# PART- 4:

# OTHER INITIATIVES

# I. BEST ENVIRONMENTAL PRACTICES

## A. THE AMERICAN COLLEGE, Madurai

### Introduction

Renovation and innovations are the two sides of the same coin as far as the American College's commitment to preserve the eco-friendly campuses is concerned. Both the Main campus that is situated in the heart of the city and the Satellite campus that is situated at the foothills of the Western Ghats on the periphery of the city have a serene green ambience with its rich bio-diversity. The administration and student community are conscious about and sensitive to the maintenance of pollution-free campus although they are prone to environmental pollution due to heavy vehicular traffic on three sides of the Main campus. Conscious efforts are taken and resources spent to preserve its flora and fauna. The student volunteers of National Service Scheme and those students who have enrolled for courses under Self-Learning Programme (SLP) show special consideration toward conservation of the eco-system not only in the campuses but also in the city.

### Environmental Awareness through Curriculum

With a view to creating awareness about preserving the Nature for posterity, the College curriculum has made it mandatory for all undergraduate students to do an environmental course from the perspectives of their Major disciplines. For instance, English literature students critically examine the changing human attitude toward nature in literature; Sociology or Economics students do a course that highlights issues related to deforestation and afforestation or with economic dimensions of the issues. Since the course is integrated into their Major curriculum, students are intrinsically motivated to do the course seriously.

### Environmental Action projects:

a. **Protection of Endangered species-House sparrow**
   The administration with the help and cooperation of student community and the District Forest Office has taken effort to green the campus and to multiply the number of sparrows that are endangered due to mobile phone towers and usage on a large scale. Student volunteers of the Green Club distribute sparrow boxes to the public every year to rehabilitate them in their houses and neighbourhood.

**b. Study of Vaigai river to mitigate its pollution and ill effects on people living on the riverside.**

**Other healthy practices:**

* The College put in place rain harvesting system connecting all buildings a decade ago, before the Government made it mandatory.
* The use of vehicles by students and faculty has been restricted to a particular area in order that its noise does not cause any ecological disturbance to birds and flora and fauna.
* Plenty of bamboo trees have been planted with a view to checking the carbon level.
* A huge tank has been dug to collect rain water and for culturing fish by students of Aqua Culture, a UGC Sponsored Community College Diploma course.
* Providing RO water with UV protector & using waste water for gardening.

**Students' Involvement in Solid Waste Management**

Solid Waste Management is one of the SLP programmes and students' contribution to solid waste management is commendable. Segregation into non-biodegradable and bio-degradable wastes, banning of plastic and polythene bags, students building soak pits for waste water generated from Chemistry and Biochemistry laboratories and bio-decomposing are practised. Students under earn while you learn scheme are involved in this project.

**Mission through Green Club**

Student volunteers of Green Club strive to develop love in students for nature and promote participation of students in learning about and improving the environment. They undertake several activities

i. Organizing seminars, debates, lectures, and popular talks on environmental issues
ii. Campaigning against the use of polythene in the city, loud speakers in public places, fireworks during festivals, unnecessary horns and for promoting recycling of glass and metals, accumulation of water in the neighbourhood water tanks
iii. Undertaking tree plantations on the campus and off the campus

iv. Observing World Ozone Day, World Forestry Day, World Water Day, and World Environmental Day

v. Motivating fellow students to imbibe in them habits and lifestyles for minimum waste generation, source separation of waste and disposing it to the nearest storage point, and

vi. Sensitizing the student community to minimize the use of plastic and polythene bags and not to throw them in public places as they choke drains and sewers thereby cause water logging and mosquito breeding.

**Conclusion:**

The American College is committed to guide student community toward the creation of a humane egalitarian society not just by precepts but through best practices on preservation of the present environment with a view to handing over to the next generation. It strongly believes that the environment is not only for the present but the eternal future. It tries to inculcate in students through its curricular activities a sense of responsibility and ownership toward preserving the environment for posterity. The present generation is its custodian and trustee in the sense that it should carry forward for sustainable development in the future.

**B. St.ANN'S COLLEGE of EDUCATION(Autonomous), Mangaluru**

* Environmental Education is institutionalized through the activities like campus cleaning, guest lectures on green initiatives, screening documentary films on eco-friendly activities, on waste management etc., maintaining the college garden (decorative plants and medicinal plants), regular bulletin displays on environment issues and celebrating World Environment Day by all the students.
* Projects on Environmental issues are undertaken by the members of Science Club, Environmental Education optional student teachers and Social Science methodology students. Some of the significant projects undertaken on environmental issues during last five years are
    * A study on the Flora of St. Ann's College of Education college campus through eco auditing.
    * Projects related to Bio-diversity.
    * A project on the maintenance of vermin compost pit and preparation of vermin compost manure as part of service learning (UBCHEA)
    * Visit to solid waste management unit of Mangalore City Corporation and preparation of a report.

* An environment and Health Awareness Programme through community based activities – A Service Learning Programme with focus on Solid Waste Management (UBCHEA).
* Training Programme to Develop Competencies among pre-service teachers to promote Sustainable Development through Specially Designed Packages (UNESCO).

* Seminar presentations on current environmental issues are being done as part of science club activities and Environmental Education classes.
* Special training is provided to develop Education for Sustainable Development (ESD) competencies. In addition awareness on ESD is given through integrated approach in methodology subjects.
* Frequent field trips are organized for B.Ed. students to gain awareness on environmental issues such as waste management, preparation of compost manure, prevention of social erosion, water conservation etc.
* Nature walks are organized as part of value education.
* Students and faculty are encouraged to participate in paper presentation on environmental issues during seminars and workshops

## C. LADY DOAK COLLEGE, Madurai
## Centre for Environmental studies

### I. Goal: Towards Energy Efficient Campus

### The Process

### a. Energy Audit

* Pilot Project by Physics students on Qualitative assessment of Energy Consumption and methods of energy conservation in the year 2008-2009 (funded by UBCHEA) in collaboration with the TamilNadu Electricity Board to minimise energy consumption.
* Students were trained to handle the energy audit instrument ALM-10 .They assessed the usage of electricity and energy loss due to faults and proposed measures for reduction in energy usage.
* **Energy audit** was led by 3- member team from National small Industries Corporation Technical Services Centre, Chennai.

