# TERI – NCSTC

## ECO EUREKA TRAINING MANUAL 2018 – 19

Catalyzed and supported by:

**National Council for Science and Technology Communication, Department of Science and Technology, Government of India**


The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

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**The Energy and Resources Institute (TERI)**

Case studies are based on TERI's projects and these were used in the sessions with subject experts during the training. Names of the experts are also mentioned in the relevant sections

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SNAPSHOTS OF

# TERI – NCSTC ECO EUREKA TRAINING 2018 - 19

## ORGANISED IN DELHI, BENGALURU AND GOA









# 1. Introduction

## Background

21st century is an era of experimentation- be it with respect to environment, agriculture, waste or energy. All these issues also have a far reaching impact, when mainstreamed with societal aspects of bringing about a positive change in the neighborhoods and surrounding. This is achievable only when the capacity building initiatives are planned with the right mix of pedagogies because imparting knowledge is an ever evolving concept, limiting not only to text books but beyond. Educators have to constantly try and test different permutations and combinations to make learning creative and attractive to students.

The right knowledge is an enabler for not only contributing to the development of well- informed citizens, but also leading towards an era where voices of young people will be heard. A look at the status of media clearly presents opportunities to broaden society's outlook and provide new technological skills and bring greater youth participation.

### About the Project: TERI – NCSTC Eco Eureka Training 2018 - 19 organised in Delhi, Bengaluru and Goa

Realizing the importance of working with the demographic dividend of India, The Energy and Resources Institute (TERI) implemented TERI- NCSTC Eco Next Investigation for Youth from 2018 – 19 which was catalyzed and supported by National Council for Science & Technology, DST, New Delhi. The program strived to create a cadre of youth who are aware, innovative and are ready to create a difference for nature conservation, eco- restoration, nature based solutions, co- creation and innovation. The project looked at science as a necessary means to mitigate and solve present and emerging environmental problems. However, the specific objectives were as follows:

- To provide a platform to the youth to learn concepts on nature conservation, eco- restoration, nature based solutions, co- creation and innovation.
- To hone leadership skills in youth, this will subsequently enable them to transform knowledge into action
- To instill a sense of responsibility and engage youth in environmental stewardship to play a proactive role in addressing issues related to sustainable development
- To encourage use of media as a means of reaching out to the masses

The programme focussed on 3 key principles of imparting knowledge, building skills and competencies and enabling action to reiterate the learnings imparted during the capacitiy building programmes. The workshops were designed to cover various aspects of environment through presentation of case studies that have been carried out at TERI. Along with knowledge, sessions that facilitated research and communication in the area of environmental science. An opportunity was provided to the participants to undertake research project through fellowship programs which paved the way to enabling action at the grass root level.


## Towards Sustainable Development Goals

***Eco Eureka Training is a journey of not only connecting nature and science to showcase how science can be used for the conservation of nature and the environment but also of self-exploration, understanding interlinkages and leadership where the goal is defined not by a destination but a belief in limitless possibilities of creating a harmonious world.***

**SDG 4**
**SDG 6**
**SDG 7**
**SDG 9**
**SDG 11**
**SDG 12**
**SDG 13**
**SDG 14**
**SDG 15**

TERI organized 6 Eco Eureka Trainings in Delhi, Goa and Bengaluru. The main objectives were to deliberate on the problems faced by these regions and the plausible solutions that provided a necessary impetus to solving the problems. All the issues that were dealt with revolved around 3 pillars of sustainable development- environmental, social and economic and had deep rooted connections with achieving the targets of SDGs. Out of 17 SDGs, trainings focused on building capacity of students on education for sustainable development (ESD-SDG 4), water, sanitation and hygiene (SDG 6), renewable energy with emphasis on biofuels (SDG 7), urban planning (SDG 11), waste management (SDG 12, 13), climate change and environment sustainability (SDG 14, 15)

## Outcomes

- Trained 175 students on key thematic areas of environment and sustainability directly.
- Involved 55 experts through active interactions with participants.
- Showcased power of science communication and WASH related issues in finding sustainability solutions.

- Engaged youth through intensive interaction spread over 40 days and 320 hours.
- Selected 17 Eco Eureka Fellows and 6 Eco WASH Fellows implemented sustainable solutions reaching out to approximately 10,000 people comprising of students, farmers, aaganwadi professionals, households, etc.
- Provided opportunities for participants to enhance their communication, leadership potential and establish networks.
- Provided exposure to live facilities and projects such as TERI's Enhanced Acidification and Methanation (TEAM) which converts food waste into biogas, Biomass Gasifier- which converts wood biomass and agricultural residue to electrical energy. In Goa to TERI Coastal Education Hub which showcases the State's typical biodiversity and natural treasures along with sustainable and eco-friendly techniques and technologies. In Bengaluru to Biodiversity Park, Rain water harvesting facility, TERI's Southern Regional Centre office green building and

## About the TERI – NCSTC Eco Eureka Training Manual:

A series of trainings were conducted by TERI for youth over the period 2018-2019. Customised city specific issues focusing on aspects of environment and sustainability were covered in training sessions conducted by resource experts. The delivery of these technical concepts were brought to a level of understanding by youth. Emphasis on science communication, ICT and project management were an integral part of the trainings. The takeaway for students from these sessions were solutions that they could adopt to have a transformative impact on society through achievement of SDGs.

We encourage the readers to get in touch with the Environment Education and Awareness (EEA) team at TERI to access more information on the subject.

# 2. City Specific **Modules**

## 2.1 Delhi

### A. Theme: Sustainable Agriculture:

Duration: 2 Hrs

**Expert:**
**Dr Nidhi Chanana,** Fellow and Area Convenor, Sustainable Agriculture, TERI

➲ **Case study: TERI's Research Initiative at Supi for Himalayan Advancement (TRISHA)**

Problem statement: The farmers of Ramgarh and Dhari blocks of Nainital district, Uttarakhand grow traditional crops like potato and other vegetables. The crops often fail either due to lack of vprecipitation or unpredictable and incessant rains leading to major pest infestation. Besides, these being input intensive crops, small farmers get poor yields due to unaffordability. In addition, small fragmented land holdings and difficult terrain make matters worse. This leads to meager returns. Man-animal conflict further aggravates the situation. Hence, such hardships have been compelling the rural community to either survive on subsistence agriculture or shift to other lucrative occupations or eventually migrate for better opportunities.

**TERI' approach:** TERI has initiated efforts by establishing TERI's Research Initiative at Supi for Himalayan Advancement (TRISHA). According to Census 2011, Supi village is located in Nainital Tehsil of Nainital district in Uttarakhand. It is situated 45km away from Nainital, which is both district & sub-district headquarter of Supi village. Supi village is also a gram panchayat. The total geographical area of village is 606.08 hectares, with a population of 2,077 peoples and 364 houses.

In 2003, 7.5 hectares of land was provided on lease for 30 years by the Government of Uttarakhand. Since agriculture is the main occupation, research and extension has been largely undertaken to improve the livelihoods of local farmers. In 2007, TERI initiated work on improving livelihoods through bio-innovations with support from Department of Biotechnology, Government of India, and subsequently, NABARD.

**Objective:** The aim was to develop the aromatic and spice crop value chain as a viable approach for providing financial security to the marginal farmers of the selected villages.

**Impact:** As the farmers were looking for respite from these tribulations, they were keen to adopt new crops/technologies that could minimize risks emanating from weather extremities. The crops that were initiated into farming were scented geranium, parsley, oregano, rosemary and garlic. Planting material was provided to farmers for cultivation in their under-utilized land. These crops were introduced as these could be grown on fallow land and that too almost round the year; and required less water and agriculture inputs. Additionally, animals do not damage these crops; therefore providing better crops and better income to the farmers in small and fragmented land holdings. Following are some of the outcomes of TRISHA:

➲ **Redressal of environmental problems**

a. Providing roof top harvesting infrastructure linked to low cost tanks proved highly relevant and was able to meet the water requirement in the farms.

b. Another innovation was the use of drum kit type drip irrigation technology. Being gravity based and hence was apt for the hilly terrain; it minimizes the initial capital cost with no electricity requirement. Hence, this technology provided critical irrigation to the aromatic crops and increased the water use efficiency by almost 4 times.

c. TERI's interventions brought fallow/ underutilized land under cultivation and water saving by 50% through cultivation of aromatic herbs vis-à-vis that of potato. Lesser use of chemical and fertilizer and use of bio-inputs such as vermin-compost helped enhance soil productivity.

➲ **Redressal of financial problems**

d. Formation of an SHG: For essential oil extraction from scented geranium, two oil distillation units have been established in Supi and Satbunga villages. Currently farmers bring the herbage of scented geranium from their fields and extract the oil. With this vision, TERI facilitated farmers to establish a self-help group called P.E.O.P.L.E. (Promotion of Essential Oil Production for Livelihood Enhancement), which is responsible to develop value added products from medicinal and aromatic plants such as dried herbs, oil and hydrosols.

e. Employment generation: The project has heralded new employment opportunities for local youth as they got acquainted with new farming systems and water management technologies to go beyond their conventional systems. They were sensitized towards micro-entrepreneurship to earn better livelihoods for their families.

f. Increased standard of living amongst women: As women were involved in most of the operations of this value chain, they got an opportunity to participate and gain knowledge about new activities. This, in turn, boosted their confidence and even helped reduce their drudgery.

g. Income of the rural people: The increase in herbage and subsequently essential oil through efficient water management led to better returns. The farmers attained additional remuneration from the cultivation of the aromatic herbs. On an average, the farmers received around 75,000-2, 00,000 per hectare annually from cultivation of parsley, oregano, rosemary and geranium cultivation. Besides, cultivation of aromatic crops assures a well distributed income throughout the year in comparison to conventional crops.