**b. GHC Accounting**

* Lady Doak College completes its Green House Gas (GHG) emissions inventory in general accordance with GHG protocol Corporate Standard convened by the World Resources Institute (WRI) specification with Guidance at the Organizational Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. The college released its Carbon neutrality action plan that includes a time frame and steps to become a Low Carbon Institution/Carbon Neutral Institution by 2025 based on the baseline inventory study to check for the GHG emission for the year 2013 & 2014 (posted in the web site).

**Impact of the study**

Implementation of climate change policy for the Institution.

**Mitigation strategies followed in LDC campus for the reduction of GHG emission during the year 2015.**

* Energy Star procurement Policy: Replacement of energy star certified appliances in all areas wherever practical and energy efficiency strategies were also carried out
* Conducting survey through online questionnaire to assess the knowledge on energy conservation and energy efficiency
* Display of stickers in various places regarding tips to reduce electricity and wastage of resources.
* Rally by LDC Eco Brigade students to public and college community to create awareness on energy conservation and energy efficiency.
* Strict adherence to college norm of turning off the electricity during day time in hostels
* Use of alternate energy resources on campus

Solar panel installed in the College hall (6kWA) and Pandian Hostel (5kWA) generated the electricity unit of about 18,000. Thus the renewable energy generated from solar panel helps in the reduction of $CO_2$ emission which accounts to about 21.02 $tCO_2e$.

* Awareness and behavioural change was created regarding energy saving and GHG emission, among the campus community

* Planting of trees was done as much as possible to increasing the carbon sequestration.

**II. Goal: To Reduce Solid Waste Generation in the campus**
**The process**

* Segregation of Biodegradable and non biodegradable waste through Two Bin system
* Mini waste paper recycling unit to process waste paper collected from departments, centers, and offices. The recycled papers were used for printing invitations, files and paper bags etc.
* Vermicomposting unit to degrade plant waste collected in the campus and the compost prepared is used for gardening and also sold in the campus
* Promotion of reusable cups, plates and tumblers
* Eco Awareness Week celebration: To sensitize and involve the students on the environmental issues and inculcate sense of individual & collective responsibility towards their surroundings, and conservation of the natural environment of our country at large through observing Conservation day , Reduce Emission Day, Waste Minimization Day and Traditional Food Carnival

**Impact of the study**

Creation of awareness on solid waste management, clean maintenance of campus, display of permanent boards focusing Eco-concerns, 3 'R's (Reduce, Recycle, and Reuse)
Supply of fresh juice instead of aerated drinks and traditional food like sundal in the canteen.

**Evidence of success**

* Team of students from the department of Biotechnology, worked on food waste generated at Lady Doak college hostel mess. We could observe the reduction of food waste from 10 kg to 6kg / day. This creates an attitudinal change among resident students.
* A mini flower garden was established using the vermi-compost generated from the leaf litter.

**III. Goal: Rainwater Harvesting and Wastewater Recycling**

Roof top water harvesting project was undertaken covering 3057$M^2$ for recharging an abandoned 10" diameter bore well. All the roof of the

selected buildings (8) were provided with storm pipes and gratings to avoid the entry of leaf and other floating materials .They are divided into three groups according to the location and shortest distance for laying rain water harvesting pipes to the recharge chamber. Necessary small chambers have been provided at all junctions for easy flow and maintenance.

Before entry of rain water into the main chamber two medium size chambers have been provided with filtering wire net and iron grating. Inside the main chamber the existing bore well pipe have been covered with stainless steel wire net 30 × 6 gauge to avoid entry of silt or sand along with rain water. In addition to it one 3 feet dia RCP ring (well ring) placed over no fine concrete bed to filter the sand particles.

The ground water level considerably increased and so the yield of water could have increased in the surrounding bore wells reducing the load of water purchased which is evident from the reduced amount we have spent for purchasing water in 2015.

**Grey Water Recycling:** Sewage Treatment Plant using Media Based Technology for treating 15KLD water was setup in the campus and the treated water was used for irrigation which considerably reduced the demand on water tankers

**D. SCOTTISH CHURCH COLLEGE, Kolkata**

**Objective:** The College aims to give its students and faculty members a green, eco-friendly environment with an enriched biodiversity. In addition, to provide a detailed environmental account of the campus, its bio-resources and initiation of conservation practices.

**Description of the best practices**

1. The campus is lit with solar street lights to minimize the electricity consumption and make use of the renewable solar light to generate electricity.
2. Distillation plants in the science laboratories reuse the outlet water which is used for gardening purposes, etc.
3. To address the problem of solid waste disposal the college is successfully running vermicomposting units and the compost generated is used for college gardening and in fostering medicinal plant growth.
4. The college has carried out a survey of its bio-resources wherein students are actively involved along with faculty members. A campus audit programme has also been initiated. Such surveys are continuing.

**Outcome**:

1. A detailed audit of the campus has been carried out which includes energy audit, fire audit, and biodiversity audit.
2. The students have actively taken part in such a programme which has inculcated in them a concern for their surrounding bio-resources and their conservation. They have also developed leadership qualities and have imparted training to the students of nearby schools and colleges.
3. The nearby schools and colleges have initiated assessment of their own campus biodiversity.
4. Very recently (*27 June 2016*), inspired by the UBCHEA workshop programmes held in Scottish Church College, the Under-Graduate Board of Studies in Zoology, University of Calcutta, has incorporated in their Zoology undergraduate curriculum a section titled "**Report on Environmental Audit**". Here students will have to study at least two faunal diversity, along with ecological notes and photographic documentations, for two seasons -- in their campus or nearby locality. The new syllabus becomes operational from the current academic session i.e. 2016-2017.

## E. STELLA MARIS COLLEGE, Chennai

The college constantly seeks to promote the care of mother earth in keeping with the spirit of St. Francis, the Patron Saint of Ecology and of the Franciscan Missionaries of Mary. Therefore, one of the primary objectives of the institution is to sensitize students on environment issues and to motivate them to promote ecological justice and sustainable development. The wide spectrum of eco-initiatives that has been undertaken by the members of the college community is a testimony to our commitment to Franciscan vision of Justice, Peace and Integrity of creation.

Stella Marians are given every opportunity to make a difference by their commitment to environmental responsibility. The college on a regular basis makes a thorough environmental assessment of the campus and implements healthy ecological practices in water and energy conservation and solid waste management through composting. The three 'R's, "Reduce", "Reuse", and "Recycle" from the essence of every eco-friendly practice adopted in the college.

**Green Cover**

Planting of trees by the final year under graduate and post graduate students is an annual tradition of Stella Maris College that has contributed to the dense green cover in the campus. The prayer garden in the campus is a place of peace and serenity with bushy greenery and birds. It is an ideal place for communication with God amidst nature's beauty. The Herbal garden with more than 100 medicinal plants is maintained by the department of Botany. Students learn the importance of conserving medicinal plants and their benefits and also participate in propagating traditional knowledge which is critical for sustainable development.

**Watershed Management**

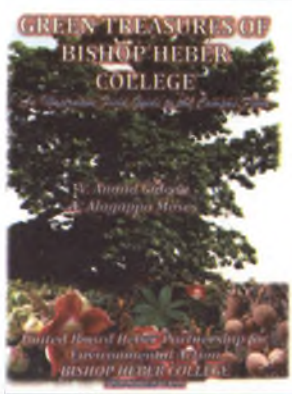
The college took the initiative to install rain-water harvesting facilities and sprinklers to optimize the use of water for gardening. Approximately 12000 to 18000 l/day of grey water generated from domestic activities in the hostels is recycled through grey water – recycling unit. This unit is used to water plants and trees and to recharge ground water. An analysis of recycled ground water carried out in the college indicated a considerable improvement in the water quality.

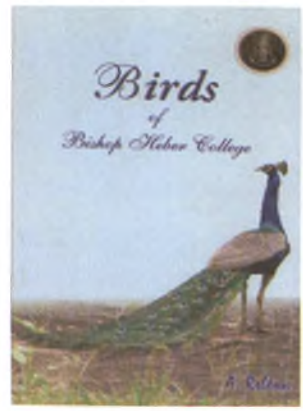
The college organizes conferences, seminars and workshops at national and international levels with environment related topics as key themes, which highlights the need to protect culture and folklore, as well as the valuable system of indigenous medicine and biological diversity.