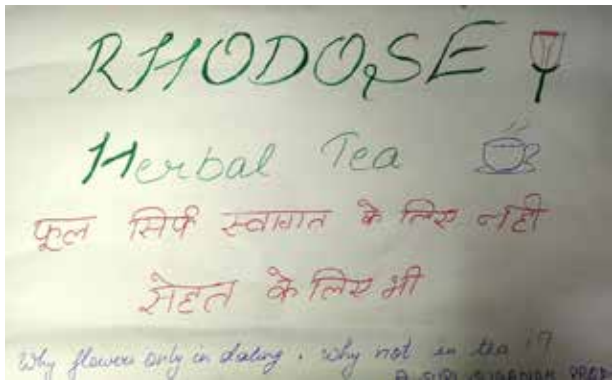
h. Market linkages: Due to long term engagement and better reap, local participation was immense and at a much better scale. TERI provided market linkages to the farmers by arranging buy-back of the produce. Products are being sold under the umbrella brand of Supi Sugandh.

### ➲ Group activity

**Material required:** Chart papers, markers colors, soft board and thumb pins.

**Team size:** A group of 30 students is divided into 2 smaller groups of 15 students each.

**Activity description:** The expert introduced two products which are under experimentation by Supi Sugandh. One was a jam made out of apples which is rich in calcium and iron and the other was a herbal tea made out of rhododendron flowers. Each group was given one product and they were asked to brainstorm and research on the possible benefits of buying the products, it's pricing, name and an advertisement which would catch the eyeballs of probable buyers. Students were asked to present their findings either in the form of a role play or a poster presentation.




*Poster from the Group Activity*
*Batch 1: TERI NCSTC Eco Eureka Training, New Delhi*

### ➲ Learning outcomes

Through this module, students became aware about the possible innovations that can be practiced on a farm or in similar settings. Students also understood the scientific interconnections that were adopted as solutions in the field of water conservation, farming practices and livelihood generation.

## B. Theme: Sustainable buildings

Duration: 2 Hrs

**Expert:**
**Ms Shabnam Bassi,** Secretary, GRIHA Council
**Mr Akash Deep,** Senior Manager, GRIHA Council
**Mr Gautam Aswani,** Project Officer, GRIHA Council

### ➲ Case study: Green Rating for Integrated Habitat Assessment (GRIHA)

**Problem statement:** Apart from the basic function as a shelter, a building should provide two fundamental physiological 'comforts' to its occupants; they are:

i. Visual comfort (the ability to allow occupants to see clearly for carrying out their daily domestic/official tasks), and
ii. Thermal comfort (the ability to keep occupants cool in the summers and warm in the winters).

These 'comforts' can be provided naturally (using sun-light, natural winds, evaporation, trees, etc.) while saving energy, and artificially (using electric lighting, ACs, etc.) involving large-scale energy generation leading to pollution and green-house gas emissions. Additionally, these 'comforts' can respond to

i. Local conditions since local conditions vary from place to place, and give lots of flexibility in designing local buildings and

ii. Global conditions which cater to "international" requirements which may drastically vary from our local conditions, and may require a lot of energy.

Lack of appropriate information and tendencies to follow fashionable trends that are short-lived often lead us to provide 'international' comfort conditions in our buildings, at the cost of very high energy consumption. It should be our endeavor to help secure the energy and resource future of our country through green buildings and habitats suitable to our country and people.

## How do buildings impact the environment?

In India, a well-designed building is built of concrete and bricks, and may have a design life of up to one hundred years. During such a period, buildings consume unimaginable quantities of resources such as;

**Land:** Farms, forests, fertile land, marshes, etc.

**Soil:** Clay, stone, lime, sand, silica, etc.

**Trees:** Wood, ply, board, shuttering, etc.

**Metals:** Steel, iron, aluminum, copper, lead, etc.

**Plastics:** PVC, UPVC, PU, etc.

**Water:** Construction, landscape, cooling, washing/ drinking / flushing, etc.

**Electricity:** Cooling/heating, lighting, pumping, entertainment / working, etc.

**Waste:** Site waste, cut trees and vegetation, excavated soil, blasted stone, rubble, construction waste, metals, boxes/cans, broken bricks, shuttering oils, demolition debris, all plastics, synthetic fibres, etc.

**E waste:** CDs, electronics, hardware, etc.

**Chemical waste:** adhesives, paints, etc.

**Sewage/sullage:** black water, grey water, etc. Organic waste peels, vegetables, fruits, etc.

India generates approximately 150,000 to 200,000 tons of waste per day. This waste has now become unmanageable and requires a lot of energy and land to get rid of, through toxic processes such as incineration or land filling. Additionally, since most municipal solid waste in not segregated at source, it becomes tougher to introduce it into the recycling stream and thus the contamination from the same is worse still. It is critical that buildings reduce their resource consumption and waste generation. And also to ensure that the waste generation is managed in a manner as to reduce the impact of the waste on the environment. Cities today are cesspools of disease and epidemic. With waste materials contaminating our ground-water, farm lands, forests, and the air we breathe. We have to turn the situation around before it is too late.

## TERI's approach: GRIHA - Green Rating for Integrated Habitat Assessment

GRIHA is India's National Rating System for green buildings. It has been developed by TERI and is endorsed by the Ministry of New and Renewable Energy (MNRE). GRIHA is a Sanskrit word, literally meaning 'A house containing several rooms'. It is taken from an ancient Indian document which is among the oldest extant texts of any language in the world – the Rig Veda.

The rating is based on nationally accepted energy and environmental principles, and seeks to strike a balance between established practices and emerging concepts, both national and international. GRIHA attempts to minimize a building's resource consumption, waste generation, and overall ecological/ environmental impact by comparing them to certain nationally acceptable limits / benchmarks. It does so, by adopting the five 'R' which are key ingredient to sustainable development, namely

i. Refuse – to blindly adopt international trends, materials, technologies, products, etc. especially in areas where local substitutes are available

ii. Reduce – the dependence on high energy products, systems, processes, etc.

iii. Reuse – materials, products, traditional technologies, so as to reduce the costs incurred in designing buildings as well as in operating them

iv. Recycle – all possible wastes generated from the building site, during construction, operation and demolition

v. Reinvent – engineering systems, designs, and practices such that India creates global examples that the world can follow rather than us following international examples.

Going by the old adage 'what gets measured, gets managed', GRIHA attempts to quantify

### CRITERIA FOR GRIHA ASSESSMENT

1. Site Selection
2. Preserve and protect landscape during construction/compensatory depository forestation.
3. Soil conservation (post construction)
4. Design to include existing site features
5. Reduce hard paving on site
6. Enhance outdoor lighting system efficiency
7. Plan utilities efficiently and optimize on-site circulation efficiency
8. Provide minimum level of sanitation/safety facilities for construction workers
9. Reduce air pollution during construction
10. Reduce landscape water demand
11. Reduce building water use
12. Efficient water use during construction
13. Optimize building design to reduce conventional energy demand
14. Optimize energy performance of building within specified comfort limits
15. Utilization of fly-ash or equivalent industrial/ agricultural waste as recommended by BIS in building structures
16. Reduce embodied energy of construction is reduced by adopting material efficient technologies and/or low-energy materials
17. Use low-energy materials in Interiors
18. Renewable energy utilization
19. Renewable energy based hot water system
20. Waste water treatment
21. Water recycle and reuse (including rainwater)
22. Reduction in waste during construction
23. Efficient Waste segregation
24. Storage and disposal of wastes
25. Resource recovery from waste
26. Use of low-VOC paints/adhesives/sealants
27. Minimize ozone depleting substances
28. Ensure water quality
29. Acceptable outdoor and indoor noise levels
30. Tobacco and smoke control
31. Provide at least the minimum level of accessibility for persons with disabilities
32. Energy audit and validation
33. Operation and Maintenance
34. Innovation Points

aspects, such as, energy consumption in terms of electricity consumed in kWh per square meter per year, water consumption in terms of litres per person per day and waste generation in terms of kilograms per day, or litres per day, renewable energy integration in terms of kW of connected load, so as to manage, control and reduce /optimize the same to the best possible extent.

GRIHA assesses a building out of 34 criteria and awards points on a scale of 100. In order to qualify for GRIHA certification, a project must achieve at least 50 points. Certain criteria / sub-criteria are mandatory and have to be complied for the project to be at all eligible for rating.

**Project scoring is as follows:**

1. 50-60 points is certified as a 1 star GRIHA rated building,
2. 61-70 is a 2 star GRIHA rated building,
3. 71-80 is a 3 star GRIHA rating building,
4. 81-90 is a 4 star GRIHA rated building and
5. 91-100 is a 5 star GRIHA rated building

The guidelines/criteria and appraisal norms is revised every three years or sooner to take into account the latest innovations/best practices happening during this period.