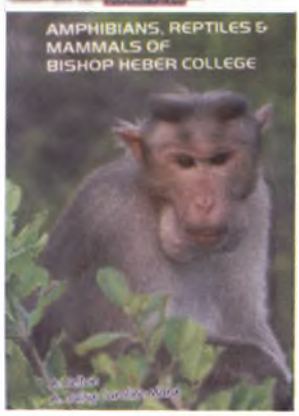
# II. Resource Materials on Environment

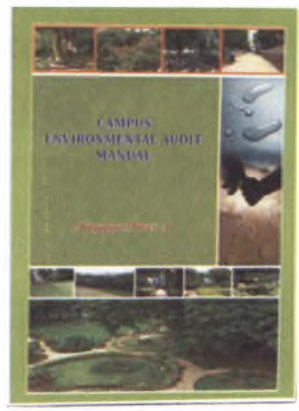
# Publications of

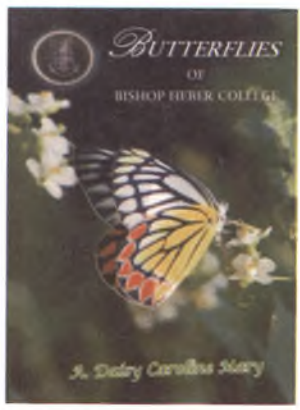
## Bishop Heber College, Trichy



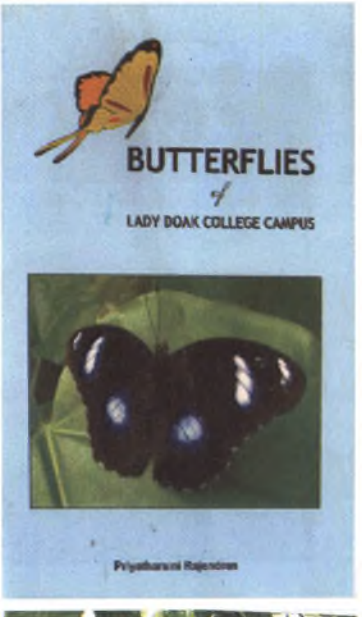



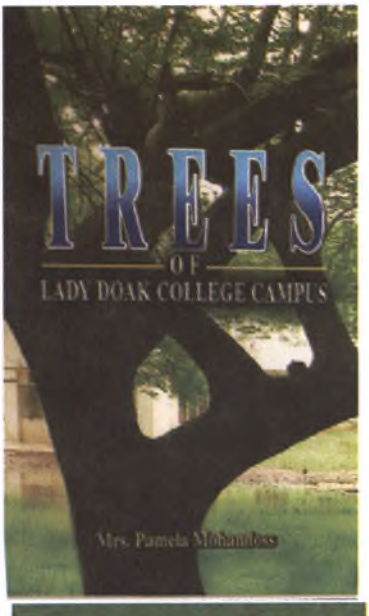



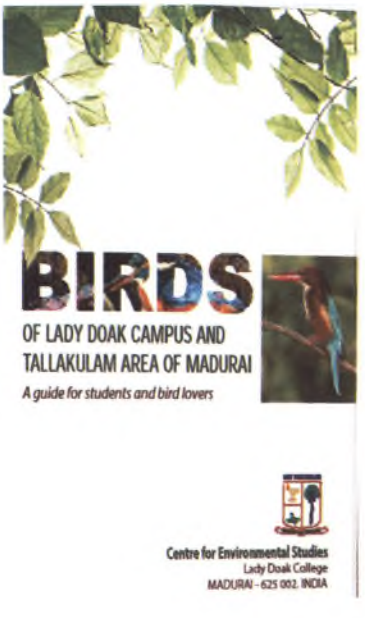



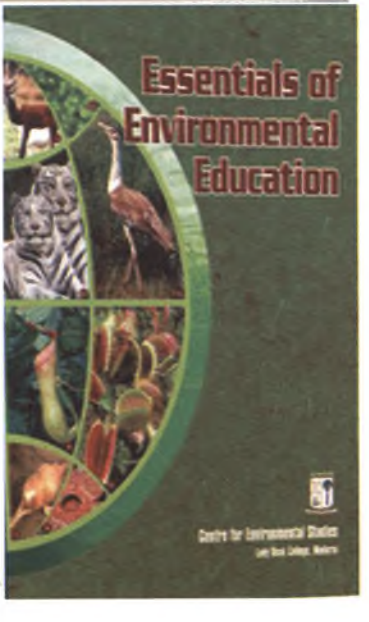
# Publications of

## Lady Doak College, Madurai



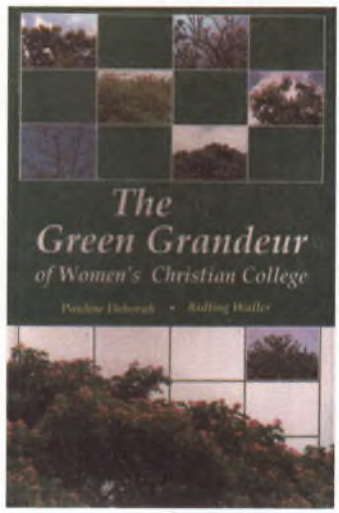



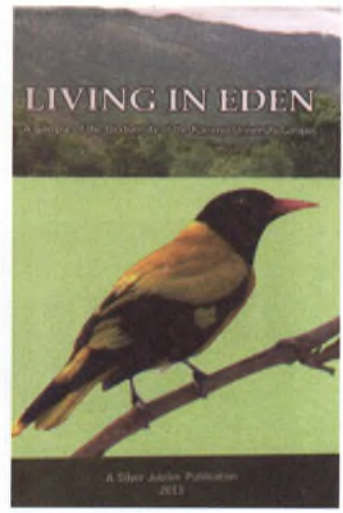



# Publications of

## Women's Christian College, Chennai




## Karunya University, Coimbatore




## Stella Maris College, Chennai

# Posters & Pamphlets on Environment

STELLA MARIS COLLEGE

பாட்டி வைத்தியம்

STELLA MARIS COLLEGE

Know your Traditions.....

Importance of Tamil proverbs in Medicine

- You can rule all the three worlds if you know the herbal medicine
- Even if it is rags gingel bottle and drink
- Even if it is a rag wash it and wear
- Wherever you come across the brook wash your feet
- Dirt leads to death
- Banyan and Bakul splint strengthen tooth
- Banyan splint strengthens teeth, Bakul splint brightens teeth
- A healthy life is a wealthy life
- Construct a dam before the arrival of flood
- Even the volunteer worker requires rest after dinner
- There is no medicinal syrup superior to dry ginger
- If there are ten peppers you can eat even in your enemy's home
- Eat Alternanthera leaves for clear vision
- River water cures humours Well water cures bile Cooked rice water cures both
- Horse gram for obese person Sesame for the weak
- He who chews well and eats well lives for a hundred years
- Berry (Solanum trilobertum) makes a man's life longer
- A man must eat onion to protect his body
- Sarsaparilla makes the body golden
- Take liquid ghee, watery butter milk and soft water
- He who has analysed thousand roots is a half physician
- Guest and medicine good for three days
- Food is medicine and medicine missing is food
- If (green) is cooked mixing with tamarind even a girl refusing to eat, will eat plenty!
- He who took poison must drink pepper water
- Vitvam cures bile
- Neem oil will be useful in emergency
- There is medicine for rheumatism but no medicine for idleness
- Long sleep is an enemy
- All these five elements are essential both at the macro level (Macrocosm) and micro level (Microcosm), The five elements are common to man and the universe
- Ginger, dry ginger and gall nut are considered to be effective tonic. A Tamil adage expresses that even an old weak man with walking stick will discard his walking stick and walk actively if he takes ginger in the morning, dry ginger in the noon and gall nut in the evening for forty days.
- Ginger in the morning, Dry Ginger in the noon, Gallnut in the night.
- Give entire world and gain health
- Head is superior in the eight open body
- Is it proper to bend on one side when the attack is on the other side?
- My Darling child do you have physical pain ? May I give you fomentation (hot water bag)
- Everything looks yellow to a jaundiced eye

Supported by

UNITED BOARD FOR CHRISTIAN HIGHER EDUCATION IN ASIA


# Curricular Material

## Service-Learning Program in Environment and Health

### Department of Environmental Sciences, Bishop Heber College

The "Five Elements of Environmental Service Learning" incorporates - exploring/ mapping local environments; making community partners; participating in local environmental service; reflecting on the learning which results from the service; and celebrate/ communicating about environmental stewardship.

**1. Service Learning Activities**

summer, winter, monsoon and spring to cover annual, biennial and perennial plants. A total of 167 plant species comprised or 74 trees, 59 herbs, 17 Grasses, 13 climbers and 4 Shrubs in the bishop Heber College Campus. The flora covers 43 Indian Native species and all other plants from exotic species in the study area. Most of the plant species recorded in the study area are of considerable ecological and economic importance, with medicinal value and useful as bio-resources to vild fauna and human beings. The results of this study provide insights into the importance of urban green space and reemphasize the need for conservation, planning and management of greenery for carbon sequestration and carbon neutrality.