**Impact:**

The greenest possible habitat would strive to achieve the following:

- Optimize demand for electricity, water and other natural resources (in construction, operation and demolition)
- Generate all its electricity on site through renewable means
- Cater to all its water demands through sustainable processes such as rain water harvesting Grow its own food on site
- Recycle and reuse all its waste on site and burden the environment to the minimum. We often refer to this process of design as “closing the loop”.
- In other words, striving to generate and utilize on-site resources to construct and operate the building and then ensuring that all the waste material is managed on-site itself, thereby leaving nothing (if possible) to be put into the municipal systems.

**In the Indian context, a building is ‘green’ when**

- It is designed using an integrated approach (as mentioned in NBC, Part 0)
- It provides its users with an “optimal” level of comfort catering to local needs (as per NBC-Part 8)
- It uses minimum resources, sourced locally (as per various IS codes and other local materials)
- It consumes minimum energy and water (as per ECBC and NBC)
- It generates optimum waste, processed locally (as per CPCB, and MoEF norms) during its construction

### ➲ Group Activity

Team from GRIHA has developed a board game titled, 'Power Wars' on the lines of Star Wars. Students were divided into 5 groups and each one of them was asked to assign titles for their respective group. A board that signifies a house and dummy electrical appliances were given to the groups. There was a total budget of Rs 150,000 given to each groups and electrical appliances were priced too with electricity consumption. Each group had to install the electronic appliances in such a way such that budget is not exceeded and electricity consumption is the least.

Another game was played on the sidelines of Tambola, where students were distributed tambola slips which had interesting topics related to environment. The moderator called out all the topics and explained the terminologies and also played the game.

### ➲ Learning Outcomes

Through this module, students became aware about an Indian rating system for building; GRIHA. In Delhi, examples of green building were discussed while in Bengaluru, TERI office itself is a green building, hence experts exposed the participants to vivid features of the building.

## C. Theme: Waste Management

Duration: 2 Hrs

Expert:
**Mr Sourabh Manuja,** Fellow, Environment & Waste Management, TERI

### ➲ Case Study:

**Problem statement:** TERI formulated a case study on East Delhi Municipality Corporation in order to deepen the knowledge on root level approach used to deal with waste management. The objective of this study is to conduct an independent audit for monitoring of waste collection systems in EDMC area as a third party and identify gaps and deficiencies in the system; this will help EDMC in improving their existing solid waste management system. The collection system refers to primary collection (door-to door collection) and secondary collection at Dhalaos.

Auditing of solid waste management is required for identification of lacunae existing in meeting regulatory compliances, occupational health and safety, managing resources in terms of primary collection, prevention of pollution etc and finally providing solutions for plugging the gaps. This

audit will also aid in understanding the scenario of waste management in the 64 wards of EDMC and help in planning future actions.

**TERI's approach:** The methodology followed by TERI included the following steps:

- **Data Collection:** Data was collected regarding the existing systems of waste collection in the EDMC area through ULB officials. The existing baseline data reports undertaken for Delhi and for EDMC were studied.
- **Mapping key stakeholders:** Key stakeholders involved in waste collection were identified and mapped on a power interest matrix.
- **Questionnaire and checklist preparation:** A detailed questionnaire was prepared to gather information about collection mechanisms for audit, shared and discussed with the Municipality officials.

## Circular Economy

A session on circular economy was facilitated by Dr Malini Balakrishnan, Senior Fellow, Environment & Waste Management, TERI. In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimized, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth and job creation. A circular economy encourages sustainability and competitiveness in the long term. It can also help to:

- preserve resources – including some which are increasingly scarce, or subject to price fluctuation
- save costs for industries
- unlock new business opportunities
- build a new generation of innovative, resource-efficient businesses – making and exporting clean products and services around the globe
- create local low and high-skilled jobs
- create opportunities for social integration and cohesiveness

- **Selection of wards and colonies:** Based on statistical analysis (>90% confidence level) 60 colonies were selected spread across 40 wards. These colonies have been selected based on the category C, D, E, F, G, H, in proportionate manner. With 40 wards and 60 colonies, approximately 1-2 colonies were selected per ward. A random selection of colonies from different categories was undertaken keeping in mind that whole EDMC area is captured geographically. The selected colony list was finalized after discussion with Municipal officials. The colonies selected were further captured for conducting interviews based on a 200 x 200 grid matrix.
- **Dialogue with households:** To triangulate and test the questionnaire, a pilot was conducted with households in the colonies equally from the three income groups.

**Objective:** The objective of this study was to conduct an independent audit for monitoring of waste collection systems in EDMC area as a third party and identify gaps and deficiencies in the system; this would help EDMC in improving their existing solid waste management system. The collection system referred to primary collection (door-to door collection) and secondary collection at Dhalaos.

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audit also aided in understanding the scenario of waste management in 64 wards of EDMC and helped in planning future actions.

**Impact:** Following were the recommendations submitted to EDMC to improve the MSW collection:

1. Capacity building of waste generators in order to increase waste segregation
2. Ensure proper segregation of waste, a three bin system needs to be introduced
3. The waste collection fleet run by EDMC presently collects all the unsegregated waste. The fleet too needs color coding, where the green truck will only pick up the organic waste and the blue will pick up recyclables, non-recyclables, combustibles, etc.
4. The primary waste collection fleet and dhalao need to be divided into two compartments, green and blue. The households/micro enterprises like vendors and hawkers who dump waste directly into the dhalao will need to segregate and dump it into their respective bins. Since more than half of the waste coming from the households is organic in nature, the fleet and compartmentalization will have to be done accordingly.
5. There needs to be an Municipal Solid Waste Management plan prepared by the ULB including a short term (next 5 years) and long term plan (20-25 years). The plan also needs to be reviewed every 2-3 years. The plan should encompass institutional strengthening; human resources development; technical capacity building; financial capacity and arrangements (public private partnership [PPP] framework);

### ➲ Students' activity: Demonstration of decentralized household waste management technique

**Material required:** 3 earthen pots (with holes as shown in the diagram along with a hole at the base of first 2 pots) and a sturdy stand

**Process:** 'Khamba Composting' or stack composting is a method of composting which takes around 8 weeks and consists of earthen pots stacked one over the other. Kitchen waste is put into the first pot, once it is full. The positions of the pots are interchanged at regular intervals. It is characterized by a distinct smell and the C-N ratio is maintained throughout. After 8 weeks, the compost for your garden is ready.

### ➲ Learning outcomes

Students have learnt how a district level waste management scenario is being captured through research methods and methodology and ways in which recommendations are sought at every ULB. They are also aware about managing their wet waste at home.

## D. Theme: Renewable energy

Duration: 3 Hrs

Expert:

**Dr Piyali Das,** Senior Fellow, Renewable Energy Technologies, TERI

**Problem statement:** We use energy every day of our lives - our electronic devices require electricity for power, our streetlights need the same for lighting, our vehicles require gasoline and diesel. We fuel our homes with domestic oil, propane or electricity from a national or local grid for lighting, heating and for powering our devices. The places we work use computers, phone networks, security systems and servers, as do our shopping malls, parking lots, sports stadiums, cars, airplanes and so on. All of these things require power from fuel.

The world is doing what it can to reduce carbon emissions and limit the global average temperature change. To move forward, we also need to realize that there is only so much that can possibly be done in limiting GHG output as the human population only increases and puts more demands on our energy infrastructure. To further help the environment and secure the future of the planet we need to move to renewable sources for our energy generation.

According to a report by the International Energy Agency, the increase of amount of electricity produced from renewable sources increased from just over 13% in 2012 to 22% the following year. They also predict that that figure should hit 26% by 2020. In terms of total generation, renewables accounts for 19% of our present usage. More clearly needs to be done though for the reasons stated above, but these figures are encouraging from the perspective of the use of renewables on its own.

We can break these figures down even further and look at the divide between renewable energy types. These are, 9% from biomass, 2% as non-biomass heat energy, 8% from hydro electricity generation and 2% of electricity generated from geothermal, biomass, wind and solar power. The largest growth area in terms of resources was coal - easily the dirtiest form of fossil fuel. The most used resource amid fluctuating price coupled with what we now understand to have been over-production for several years, was oil.

Idaho (U.S) came out on top as it produces most of its electricity from geothermal sources thanks to the volcanic activity of its topography. Idaho is a success story of a renewable future and it reports some of the lowest energy prices (to the customer) of any state.

**TERI's approach:** Following two demonstrations were explained to the students through live demonstration.

**TERI's Enhanced Acidification and Methanation (TEAM)** convert food waste into biogas. The plant at TERIgram processes nearly 25 kg of food waste in a day to create 4 cubic meter biogas. This has also been installed at the City and Industrial Development Corporation (CIDCO), Mumbai; the ONGC Colony (Noida); and Numligarh Refineries Limited (Assam) among other places.

**Biomass Gasifier for Thermal and Power Applications:** TERI independently began research work in gasifier technology in the mid-1980s. Since, the gasifier technology has been customized for a range of direct-heat application and tested successfully in the field. Silk processing, large-cardamom drying and gasifier-based crematoria are a few examples of the applications worked on at TERI. This technology is slowly replacing both traditional biomass use and gas-powered systems, as it provides an excellent de-centralized source of energy at an affordable cost. Apart from rural households, biomass fuels are the main source of energy to a large number of small, rural and cottage industries.