| S.No. | Name of the Activity |
|---|---|
| 1. | **Environmental Education and Awareness**<br>• **Community** |
| 2. | **Assessment of flora and fauna of local environment**<br>1. Assessment of flora and fauna<br>a. Biodiversity register<br>2. Conservation<br>a. Nursery development<br>b. Nest box<br>c. Bird feeding<br>d. Water bowl for birds<br>e. Butterfly garden<br>3. Tree planting<br>4. Identification of invasive species<br>5. Cataloguing Medicinal plants |
| 3. | **Environmental Health & Hygiene**<br>1. Health & Hygiene issues<br>2. Awareness<br>3. Practices |
| 4. | **Energy audit**<br>**1.** Audit and assessment<br>2. Awareness and alternatives<br>3. Reducing Energy Consumption |

| | |
|---|---|
| 5. | **Environmental Pollution**<br>1. Inventory of pollution sources Industry, mining...<br>2. Water Quality Assessment/Monitoring<br>(a) Pond water, open well and bore well water samples<br>3. Air Quality Assessment / Monitoring - CO, $CO_2$<br>4. Noise levels<br>5. Soil Quality Assessment<br>6. Solid waste |
| 6. | **Soil and Land use Mapping**<br>1. Community map creation<br>2. Assessment of Soil quality<br>3. Agricultural practices - sustainable |
| 7. | **Cultural Heritage, Historical and Archaeological perspectives**<br>1. History of the village<br>2. Ecological practices - Past and present<br>3. Ecological Restoration |

## 2. Environmental Service Learners

Students admitted in ali the departments in the first year are to take up ESL as a community activity along with the Environmental Studies course they undertake for two semesters. Around 2, 200 students admitted in the first year are divided in to various groups with different subject background. The planned activities are allotted to different group of students according to various subject backgrounds.

Students of Arts, Commerce and Management background are to work with the Economics of Social issues, budgeting and sustainable management of resources, Environmental awareness programs and Recording of Cultural heritage and traditional practices.

Students of Science Stream are to work with Bio-resources and its sustainability, Environment, health and sanitation, Water and land quality and its sustainability, Pollution and Energy auditing and conservation and sustainability of Resources.

The ESL is monitored by Faculty (ESL Mentors) from Environmental Sciences Department and a faculty deputed from each department respectively.

## 3. ESL Community Network

The planned ESL activities are being carried out in any of the selected villages by the allotted ESL students. Needs of the villages are identified periodically in consultation with the local community by the ESL students and teachers in order to motivate them to carry out SL activities. Subject specific activities for different discipline were designed based on International standard learning resources.

# SUMMARY and CONCLUSIONS

## SUMMARY

The environmental action initiatives undertaken by the Indian partner institutions of the United Board have served to enhance learning by faculty and students within the campus and by reaching out to the community proximate to the College or University. Fifteen of these experiences have been documented in the Compendium. The partner institutions are located in the states of Tamil Nadu and Karnataka in South India, West Bengal in the East.

Many of the institutions are located in urban centres like Kolkata, Bangalore and Chennai, but a few are in rural areas and smaller towns. The urban campuses are typically 20-30 acres in area while the largest rural campus, Karunya University extends over 700 acres. Nevertheless most of the campuses provide unique learning opportunities within the campus itself- in terms of documenting the biodiversity, as well as managing resources such as energy, water and wastes.

Some of the projects involved interaction with the community outside the campus. These projects created opportunities for "environmental service-learning" by studying the environmental and health problems of the community and suggesting remedial measures. A few projects came up with innovative environmental solutions.

Some Colleges developed curricular material for the environmental studies course which is mandatory for all college and university students in India. Resource material like environmental audit methodology was also developed. The focus of the projects supported by the United Board was on environmental action rather than on pure academic research in environmental science/management. The projects have also stimulated the creation of interdisciplinary centres which draw faculty and students from different departments.

### 1. The Campus as a Classroom

Environmental action projects enable students and faculty to learn outside the classroom but inside the campus, as a way of augmenting their knowledge. The most obvious area is the campus biodiversity-documenting the flora and fauna found on the campus. The Compendium carries two articles on campus biodiversity- one by Samrat Bhattacharjee of Scottish Church College, Kolkata, and the other by Anand Gideon and others of Bishop Heber College, Trichy. There have been other studies that resulted in publications such as the

"Trees of Women's Christian College", "Trees of Lady Doak College" and "Living in Eden"(Karunya University) which were also supported by the United Board. Thus there is good documentation on the biodiversity found in various colleges even though many of them are located in urban areas.

In most of the cases, students of Botany, Zoology or Biotechnology accompanied their faculty on surveys of the campus. They identified plants/trees, birds, butterflies, insects, reptiles and other mammals. Such exposure is invaluable to the students to increase their knowledge apart from what they learn in the classroom. The Compendium contains photographs sent by the authors. However, it was not possible to include all the photographs due to constraints of space and cost.

Scottish Church College does vermi-composting of the campus waste which is used as a fertilizer for their plants avoiding the need to buy commercial fertilizer from outside. RanaSen provides more details in his article on green campus initiatives. Christ University and Karunya University also do composting of their campus waste and use the compost for gardening.

## 2. Managing Campus Infrastructure

Since most of the Colleges have several thousand students and staff, the energy and water requirements are considerable. Increasingly, with more affluent life styles, solid waste management is a serious problem in almost every campus. The scale of the problem is of an even higher order in Christ Universitywith a large student population of around 15000 and Karunya University which has a large number of residential students.

Christ University is a pioneer in solid waste management, and has provided training for several colleges. Paper and plastics are recycled while organic wastes are composted. The Centre for Social Action provides gainful employment in recycling for poor women from local self-help groups. Phinu Jose provides details of the various waste management measures undertaken, including awareness creation at Christ University.