Impact: Following are the impacts for undertaking research in renewable energy domains:

1. Throat-less patented design
2. Multi-fuel capability
3. Low initial investment
4. Better conversion (solid gas) efficiency (>75%)
5. Production of clean gases in the exhaust
6. Available in both, downdraft and updraft mode

7. Can be customized for a variety of applications
8. Thermal application to meet the process heat requirement
9. Power application for rural electrification and captive use
10. Reduced deforestation through fuel wood savings
11. Substantial reduction in diesel/kerosene/furnace oil cost (since 3-4 kg of biomass can replace 1 litre of petroleum fuel)
12. Use of castable insulation material in the fire box capable of withstanding high temperatures (upto 1860°C)
13. Since biomass is a carbon neutral fuel, the net emission of CO2 would amount to zero

- **Group activity:** Students were exposed to both the plants at TERIgram and explained the features thoroughly
- **Learning outcomes:** Students have learnt the different experiments undergoing within renewable energy domain. They are also aware about overall scenario of renewable energy sector globally.

## 2.2 Bengaluru

### A. Energy Efficiency, Conservation and Application of renewables

Duration: 2 Hrs

Expert:

**Dr. G R Narasimha Rao**, Senior Fellow & Director, Industrial Energy Division, TERI

**Ms Sabreen Ahmed**, Associate Fellow, Industrial Energy Division, TERI

**Mr Arjun Shetty**, Research Associate, Industrial Energy Division, TERI

**Mr S Satish Kumar**, Associate Fellow, Industrial Energy Division, TERI

**Mr R Vijay Mohan**, Associate Fellow, Industrial Energy Division, TERI

**Mr. Yatharth Kumar Sharma**, Research Associate, Industrial Energy Division, TERI

**Problem statement:** Climate change is for real and there are increasing evidence of its impacts especially in terms of extreme weather events and melting of glaciers. The various Climate Agreements is a testimony to this belief and need for collective action across nations. One major contributor to climate change is the increased emission of Green- house gases (GHGs) on account of anthropogenic activities. In order to stabilize the atmospheric concentration of GHGs, 170 of the 197 parties to the United Nations Framework Convention on Climate Change (UNFCC) voluntarily agreed to reduce emissions to limit global atmospheric warming to two degrees Celsius through country defined mitigation targets called Nationally Determined Contributions (NDCs). India has committed to reduce the emission intensity of its GDP by 33 to 35 percent by 2030 from its 2005 level and promote an increase in non-fossil-fuel based electricity capacity from 12 percent of total capacity in 2014/15 to 40 percent by 2030. It also plans on increasing forest cover to absorb 2.5 to 3 billion tons of Co2 by 2030.

Another major concern for India is to enhance its energy security by increasing the in-house energy generation. In 2017, India has imported 36.2 percent of its total energy requirement. Hence, India has to increase its energy generation without increasing its emission. Currently 81.9 percent of the electrical energy in the country is generated from carbon based sources of which 76.2 percent are coal based power plants. Of the non-carbon based sources, hydro electrical generation contributes to around 9.1 percent, nuclear is 2.5 percent and renewables is only 6.4 percent. Hence there is an urgent need to judiciously optimize the use of energy and simultaneously shift to renewables.

**TERI's approach:** In 2010, seventy one percent of India's emissions were from the energy sector and hence there is a need for aggressive policy on energy efficiency, demand side management and shift to renewable sources of energy. TERI has a qualified team that conducts energy audits wherein the energy consumption patterns of commercial and industrial operations are studied so as to formulate plans that help energy conservation and efficiency. TERI has also helped around 50 educational institutions in Bengaluru in a phase wise manner to adopt rooftop solar application. In addition to installation of the facilities, operation maintenance and continuous monitoring of energy conservation and it impacts have been studied by TERI. It has worked closely with the local electricity department (BESCOM) to have net metering facilities installed in these institutions so as to not just enable them to get off the grid, but to also supply the surplus electricity to the grid which becomes a source of income that covers not just the overall investment cost but also helps them to utilize these additional funds for educational purpose.

**Objective:** To provide an overview of the energy sector in India and present case studies of working towards energy efficiency, conservation and solar rooftop application.

**Impact:** TERI has been thus working with key stakeholders such as industries, commercial establishments and institutions which tend to use more energy for their business and services.

- TERI has been able to work out win-win solutions that benefit the stakeholders as well as the environment. Stakeholder benefits are extremely important to incentivize them to adopt long term sustainable energy efficient practices.
- Change in the approach of stakeholders who by and large look at energy conservation and efficiency as incidental. Energy audits and its recommendations demonstrate the financial saving to the companies and hence becomes a central part of their operation.

- Solar roof top application has been able to generate around 615405 KWh of electricity generating around 64 lakhs rupees.
- This renewable source of energy has helped in reducing carbon emission by 400013 kg.
- These interventions are long term interventions as it will be continued for a longer period of time.
- Revenue earned by generating solar energy has helped institutions to invest the same in enhancing the educational facilities at the institutions.

➲ **Learning outcomes:** Students were appraised about the overall energy sector in India and got in depth knowledge of how energy audits and solar roof top applications were conducted. Moreover students were taken to see the actual functioning of solar rooftop at the TERI centre.

## B. Environmental Friendly Plastics

Duration: 2 Hrs

Experts

**Dr. R N Sailaja,** Senior Fellow, Resource Efficient Technologies, TERI

**Dr. Prateek Roy,** Associate Fellow, Resource Efficient Technologies, TERI

**Mr. M Ameen Khan,** Research Associate, Resource Efficient Technologies, TERI

**Mr Kaushik Chandrashekar,** Associate Fellow, Environment & Waste Management, TERI

**Problem statement:** One of the most widely used materials in our daily life is plastic. It strength, lightweight and ability to be easily molded into shapes, films, forms, fibers or textiles has resulted in its wide usage for various products. The comfort, convenience, safety and prices at which it is obtained against other products make it extremely popular. Plastic is derived from materials such as natural gas, oil, coal, minerals and plants. Around 17 million barrels of oil is used on plastic production each year. Its production has been increasing over the years. An analysis by Plastindia Foundation suggests that the industry has grown at a compound

annual growth rate (CAGR) of 10%, in volume terms, from 8.33 million metric tonne per annum (MMTPA) in FY 10 to 13.4 MMTPA in FY 15 and is expected to grow at 10.5% from FY 15 to FY 20 to reach 22 MMTPA. The average per capita consumption of plastic in India is about 11 kg, which is considerably low as compared to the global average of 28 kg. However the Ministry of Petroleum and Natural Gas, Government of India suggests that the annual per capita consumption in India would be 20 kg by 2022.

The increasing usage of plastic has resulted increase in plastic waste generation, which tends to be occupy space on Earth as it doesn't degrade like organic waste. On an average per day around 15,342 tonnes of plastic waste is generated. These result in an unpleasant landscape which are littered with plastic, choking of drains that can cause floods and water logging, release of GHGs from landfills at times leading to fire, pollution of water bodies with micro plastic, adverse impacts on animal and marine life. Plastic that is burnt releases toxic and cariogenic elements into the air causing health problems. Plastic that gets into the food chain too can have detrimental impact on human health.

**TERI's approach:** In order to address this problem, TERI has been promoting the reduction of single use plastic and recycling of plastic. It has conducted studies to understand the percentage share of recycling of different plastics and has worked extensively with the youth, various sections of society to reduce and recycle plastic usage. It has also worked on promoting technology applications that convert plastic waste into a resource. In addition to these, another area of pioneering work carried out at TERI is to have been is to produce bio based plastic that is environmentally friendly.

**Objective:** The objective of this session was to provide an overview of the plastic sector and its allied advantages and disadvantages. The session also showcased how some of the disadvantages related to the use and disposal of plastic could be addressed through addition of additives that changed the properties of plastic.

**Impact:** There is a huge dependence on plastic for every life usage which will cause adverse impacts on the environment. The aim of research carried out at TERI has been to reduce this impact by the following:

- Change the property of the plastic and make it bio-degradable.
- Enhance the application of plastic to make it more absorbent.
- Reduce the damage of fire on life and property by the use of flame retardant plastic.
- **Group activity:** Students were taken to the environmental lab at TERI where lab scale work has been carried out with regard to bio based plastic. The students also engaged in a discussion on plastic wherein they took a stand on the usage of plastic and came with solutions to make it benign.

- **Learning outcomes:** Students learnt that the use of plastic can be enhanced by adding natural additives to plastic to make it bio-degradable. Some of the natural additives that were presented were soy based nanocomposites, Modified cellulose/chitosan-NC composites, Crosslinked starch-NC composites and Crosslinked starch/cellulose- kenaf fibre nanocomposites. Students also learnt about superabsorbent biopolymeric nanocomposites that would absorb and retain extremely large amount of liquid relative to their own mass. The application of these in terms of infant diapers, hygiene products, Agriculture, horticulture and medicines was also presented. Another important area of was about flame retardant plastic which was prepared by chemical additives to promote fire safety.