Jibu Thomas and Karthikeyan conducted a solid waste audit at Karunya University for the campus buildings and residences. They provide quantitative characterization of the solid waste generated during normal days and during a sports tournament which attracts a large number of students from other colleges. Karunya has a biogas plant which digests

food waste from the hostels and produces gas which is used for cooking.
Energy bills are mounting in almost every institution. There is, therefore scope for energy conservation and/or renewable energy options like solar power. Anand Karunakaran of Bishop Heber College provides energy audit data and a proposal for a solar energy plant. Madras Christian College has received a large grant with support from the United Board for a solar plant which will meet 40 per cent of the campus energy requirements. Some other colleges have installed solar lighting and solar water heaters to reduce energy bills.
Salesian College in Darjeeling has designed and installed a micro-hydel project since they are located in the hills, to supplement grid power. Samar Thapa gives details of the project and some of the issues in implementation. Energy use is discussed in the articles from Scottish Church College and Lady Doak.
Water management is another area where conservation and/or recycling or reuse leads not only to better utilization of a scarce natural resource but can also save money for the institution in the long run. Rana Sen describes how Scottish Church College is reusing the water from the distillation plants thus reducing the fresh water requirement from public sources and also saving the electricity cost of pumping to overhead tanks. Karunya University, Christ University and Lady Doak College reuse the waste water from the treatment plant for gardening or plantations. However, this requires the construction of waste water treatment plant(s) and permission of the Pollution Control Board. Creating awareness among the students to conserve water in hostels could also reduce water usage. There are plenty of opportunities to manage energy, water and wastes in a sustainable manner in most campuses, thus reducing their ecological footprint as well as saving money for the institution.

### 3. Innovative Environmental Solutions

A few of the projects came up with innovative environmental solutions in the course of the project. Jaba Priya of Madras Christian College shows that chemical conversion of plastic PET bottles to solid terephthalic acid will provide greater revenue to the recyclers in comparison to the bottles. However, the economics of the conversion has to be worked out if it is to be adopted on a large scale. Reference has already been made to the micro-hydel project at Salesian College, Darjeeling.

Priyadarshini and others from Lady Doak College calculated the ecological footprints of four groups- Faculty, Staff, Day students and Resident students using survey data and factors from the literature. While the absolute values may be subject to debate, the relative footprints among the groups indicate which are more resource intensive. They also calculated the carbon footprint of the college using electricity usage data. Carbon sequestration in the main campus is small due to the minimal vegetation, but the satellite campus can sequester more carbon if the College wants to become carbon neutral.

Priscilla Jebakumari and Sathya Bama of Stella Maris College, Chennai have learnt about the uses of medicinal plants from the Irula tribe. They used ethno-botanical methods linking local knowledge to the environment. They have also established a seed bank repository on the campus. Thus, different projects have used innovative methods ranging from laboratory and engineering to social science and management aspects of the environment.

## 4. Environmental Service-Learning

"Service-Learning" is a concept that has gained currency in recent years in the educational field. Traditionally, colleges send students to the local communities for social service activities. In India, most higher education institutions require students to participate in the National Service Scheme (NSS) as part of their extension requirements. However, it is now recognized that students can also learn from the interaction with the local community about their problems and concerns. Service-Learning requires students to get some theoretical training before they go out into the community. They are expected to reflect on their experiences when they return to the campus in the form of a report or presentation. Environmental Service-Learning (ESL) extends the concept of service-learning to the environmental domain. Students are given some background in environmental sciences or management before they go to the community to study their environmental and health-related problems. They return to the campus to analyze data and to suggest remedial measures.

The Compendium contains several such community initiatives on environment and health. Leonilla Menezes and Sharmila Mascarenhas of St. Ann's College of Education, Mangalore developed ESL methodology to train teachers and students to study the environment and health problems of rural areas. There are two case studies of

environmental service-learning by faculty of Lady Doak College, Madurai. Dhanaseeli and others discuss the environment and health problems of a highly congested and polluted community near the campus. Priscilla and others conducted a health impact study in and around an open air crematorium. Students collected air and water samples which were analyzed in the laboratory after they returned to the campus.

Mary Pearl and Betsy Selvakumar of Women's Christian College, Chennai created awareness among both students and the local community about the problems caused by the indiscriminate use and disposal of plastic bags. Samar Thapa and Sandeep Sundas of Salesian College, Siliguri discuss the efforts by the College to get a dump site relocated. A dumping ground adjacent to the campus was causing serious odour problems as well as contamination of the ground water. The quality of the well water was analyzed in the college. The Stella Maris case study of the medicinal plants used by the Irula tribe could also be described as an ESL exercise.

## 5. Institutionalizing Environmental Studies

### A. Interdisciplinary Environmental Centers

Environmental studies once was just a part of Biological Sciences curriculum. But when the environmental issue became a crucial global issue, it caught the attention of physical, biological and social scientists and others across all disciplines to study and conserve environment and evolve remedial and mitigation strategies to prevent its degradation. Colleges and universities moved to transcend traditional subject barriers and as an outcome **Center for Environmental Studies** was established in some institutions like Lady Doak College, Madurai and Union Christian College, Aluva, Kerala, with the seed money given by the United Board. The center engages in the following activities, with a senior professor as coordinator and a team of teachers drawn from different disciplines as members.

- Promote an innovative and trans-disciplinary approach to the study of environment; designing various academic, extension and community based programs.
- Develop faculty expertise and students competence through seminars, field visits, research and training at national / international level
- Build up resources and facilities to serve as nodal center for

consultation & research

- Promote environmental education on and off campus through advocacy, awareness and action programs
- Coordinate inter-disciplinary eco projects such as pollution studies , alternate energy, resource/ waste management & conservation
- Document and publish valuable information on campus biodiversity, energy audit and other environmental issues.

**B. Curriculum Development for Environmental Studies**

As early as 1984, Bishop Heber College initiated a department of Environmental Sciences in a unique way drawing faculty expertise from Chemistry, Biology, Social Sciences and other interested departments, to offer a PG course in Environmental Sciences. Since then the department has developed as a reputed center for teaching, training, research and extension activities in environment .Recently the department with the support of UB, has designed a curriculum for Environmental Service Learning offered to all UG students (details annexed). The college is also known for conducting Nature Study to groups of students and faculty at national and international level. Bishop Heber College was identified as the nodal center in 2010 by UB to collaborate with other member institutions in promoting Environmental action projects. Campus environmental audit was one of the focuses of this collaboration and a manual was developed on green campus audit.

Similarly, Madras Christian College in collaboration with a few other Asian Universities, introduced an interdisciplinary innovative course on Marine Studies and Coastal Resource Management (MS&CRM) at master's level supported by UB.

Lady Doak College was also recognized as a nodal center by UB in 2012-13 to form a consortium with five other colleges to produce a text-book for Environmental Education (see under publication section).Apart from explaining theories, concepts and environmental issues, activities for outdoor exploration and personal investigation are outlined in this book to make it user friendly. Availing the academic freedom under autonomy, courses were designed on environmental aspects relevant to one's discipline, like Environmental Chemistry, Environmental Economics and Environmental History or "Know your environment" a part of value education.

## CONCLUSIONS

The Compendium documents some of the environment and health related outcomes of projects implemented by the Indian partner institutions of the United Board. The coverage is not comprehensive as it is based on the responses of the Colleges and Universities to an appeal made by the Editors. Partner institutions have carried out many other initiatives- some supported by the United Board; some by other donor agencies: and some by their own managements particularly in areas relating to energy and waste management. Thus, the Compendium is intended to be illustrative of what higher education institutions can do in terms of environmental action. Other colleges in India or other Asian countries can use these case studies as a model.

It may also be time to move to a higher level, such as environmental certification/accreditation of institutions as done in The Philippines. Currently the accreditation of higher education institutions in India, requires a section on best management practices which includes environmental initiatives. However, colleges in India and particularly the partner institutions of the United Board can think of a process of certifying or accrediting environmental sustainability. Environmental Audits which are still at a rudimentary level can be developed further as a tool for environmental accreditation.

Finally, the Compendium reflects the outcomes of sustained support by the United Board in the area of Environment and Health. It is up to the partner institutions to take these initiatives forward using their own resources:

(a) To enhance learning by students and faculty of the environment in which they live; and

(b) To improve the quality of the environment of their campus and the communities around them.

# LIST of CONTRIBUTORS

1. **Dr. Samrat Bhattacharjee,** M.Sc., Ph.D., Assistant Professor & Head of Zoology Department, Scottish Church College, Kolkata. His doctoral research was on super family Vespoidea of Jaldapara Wildlife Sanctuary, West Bengal. He has nine publications in National and International journals and has been a reviewer for the Journal of Bombay Natural History Society. He has involved in several UB projects of the college and one UGC Project on Ant Faunal Diversity of Narendrapur Bird Sanctuary, West Bengal. He serves as a member of the UG Board of Studies in Zoology, University of Calcutta.

2. **Dr. Rana Sen,** M.Sc., Ph.D., Associate Professor of Chemistry, Scottish Church College, Kolkata is a theoretical Chemist with more than three decades of teaching experience. He is associated with the UB projects for several years, particularly relating to environmental action. His area of interest is the development of a Green Campus and has involved in projects on vermi composting, water conservation and recycling.

3. **Ms. Phinu Jose,** MBA, ia an Assistant Professor in the Department of Management Studies and Director, Centre for Social Action, Christ University. She is specialized in Marketing and Human Resources. Her area of interest is Social Entrepreneurship and innovation. She is also interested in facilitating Learner-centric teaching along with Communication and Marketing. She is active and enthusiastic about sport, art and any value-addition activities that enhance student development. She has been an Associate NCC officer at Christ University previously.

4. **Dr. Jibu Thomas,** M.Sc., Ph.D., Assistant Professor in the Department of Biosciences and Technology since 2010 at Karunya University, Coimbatore. He is actively involved in research related to Environment, Sustainable agriculture, Bio formulations, Bio fuels and Green technology. He has been the Coordinator for Nature Club – Environment Unit where about 250-300 students participate in outreach programs. To his credit he has about 20 international peer reviewed publications and 30+ national publications

5. **Dr. Karthikeyan S.,** MBA, Ph.D. The Head of Centre for Extension Activities and co-ordinates the various extension activities under 15 clubs in Karunya University. He monitors the activities where about 1200-1500 students participate and earn their non academic credits each year. He is also the author of many publications.

6. **Dr. D.J.S. Anand Karunakaran,** M.Sc., PhD, Assistant Professor of Physics, has 10 years of teaching at Bishop Heber College, Trichy. Previously he has been teaching and training higher secondary school teachers for more than a decade. He has expertise in Energy Audit and offers consultancy in the field of solar and wind energy. His areas of interest are Dielectrics and Ferroelectrics.

7. **Prof. A. Alagappa Moses,** Head, Environmental Sciences, Bishop Heber College, is an Empanelled Functional Area Expert in the field of Ecology and Biodiversity (EB) for Category A Projects accredited by the National Accreditation Board for Education and Training (NABET) since 2010. His areas of specialization include Wastewater Engineering, Environmental Impact Assessment, and Environmental Audit. He has participated in several Environmental Management programmes in The Netherlands (1987), France (1987), Italy (1987) USA (1998) and Thailand (2010) and is an active researcher with several publications. Has organized many environmental programs at national and international level.

8. **Dr. V. Anand Gideon,** M.Sc., PhD, is an Associate Professor of Botany, Bishop Heber College, Trichy since 1998. His area of specialization is In vitro Conservation of endangered plants. He has carried out research projects in Butterfly breeding and rearing and documented the Green Treasures of Bishop Heber College under the auspices of Heber Au Sable Institute and United Board respectively. He has published 12 research papers in National and International Journals.
He has undergone training in Limnology and Wildlife Ecology in Au Sable Institute of Environmental Studies, Michigan, USA in 2013 and Green Accreditation in Miriam College, Philippines.

9. **Mr. P. Vivekraj,** M.Sc, is a University rank holder in his post-graduation, and class topper throughout his academic journey. He has authored eight papers and participated in various seminars with paper presentations. His specialization is "Conservation Biology".

10. **Dr. M. Sheela Mary,** M.Sc, M.Phil., Ph D., is an Assistant Professor of Environmental Sciences, Bishop Heber College since 2014. Her areas of interest are Environmental Toxicology, Environmental Microbiology, Biotechnology and Service Learning. She has published six papers in International Journals and a book.

11. **Dr. Manorama Dhanaseeli,** M.Sc, M.Phil., Ph.D., Associate Professor of Botany & Microbiology, Lady Doak College, Madurai, has 34 years of teaching and research experience. Earlier she has been jointly coordinating the Centre for Environmental Studies. Her area of specialization is Mycology and Biological control of weed pathogens. Her special area of interest is gardening and flower arrangement. She has actively involved in several community outreach projects.