## C. Management of Water Resources

Duration: 2 Hrs

Experts

**Ms. Mary Abraham,** Fellow, Water Resources Policy & Management, TERI

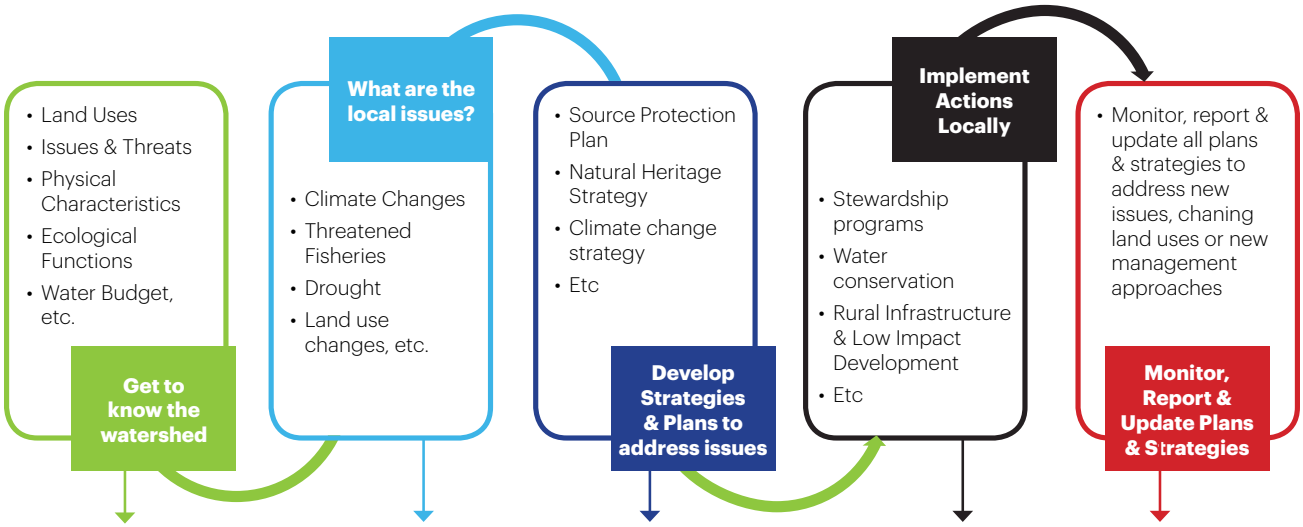
**Problem statement:** Despite the water being abundant on the Earth's surface, only less than 2.7% of global water is fresh-water. Most of this freshwater (2.05%) are locked in ice caps and glaciers and hence less than 0.7% is available for human use. In India, the major consumption of fresh water is for agriculture (83%) followed by industry and domestic consumption. In addition to competing sectors for water resources, encroachment of water bodies, increasing population, unreliable precipitation on account of climate change and changes in land use patterns have contributed to reduction of fresh water bodies. Given the limited availability of water, it is pertinent to ensure that water is judiciously used and that these fresh and clean water sources are not polluted.

**TERI's approach:** TERI adopts a multidisciplinary approach for conducting water audits and quality testing for commercial and domestic use and providing assistance in implementing the plans. It has also provides inputs to policy. It has been working on designing and implementing watershed management across different parts of the country.

The integrated water shed program is carried out by following five broad steps. In the first step, efforts are made to document and collect information that helps one to understand the water shed area and the local issues and competing sectors within the same. Based on this information develop strategies and plans to address the issues and work in a time bound manner to implement these plans and strategies. While doing so, the programs also devise mechanisms to monitor and review the working of these plans and strategies so that necessary changes can be made to ensure that these work well.

The water shed management program adopts a participatory approach which results in active involvement of community in decision making process, it works to forge multi stakeholder

## Integrated Watershed Management Process




### Stakeholders Input

To be successful, IWM required collaborations and involvement of a wide variety of community interests and water users including municipalities, businesses, residents, agencies and landowners. They devide on the priority issues that need to be addressed, help to set goals, decide on what actions to take and implement locally.

Each Strategy & Plan is developed, implemented, monitored and updated through a cyclical process which keeps it up to date and responsive to local needs.

partnership for service delivery and management, adopts scientific planning/technology innovation and customisation, and develops mechanisms for financial stability. Some of the interventions that were undertaken are provided below:

- Ground water recharge
- Water conservation and management
- Sanitation and Hygiene Promotion
- Women Development Initiatives
- Health and Education
- Demand water management
- Capacity building and Institutional strengthening

**Objective:** The session aimed at orienting students to the prevailing issues relate to water resource. In order to conserve and efficiently use water, a case study of integrated water shed management was presented.

**Impact:** Integrated watershed management effectively works on devising solutions for local problems by involving all the relevant stakeholders. A sense of ownership and commitment from the various stakeholders is important for the sustenance of the project. Some of the outcomes of the project are:

**Community**

- Identification and implementation of sustainable water conservation and management strategies
- Institutional Development (micro credit, SHGs, Youth groups and Village Development Committees
- Development of environmental hygiene education in the region
- Development of awareness and improvement in health and sanitation
- Enhanced capacity of community through livelihood training and strengthening of community
- Better synergies and communication amongst competing stakeholders to collectively manage water resource.
- Improved returns from agriculture and better economic conditions

**Environment**

- Revival of water bodies
- Improvement in water availability and quality
- Prevention of soil erosion
- Reduction of deforestation and enhancement of green cover

➲ **Group activity:** Students were taken for a guided tour to the Jnana Bharathi Biodiversity Park. Here they were able to see how the various water conservation techniques such as trenches, pits, dykes. They also saw the application of the water shed management at the Park to increase the ground water table, rejuvenate surface water and enhance green cover.

➲ **Learning outcomes:** The students learnt how integrated watershed management is carried out and its benefits to the community and environment.

## 2.3 Goa

### A. Theme: Coastal and Marine Habitats

Marine Resources Conservation And Technologies

Duration: 3 Hrs

Experts

**Dr Fraddry D'Souza,** Fellow & Area Convenor, Coastal Ecology & Marine Resources Centre, TERI-Goa

**Problem Statement:** World Ocean covers about 71% of total earth. The oceans influence global climate, teem with biodiversity, facilitate transportation and commerce, and provide resources for us. Oceans influence the atmosphere, lithosphere, and biosphere. In the view of India, India has a long coastline of about 7,500 kilometers, with an exclusive economic zone (EEZ) of 2.02 million square kilometers. Administrative divisions of the coastal and marine ecosystem in the country include 9 states and 5 Union Territories. India also has a rich and diverse


*Source: UNEP 2002c; data from Burke and others 2001, and Harrison and Pearce 2001*

ecosystem with Estuaries, Coral reefs, Salt marshes, Lagoons, Sandy and Rocky beaches, Backwaters, Mangrove forests and Seagrass beds. It has also about 3975 fishing villages with a total population of 3.99 million (National Marine Fisheries Census 2010). Considering these, the principal economic activities along coastline dependent on natural resources such as Fishing, Ports and Shipping, Agriculture, Industry, Tourism, Energy and Mining. However, the changes that have been made to ecosystems have contributed to substantial Net Gains in human well-being and economic development but these gains have been achieved at growing costs in the form of degradation of many ecosystem services. India has witnessed significant environmental decline due to degradation of marine and coastal ecosystems attributed to Fisheries & aquaculture, Coastal development and land use, Pollution, Marine transportation, Invasive species, Biodiversity, Impacts of climate change, and Coastal hazards. These booming population growth and economic and technological development are threatening the coastal ecosystems that provide these economic benefits. Some of the coastal state of India the population density reaches more than 1,000 people. As coastal population grow, sewage and agriculture run-off (food production, aquaculture) become a threat to coastal waters.

Plastic pollution, also one of the greatest threats to Ocean Health worldwide is set to treble between 2015 and 2025 without intervention, has a physical presence in the oceans, and can accumulate on the coasts or in particular areas of the sea.

**TERI's approach:** Work undertaken in this sector includes ecological baseline assessment and biodiversity mapping of coastal ecosystems; assessment of fishery productivity community based resource management by building capacity in artisanal fishery; entrepreneurship

development, livelihood diversification and woman empowerment in sustainable aquaculture culture technologies through trainings and demonstrations.

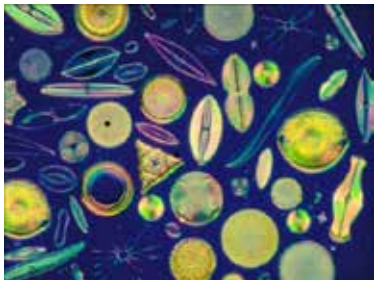
**Impact:** The session also talked about the solutions and thus the importance of microalgae as a source for several economically important products. Microalgae are the primary producers, typically found in freshwater and marine habitats, including lakes, pounds, rivers, oceans, and even wastewater. They are renewable, sustainable and economical sources of biofuels, bioactive medicinal products as well as food ingredients. It focused on a range of bioproducts such as polysaccharides, lipids, pigments, proteins, vitamins, bioactive compounds and antioxidants which can be effectively harnessed from microalgae. High lipid content of microalgae makes them a lucrative option for the production of biodiesel. Furthermore, they can be employed efficiently for the wastewater treatment and atmospheric CO2 mitigation. The talk also discussed the limitations and challenges associated with microalgae which need to be tackled to upgrade the technology from pilot-phase to industrial level.