12. **Dr. A.S. Priscilla,** M.Sc, PhD., is an Assistant Professor of Zoology with 15 years of teaching and research experience. Her area of specialization is Immunology. She had been a United Board Fellow of 2012 – 2014 batch and former Joint Co-ordinator of Centre for Environmental Studies. She has been coordinating the Life Frontier Education program of the college.

13. **Dr. Leonilla Menezes (Sr. M. Clare, A.C.),** M.A., M.Ed., Ph.D., Principal of St.Anne's College of Education, Mangalore, has 26 years of teaching experience at undergraduate and post graduate level. Her areas of specialization are Philosophical and Sociological Perspectives of Education, Educational Technology, Guidance & Counselling and Institutionalizing Service Learning. She is also a recognised Ph.D. Guide in Education under Mangalore University.

14. **Mrs. Sharmila L. Mascarenhas,** M.Sc., M.Ed., is an Assistant Professor, St. Ann's College of Education (Autonomous), Mangaluru. Her areas of specialization are Content Based Instructional Methodology of Teaching Biology, Philosophy of Education, Psychological Perspectives of Education, Environmental Education and Computer Education. She has a teaching experience of 10 years at the undergraduate and 3 years at post graduate level.

15. **Mrs. D. Joy Marjorie Annal,** M.Sc., M.Phil., Assistant Professor of Botany has 9 years of teaching experience and her area of specialization is plant microbe interaction. She has a passion for sustaining a healthy environment. She has been active in community based environmental projects

16. **Mr.Samar Thapa,** M.Sc., M.Tech., is an Assistant Professor of Environmental Studies in Salesian College, Sonada, presently pursuing PhD in Thermal Comfort. His area of interest include building energy conservation and modelling, green buildings, solar thermal systems and biomass briquetting. He has published several papers in various national and international journals.

17. **Dr. Priyatharsini Rajendran,** M.Sc, M.Phil., Ph.D., Assistant Professor of Zoology, Lady Doak College, with 22 years of teaching and research experience .She is jointly coordinating the Centre for Environmental studies since 2003 till date. Her area of specialization includes fish immunology and environmental studies, biodiversity, with special interest in birding.

18. **Dr. Akshaya. Mu,** M.Sc.,M.Phil.,Ph.D., Assistant Professor with 2 years of teaching and research experience at the Department of Biotechnology, Lady Doak College. She is a member of the Centre for Environmental studies, since 2014. Her area of specialization includes Molecular Biology, rDNA technology and Environmental Biotechnology.

19. **Dr. R. Gunaseeli Sathiamoorthy,** M.Sc, M.Phil., PhD., presently the coordinator for centre for Environmental studies at Lady Doak College. She is the former Vice Principal and Head, Department of Botany and Microbiology with 32 years of teaching and research experience. Her areas

of specialisation include Phycology, Taxonomy, Genetics and Environmental Studies.

20. **Ms.Jaba Priya T,** M.Sc., M.Phil., Assistant Professor of Chemistry, Madras Christian College is an active teacher cum researcher, has authored / co-authored many research papers and books. Her areas of interest include adsorption of dyes, Supra-molecular Chemistry, depolymerisation of pet bottles and Service Learning. She has been handling projects funded by Government and private organizations.

21. **Dr.Priscilla Jebakumari,** M.Sc., M.Phil., Ph.D., is an Associate Professor of Botany at Stella Maris College, Chennai. Her area of interest is Soil Microbiology and Service Learning. She is also the Academic Dean of the College. She has been actively involved in the environmental projects of the college.

22.**Dr.S.Sathaya Bama,** M.Sc., M.Phil., PhD., Asst.Prof.of Botany, Stella Maris College, has more than 15 years of teaching Botany. Her area of Specialization is Phytochemicals, Biofertilizers and Ethnobotany. She has published two books and several research papers in reputed journals.

23.**Dr. Betsy Selvakumar,** M.Sc., M.Phil., Ph.D. Associate Professor & Head, Zoology & Biotechnology at Women's Christian College, Chennai , has more than 3 decades of teaching & curriculum design. She was the United Board Fellow (2004-2006) at the Valparaiso University, Indiana, USA and International Christian University, Japan. She has designed innovative courses in Field Zoology, Nutrigenomics, Bioinformatics and Service Learning. A vibrant campaigner against plastic usage & actively promotes Bird Watching.

24. **Dr. Mary Pearl Ravikumar,** M.Sc., M.Phil., Ph.D. Assistant Professor & Dean of Student Services., Women's Christian College, Chennai. As a coordinator of Eco Club of the college for many years and a keen bird watcher and nature lover, she has been instrumental in igniting the passion of students for Environment.

She visited Miriam College Campus, Manila, Philippines, for a training Program on Campus Environmental Audit. She has carried out several environmental projects such as plastic bag menace and 'Resource recovery on campus' setting up a vermicompost unit. She has been an active campaigner of "White Pollution".

## Editors

**Dr. Nirmala Jeyaraj,** M.Sc., PhD. Former Principal (1996-08) of Lady Doak College, Madurai, and Former Program Director (2008-09) of the United Board, Hong Kong. She has specialized in Molecular Biology with more than three decades of teaching and research experience with publications to her credit. She was UB sponsored Visiting Professor (1991-92) in USA and a Visiting Scholar (1986-88) in UK. Her other areas of interests being Gender Studies, Environmental Studies and Service Learning, these were institutionalized at Lady Doak during her tenure as Principal. Currently as an educational consultant, she guides colleges in their Quality initiatives.

**Dr. Paul P. Appasamy,** B.Tech, M.S., MBA, Ph.D. Former Vice-Chancellor, Karunya University, Coimbatore and Former Director, Madras School of Economics and Madras Institute of Development Studies, Chennai. Research interests include environmental economics, water resources management and urban development. Former Trustee of the United Board for Christian Higher Education in Asia. Currently serves on the Boards of some Christian Colleges and as Honorary Professor, Madras School of Economics, Chennai.