**Outcomes:** The session helped students understand the following:

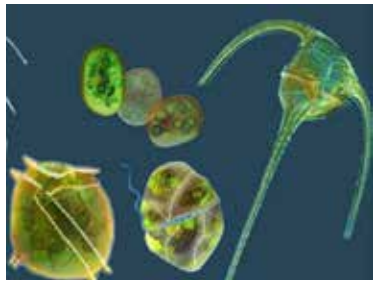
- Marine environment
- Major marine ecosystems
- Human uses of marine resources
- Human impacts on the marine environment
- Climate Change & Implication
- Conservation and technologies

**Microalgae as multipurpose resource- their importance and application**
**Expert: Dr Devika Joshi, Coastal Ecology & Marine Resources Centre, TERI-Goa**

**Problem Statement:** Primary productivity in Ocean is the rate at which energy is converted by photosynthetic and chemosynthetic to organic substances. Algae (Micro or macro) produce approximately 5200,000,000 tons of organic carbon per year accounting for 50% of the total organic carbon produced on earth each year. Microalgae are microscopic organisms that grow in salt or fresh water. The three most important classes of micro-algae in terms of abundance are- A- Diatoms(bacillariophyceae), B- Green algae (chlorophyceae) and C- Golden algae (chrysophyceae)



A



B

C

Biotechnological application of products from microalgae

| Product | Applications | Microalgal Producers |
|---|---|---|
| **Carotenoids**<br>**β-carotene**<br>**Astaxanthin** | Food colourant; antioxidant; cancer-preventive properties<br>Pigmenter for salmon, antioxidant | Dunaliella salina<br>Haematococcus pluvialis |
| **Mycosporine-like amino acids (MAA)** | UV-screening agent ; sunscreen | *Aphanizomenon flosaquae* |
| **Polysaccharides** | Viscosifiers, lubricants and flocculants for industrial applications; antiviral agent | *Porphyridium cruentum* |
| **Phycotoxins – okadaic acid, gonyautoxins, & yessotoxins** | Experimental tools for investigations on neurodegenerative diseases | Dinoflagellates (e.g. Amphidinium, Prorocentrum & Dinophysis) |
| **Lipids – triglycerides and hydrocarbons** | Biofuels | *Chlorella protothecoides*<br>*Botryococcus braunii* |

TERI's approach: TERI has provided ways to show the importance of microalgae as a source for several economically important products. As Microalgae are the primary producers, typically found in freshwater and marine habitats, including lakes, pounds, rivers, oceans, and even wastewater, they are renewable, sustainable and economical sources of biofuels, bioactive medicinal products as well as food ingredients. TERI's work focuses on looking for a range of bio products such as polysaccharides, lipids, pigments, proteins, vitamins, bioactive compounds and antioxidants which can be effectively harnessed from microalgae. High lipid content of microalgae makes them a lucrative option for the production of biodiesel. Furthermore, they can be employed efficiently for the wastewater treatment and atmospheric CO2 mitigation.

Outcome: Students have been able to learn and have an overview of the importance of microalgae as a source for several economically important products.

## B. Theme: Water Resources Management

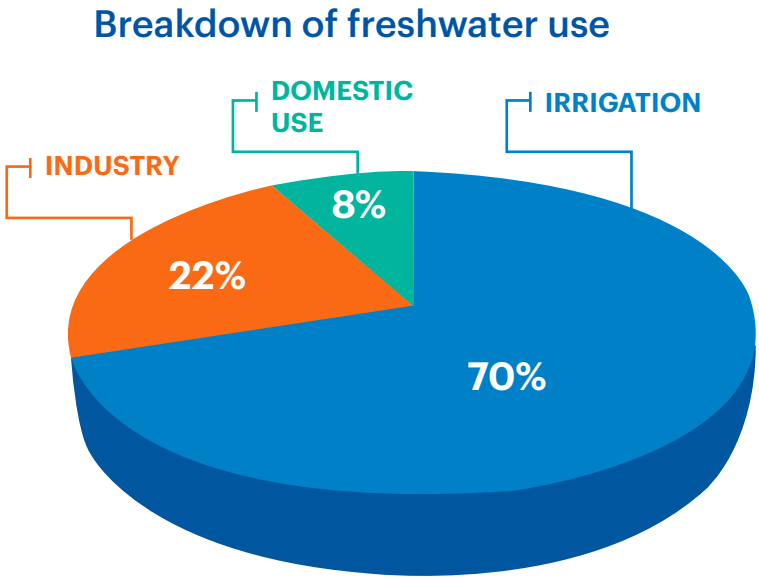
Exploring Nature-Based Solutions To Water Challenges

Duration: 3 Hrs

Experts

**Ms Kavita Patil,** Research Associate, Coastal Resources and Marine Ecology, TERI-Goa;
Ms Ashwini Pai Panandiker, Fellow, Coastal Ecology & Marine Resources Centre, TERI-Goa

**Problem Statement:** While 67% of Earth's surface is covered by water, only less than 2.7% of global water is freshwater. Most of the freshwater (2.05%) are locked in ice caps and glaciers. Only less than 0.7% is available for human use. In India, around 83% of freshwater is used for agriculture. Fresh, clean water sources are limited. Most of water on earth is salt water and becomes expensive for us to reuse it. Droughts further limit access to clean and fresh water. Groundwater over drafting leading to diminished agricultural yields and over scarce water resources sometimes leads to regional conflicts. It has been said that by 2025, 800 million people will experience absolute water scarcity, and two-thirds of the world population could be under stress conditions.




**TERI's approach:** TERI- Water Resource Area have been aiming to develop solutions for providing equitable access to clean and safe water, while ensuring social, environmental, and economic sustainability in water resource allocation. A team consisting of Environmental Scientists, Hydrologist, Water and Sanitation and Health Specialists, Water Technology and Engineering Expert ,Water Quality Expert ,Social Scientists and Ecologist have together come in to work on various projects such as Optimal Water Flow Management for Crop Irrigation (OPTIFLO),Assessing the impact of climate change on water availability in Uguem river sub-basin and many more.

TERI has also created Membrane bioreactors (MBRs) which are an advanced treatment technology integrating biological treatment with membrane filtration that is compact. In order to tackle the problem of high- membrane cost, TERI has developed ceramic membranes from waste fly-ash obtained by combustion of agricultural residues. The membranes have a pore size of 1-10 μm and is tested for both sewage and industrial (distillery) wastewater treatment.

## Case Study: DST project

The objective was to provide reliable, sensor-controlled irrigation water using an "off-the-grid"treatment technology, known as riverbank filtration (RBF). However, it was also meant to provide clean water to farmers using bank filtration technology, provide renewable electric power to off-the-grid farmers, thereby reducing stress on current electricity infrastructure and provide increased effectiveness solution for water use by farmers. The customized convergent technological solution has been demonstrated to the farmers in two villages in Goa that are using different water resources i.e. river and lake. Both the water resources are polluted by untreated sewage and also influent from small-scale industrial units.

- Navelim Village – Around 30 farmer households are currently practicing horticulture using water from RIVER SAL which is highly polluted with sewage.
- Cortalim Village – Around 150 farmer household depend on the polluted NAUTA LAKE water for irrigation.

➲ **Group Activity:** The students were divided into four groups and were given a situation regarding freshwater supply of a school and were asked to showcase their response to various situational aspects. Later on they were asked to present their work to the entire group. A film created by TERI "Losing Ground" was also screened for the students.

- **Lab Activity:** Laboratory practices and activities carried out which explained about the laboratory setup and how to handle chemicals and instruments. Certain lab instruments, (HCS) hazard safety pictogram were introduced where the experts explained how water quality is assessed and discussion about Ecoli and its hazards were also held. The experts showed certain instruments required for detection of Ecoli such as sterile bottle, sterile plates, and quantity tray. They also showed an instrument called data logger used for monitoring wells.

**Outcome:** The students were able to identify and connect the macro level problems with solutions at micro level. The students also got introduced to certain new instruments and had an overall good learning experience.

## C. Theme: Goa's Biodiversity

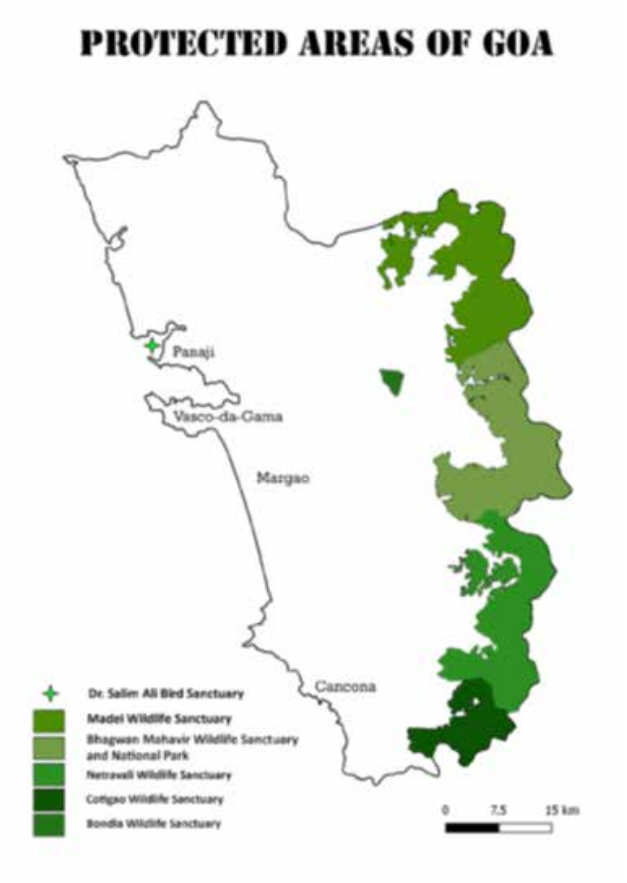
Duration: 8 Hrs

Experts

**Ms Kavita Patil,** Research Associate, Coastal Resources and Marine Ecology, TERI-Goa;
Ms Ashwini Pai Panandiker, Fellow, Coastal Ecology & Marine Resources Centre, TERI-Goa

**Problem Statement:** After 450 years of Portuguese rule, Goa was liberated on 19th December 1961, and along with Daman and Diu, Goa became the Indian union territory. On 30th May 1987, Goa was declared as India's twenty-fifth state. Goa is the smallest state situated in Konkan west region of India. It is bounded by two neighboring states of Maharashtra in the North and Karnataka in East and South, while the Arabian Sea forms its western coast. Goa lies between the latitudes 14°53'54" N and 15°40'00" N and longitudes 73°40'33" E and 74°20'13" E, which encompasses an area of 3,702 km2 (1,429 sq mi) and coastline of 101 km (63 mi). Throughout the year Goa's climate remains hot and humid. It has the shortest winter and monsoon starts from June. Goa has seven major rivers Mandovi, Zuari, Terekhol, Chapora, Kushavati, Betul,

Talpon and the Sal. The Mormugao harbor situated on the mouth of the River Zuari is the best natural harbors in South Asia. Most of the cities of Goa are situated on the banks of rivers and are connected with ferry boats and bridges. Goa has one International Airport at Dabolim near Vasco-da-Gama in Marmugao Taluka. Goa's State animal is the Gaur (Indian bison) and state bird is the Ruby Throated Yellow Bulbul (aka Black Crested Bulbul). The state tree of Goa is the Matti (Terminalia eliptica). The state of Goa has one National Park namely Molem National park and six Wildlife Sanctuaries which include Bondla Wildlife Sanctuary, Mahaveer Wildlife Sanctuary, Cotigao Wildlife Sanctuary, Mhadei Wildlife Sanctuary, Netravali Wildlife Sanctuary, one bird Sanctuary namely the Salim Ali Bird Sanctuary located on the island of Chorao.




**TERI's approach:** The People's Biodiversity Register, or PBR, is an attempt at recording the knowledge and perceptions of the population of any given region on the local biodiversity and its status, uses, history, current changes and the forces spurring these changes. Through the PBR an attempt is also made at documenting local perspectives on who would gain or lose as a result of the utilisation of biodiversity resources and changes in ecological settings. An information system of this type has potential to support the management of natural resources in a decentralised manner, as also permitting the equitable sharing of the benefits obtained from the commercial utilisation of such resources and the knowledge associated with them. It is expected that the process of development of the PBR will augment and reinforce the knowledge of the public on the significance of biodiversity conservation, its sustainable use and equitable sharing of benefits derived from it, as well as mobilising for grassroots action (Gadgil, 2000). This session will introduce the PBR process and the methodology followed for developing the document for the Biodiversity Management Committees under the Village Panchayats and Municipalities of Goa.

**Impact:** TERI experts helped them understand the biodiversity and its importance and also the need for ecosystem conservation as Ecosystems play a critical role in human wellbeing and economic development, healthy ecosystems harbor rich biodiversity, need to conserve vital ecosystems and biodiversity, restoration of degraded ecosystems and landscapes, protected areas as Corridors for mega fauna species, seed banks for agro biodiversity.

**Group Activity:** The students were asked to form a team of 3 to go around the college campus area and photograph the various flora and fauna or whatever they found intriguing in nature and quizzes were also held. This was part of a basic capacity workshop under the mentors.

**Outcome:** Students learnt about the biodiversity present in Goa and the various habitats in which it can be observed. Also it helped to know the ways and means about biodiversity to younger generation, its importance and how they can be involved in documenting their observations with the objective of conservation in future.

Through photography workshop, student learnt the importance as per the following:

- Significance of recording- information is available in future
- Existing species may be lost
- Discovery of new species
- Invasive species- weeds and pests
- Impacts of global warming on annual migration
- Seasonal trends- e.g. ebird.org

## D. Theme: TERI Coastal Education Hub

Duration: 8 Hrs

Experts

**Ms Asha Giriyan,** Fellow, Coastal Ecology & Marine Resources Centre, TERI-Goa

**Problem Statement:** Coastal ecosystems provide a wide range of services to human kind. Coastal wetland carries a wide variety of marine biodiversity (flora and fauna) which needs to be conserved. The services they provide, influences human welfare both directly via food consumption and indirectly via support and regulatory services. The verdict is that these functions and services are increasingly under threat from growing pressures such as overfishing, water contamination, coastal habitat destruction and loss of biodiversity. Goa, being one of the very popular tourist destinations on the west coast of India and having fragile resources bears the stress of the dependent local communities including floating populations and their ecological footprints. Goa has lot of traditional and indigenous technologies and wisdom practiced by the local communities. Therefore, conservation of these resources is

imperative. However, these resources are mostly neglected as only select individuals are aware about these resources. Hence, there is an urgent need for the youth and society by large to reacquaint, appreciate and deepen their knowledge about these coastal and marine resources.

**TERI' approach:** The Coastal Educational Hub, covering an area of approximately 58,000 sq. mt., is situated in the wetland area of Batim, Goa Velha, Goa. The wetland provides a unique element to the Hub as it is a mosaic of multiple ecosystems wherein diverse activities are generally carried out, such as solar salt harvesting, traditional fishing, traditional aquaculture and agriculture-related activities (khazan and sluice gate technology). The tidal water source to these areas of the Hub is through a creek that opens into the Zuari River Estuary.

One of the aspects by which conservation of an ecosystem can be made possible sustainably, is through Environment Education. The traditional and indigenous technologies and wisdom will be recognized by students, youth, farmers and visitors through such educational tours and training programs. It has been clearly recognized that students show the most significant levels of interest when presented with those environmental issues that are of pertinence in the local context, and are highly predisposed to absorbing scientific knowledge about the natural world that makes up their immediate surroundings. Well-organised educational tours to such coastal wetlands would, to a large extent, help in conserving such niche ecosystems. Integrating natural resources, the facilities established at the Hub include:

- TRADITIONAL FISHING & GUIDE BOAT TOUR: A guided canoe boat tour to experience estuarine creeks and mangrove ecosystem. Activities include live demonstrations of traditional net casting in creeks and traditional crab traps.

MANGROVES - are natural capital that provides a wide array of goods and services in the coastal environment for society as a whole. The ecological functions of mangroves and the high value of the ecosystem are highlighted by the thick mangrove vegetation developed at the Hub on the periphery of the creek. The students and visitors at the Hub will make an acquaintance with intrinsic and unique values of mangroves for creation of awareness and protection.

KHAZANS - is a self-operational system, utilizing tidal, hydro, and solar energy, and has agriculture-aquaculture-salt panning functions that are highly complex but eco-friendly. This unique and endemic technology has been present in Goa for over three millennia, and their protection is the conservation of local culture and global biodiversity. Learning the components of the khazan, sluice gate technology, and solar salt panning and awareness of their practical and cultural importance will be advanced at the Hub to aid in their conservation, and fostering appreciation of our heritage.

AQUATECH PARK - holds great importance in contributing to food security and nutrition, and in generating employment. Natural fisheries the world over are overexploited, and therefore aquaculture will be vital to meeting fish demand. The AquaTech Park at the Hub showcases mussel culture, oyster culture, pearl spot fish cage culture, and crab farming and aquaponics demonstrations and fish processing and packaging, which will aid in entrepreneurship development, livelihood diversification and woman empowerment.

ORGANIC FARMING & SUSTAINABEL TECHNOLOGIES - the prolonged usage of chemicals in farming and agriculture has produced human health hazards and caused environmental pollution and groundwater contamination. To combat such effects, organic farming, livestock rearing, vermicomposting, and biogas plant are being promoted for sustainable production, income, and socio-economic development of the farming community. Students, farmers and visitors at the Hub will have a learning experience about livestock rearing, organic kitchen gardening, vermicomposting, and rain water harvesting, and biogas plants utilizing livestock waste and kitchen waste.

TRAINING CENTRE - other established components of the Hub are the Training Centre where the knowledge of the students will be further increased and enhanced, and hands-on training on items useful in daily life will be given.

Outcome: Students were provided an opportunity to experience what lies beyond their horizon and brought new experiences, teaching and learning techniques, local people and lifestyle.







# 3. TERI – NCSTC **Eco Eureka Fellowship**

## 3.1 Case studies

**Eco Eureka Fellows**

| Sl. No. | Title of the fellowship project | Description of the fellowship project | Team Members | Outreach / Outcomes |
|---|---|---|---|---|
| 1 | The Composting Project | The Composting project was initiated to set up a compost pit to reduce the kitchen waste from the hostel mess that was collected in the Dhalao for the area, which is a source of bad odour and disease, and also to change mindsets about the traditional practices that people have been working with as far as waste management is concerned. The most important aspect has been to set up a model for composting in an institutional setup like a college and at a low cost without need for much technical knowledge. Also, to speed up the process, so as to deal with the larger amounts generally generated, a culture developed by NCOF was used which simulated the conditions of a traditional pit which used cow dung as a catalyst to do the same. | Arveen Kaur Sodhi, SGTB Khalsa College, University of Delhi | Direct outreach: 1000 Indirect outreach: 5000 approx. |

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| 2 | Circular Economy at College Level | The project aimed to make the college a green space with the practice of vermicomposting and converting the leaf litter and raw kitchen waste into manure. Hands on training programme was organised by introducing the red worms (Eisenia fetida) in the pre-digested waste. This project also collaborated with ECO CLUB SVC and DBT STAR STATUS COLLEGE SCHEME through SCIENCE FAIR that was held in the college. The project also had collaboration with LFT (Leaders for Tomorrow) Society where students planted saplings, conducted cleanliness drive and also a collection drive in and around the campus. | Jassika Gupta, Sri Venkateswara College, University of Delhi<br>Team Members: Abhimanyu Madhusudanan, Dilip R, Sri Venkateswara College, University of<br>Delhi | Direct outreach: 1000<br>Indirect outreach: 5000 approx. |
| 3 | Beating Plastic pollution in Market and Schools | The project aimed to reduce the use of plastics by promoting cloth bags and reusable cutlery in the college campus and neighbourhood area with a focus on school children. The idea was to collect waste/refused clothes from households and tailors who stitch uniforms for Army and schools. These waste clothes were then given to needy lady tailors who stitched cloth bags out of it. The bags were distributed to shopkeepers, households and provided at college hostels so that students use them to avoid polythenes. Apart from this, awareness drives and cleanliness drive were conducted in the campus. | Rachana Yadav, Forest Research Institute, Dehradun<br>Team Members:<br>Diksha Verma, Anchal Verma, Forest Research Institute, Dehradun | Direct outreach: 805<br>Indirect outreach: 4000 approx. |
| 4 | Disposal of Wet Waste | The main purpose of the project was to reduce the production of waste in the locality and effective ways of disposal of waste. So far, through implementation of project, the project has converted at least 150 litres of wet waste to organic fertliser in one month and has been successful in recycling a lot of plastic and e waste was recycled by rag picker. | Aditya Pathak, I.M.S (UCC) Adhyatmik Nagar, Ghaziabad ,Uttar Pradesh<br>Team Members: Abhinav Tyagi, Darshan College, I.M.S (UCC) Adhyatmik Nagar, Ghaziabad, Uttar Pradesh | Direct outreach: 18 households<br>Indirect outreach: 200 approx. |
| 5 | The Green Periods Project | The Green Periods Project was developed specifically to fill the critical gap in Menstrual Health Management (MHM) programming in schools. Its three-pronged approach of education, distribution, and conversation combine to effectively address issues of access, stigma, myths, and lack of knowledge that hamper women from being healthy during menstruation and prevent further endangering the environment with 'single-use' plastic products. The program aimed to provide beneficiaries with a comprehensive education about their personal health, and gave them the tools to manage their bodies safely. | Jasmine Kaur Narang, Panjab University, Chandigarh<br>Team Members: Srishti Chauhan and Ayushi Goel, Panjab University, Chandigarh | Direct Outreach:<br>Girls and women: 1500+<br>Teachers: 54<br>Adolescent boys: 90+<br>Schools: 8<br>Indirect Outreach:<br>Girls and women (through advocacy): 120+<br>Health workers: 18 |

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| 6 | Muscles Cultivation | The project was basically chosen for overcoming the less cultivation and problem that one faces in coastal areas because of extinction species.<br>The idea of the project was about the cultivation of muscles in helping to increase its population and save its extinction. | Bindia Balu Pednekar, DM'S College and Research Centre<br>Faculty Member: Rajesh Pednekar, DM'S College and Research Centre | This is a work in progress idea and so confined to a closed group |
| 7 | Waste management of Marcel | The project was about doing a proper waste management of Amaywada through cleaning and installing dustbins and a composting unit.<br>The second part of the project was doing composting with the decomposable waste. | Simran Andrade Govt. College of Arts, Science and Commerce.<br>Team Members: Aditi Chodankar Kausar Sheikh and Krupali Sutar, Govt. College of Arts, Science and Commerce<br>Faculty Member: Dr. Daphne Faria Govt. College of Arts, Science and Commerce | Target group was the villagers of Amaywada. They were targeted indirectly there was awareness created among them. |
| 9. | Waste Management and Organic Gardening | Waste Management and Organic Gardening, was an idea of utilizing college canteen waste for the best purpose. In this project wet waste from college canteen which comprised of degradable items such as leftover food, fruit and vegetables peels etc. was collected.<br>With a growing demand for vegetables especially local vegetables, organic gardening was undertaken on the college campus to promote the same as well inculcate the idea of innovation and entrepreneurship among fellow students for a sustainable future. | Santosh Ramjit Yadav Government College of Arts, Science and Commerce, Khandola<br>Team Members: Myron Pereira Shreyali Shailesh Baadkar Government College of Arts, Science and Commerce, Khandola<br>Faculty Member: Dr. Daphne G. Faria Government College of Arts, Science and Commerce. | The project reached students, teaching and non- teaching staff. The students who were sensitized carried the message to their respective families. Similarly, was the case with teaching and non-teaching staff who took the information to their respective families. |

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| 10. | Rain Water Harvesting in College | The project met the growing need of water to the population in the campus. Being a plateau topped hill, college campus run for approximately 30 Acres which received ample amount of rain due to its tropical location. Apart from surface run off a lot of rain water was unutilized which fell on the roof of the buildings. The main highlight of the present project was utilization of the roof water to recharge the groundwater. This demo or pilot project on Rain Water Harvesting helped in creating awareness on Rain Water Harvesting. | Esha Gadekar<br>Dnyanprassarak Mandal's College and Research Centre, Assagao, Goa.<br>Faculty Member:<br>Dr. Rajesh Pednekar and<br>Mrs. Yogita Karkhanis<br>Dnyanprassarak Mandal's College and Research Centre, Assagao, Goa | The project served as a base for larger scale bigger project which will directly as well as indirectly benefit the society as a whole. |
| 11. | Waste Disposal and Management | The main aim was to create awareness among the citizens about the need for proper disposal of waste and effect of waste on the environment as well as on the living beings.<br>Along with that people were told ways to dispose their dry waste: how they can utilise the kitchen waste and convert it into manure and also about ways to recycle the paper and plastic materials by making papers bags etc. Cotton bags were gifted as a token of appreciation to the people. | Harshada Shripad Sawant<br>Goa College of Home Science<br>Team Members:<br>Esha Shripad Sawant and Anvisha Ashok Naik.<br>Goa College of Home Science | Around 43 people of the locality were directly impacted. The Panchayat members, the Ward members, the labourers and the people of the neighbouring areas were in indirectly impacted. |
| 12. | Batch studies of removal of Chromium (VI) from synthetic waste water using modified biopolymer | The project provided a tested solution to remove heavy metals from contaminated water using modified biopolymers. Chitosan Biopolymer is used as the adsorbent to reduce the levels of Chromium. Presentation have been made to Karnataka State Council for Science and Technology to enable industrial application of the findings. | Sacheta Ramachandra Bhat<br>Team Members:<br>Renuka Shivani and Manohar M S | Preparation of immobilizd chitosan.<br>Immobilization of chitosan can increase the removal efficiency of chromium than chitosan which indicates that adsorption is higher with immobilized chitosan. This can make a difference in industrial level. |

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| 13. | Harvesting hydro power along with rainwater | The project had a twin objective of water and energy conservation. While transporting the harvesting rain water it is connected to hydro-electric turbines and a generator. The turbines turn and rotate with the water movement and produce electricity. | Syed Sadiq Khadri J Dayananda Sagar College of Engineering Team Members: Sanjana DJ and Theja P, Dayananda Sagar College of Engineering | A kit that can help generate electricity using rainwater harvesting. Findings of water pressure and rotation of blade and its design. |
| 14. | Bio-Fuel | The project aimed to promote the cultivation of bio-fuel and link the producers to bio oil mills. A sensitization and awareness program with farmers was carried out and a website was designed to provide information on bio fuel. A group of farmers were made aware of growing biofuels. Also, a website that contains information on biofuels has been developed. | Shilpa S St. Claret College Team Members: Shilpa R and Lohit Rao J, St. Claret College | Directly it reached out to farmers, Management at Mahatma Gandhi Institute of Rural Development to help farmers with details related to growing of bio fuels and extraction of oil. |
| 15. | Clean-up Collab | The project developed a digitized waste segregation system. The project was tested in the college hostel and a few shops were approached to be part of the program. These waste generators were asked to segregate waste and the wet waste collected was weighed and QR code was provided. A website was developed that helped the waste generators log in and document the waste they disposed using the QR code. Based on this waste generators would be rewarded. A simulation software ASTEN Plus V10 was used to convert bio waste into biogas and then biogas to methnol. | Rakshita H M S Ramaiah Institute of Technology Team Members: Vivek V Hathwar and Chandana M Patel, M S Ramaiah Institute of Technology | The project directly reached out to 6 hostels that catered to around 2500 residents who generated around 638 kgs of wet waste daily. Around 4-6 shopkeepers were also approached. |
| 16. | Pollution free path | To design an application that provides a less polluted path to commuters. It developed a web mapping service to provide the least polluted path and developed detailed navigating directions between two locations through the provided waypoints. A proto type of a mobile app and a web portal that demonstrates the functioning of the app has been developed. | Shadan Alam Kaifee PES University, Bengaluru Team Members: Altamash Sameer and Samyama Y, PES University, Bengaluru | This is a work in progress idea and so confined to a closed group. Once it has been tested it will be applied to a wider audience. |
| 17. | Efficient Use of Microalgae Grown Using Polluted water | The project aimed to utilize polluted water for growing algae and post harvesting to use the algal biomass for biodiesel. Biodiesel was produced and established better water quality parameters related to BOD and DO. | Akshatha S Ravi REVA University Team Members: Neha Tanwar and Y Umadevi, REVA University | Around 50-60 students were made aware of the project in the college.<br>A linked post was put up which received around 200 views. |

**For more information contact:**

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