



## Implementation of Environment-Friendly Strategies for Energy Conservation and Mitigation of Climate Change – A Holistic Approach in Mangalagangothri Campus

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**Abstract.** The harnessing of renewable energies and mitigation of climate change are like two faces of a coin. Decentralized implementation and individual-level practices of eco-friendly strategies contribute a lot on a global scale. In this context, Mangalore University on its headquarters Mangalagangothri campus, adopted and implemented many eco-friendly activities, technologies, and policies for sustainable development. Installation of solar power panels for electricity generation, of the current estimated value of 23,13,311 kWh/month; replacement of incandescent bulbs with LED bulbs with an energy saving of around 62% and procurement of most energy-efficient electronic & electrical appliances (47%) are some of the technologies that have been implemented for energy conservation. Implementation of e-Governance and e-Office program of Govt of Karnataka, and campus management system, social media, and email-based official communications have significantly reduced the usage of papers (>70%); a complete ban on single-use plastics; recycling of organic wastes through vermicomposting, pot-composting, biogas production; encouraging electric vehicles are some of the adopted strategies. Altogether these strategies have significantly reduced the release of greenhouse gases in and around the campus in our efforts to join with global efforts to drop carbon footprint below 2 tons by 2050. The rainwater harvesting through the rooftop catchments and check-dams contributed to  $\approx$  50% water conservation. The campus comprises 32.4% of its total area with natural vegetation (463192 m<sup>2</sup>) and currently with 30.8% planted vegetation (439670 m<sup>2</sup>) of the total area (1428540 m<sup>2</sup>). The campus biodiversity was

further enriched by periodical tree plantation drives with special reference to the planting of fruit-yielding saplings. As an Institutional Social Responsibility (ISR), the university has been making efforts to disseminate the knowledge of eco-friendly practices, by conducting public awareness programs and publishing popular articles in regional language. Despite the COVID-19 pandemic and government-imposed lockdown to curb the spread of the novel coronavirus, the University has continued eco-friendly activities and setting up of infrastructures, by strictly following safety guidelines. Overall, our continued holistic approaches of various eco-friendly strategies, in terms of the utility of advanced technologies, eGovernance, solar energy, and rainwater harvesting, organic wastes management, recycling of solid wastes, and many others, have been implemented since its inception have significantly helped in saving energy and reduction in the emission of greenhouse gases.

**Keyword:**

Climate change; Eco-friendly strategies; Carbon footprint; Greenhouse gases

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## 1. Introduction

Conservation of nature with a focus on saving energy and mitigation of climate change is the need of the hour. Having realized scientific reasons for climate change, many strategies, and technological advancements have been made for the last few decades to conserve energy and reduce the emission of greenhouse gases. For the last few decades, the United Nations - Environment Program (UN-EP) has been encouraging a multi-dimensional approach towards mitigation of climate change by promoting climate-resilient and low emissions strategies [1]. It is well said that environmental sustainability is becoming an increasingly important issue for the world, the role of higher educational institutions in relation to environmental sustainability is more prevalent [2]. As a popular proverb, '*Little drops of water make a mighty ocean*', goes, decentralized and individual-level efforts contribute a lot to mitigate climate change, on a global scale. In this context, Mangalore University on its Mangalagangothri campus, since its inception in the 1980s, has been trying its best to implement various environment-friendly strategies.

### 1.2. Mangalagangothri Campus:

The University campus at Mangalagangothri is located at a distance of about 20 Km to the southeast of the historic coastal town of Mangalore and is spread over an area of 353 acres, with state-of-the-art buildings. Overlooking the confluence of the river Nethravathi with the Arabian Sea on the one side and the cloud-capped Western Ghats on the other, the impressive architecture of the various buildings matched with the green cover creates an amazing physical platform of the magnificent academic environment. The campus presents a clean environment courtesy of the housekeeping support staff. Its sprawling green lawns are consistent with best environmental practices and water harvesting mechanisms. The University has jurisdiction over the districts of Dakshina Kannada, Udupi, and Kodagu. Currently, a total of 2,812 students and 812 employees, including teaching and non-teaching staff, are on the campus. All our staff and students have joined hands to develop an eco-friendly sustainable campus. The COVID-19 pandemic has affected many of our regular activities, including conducting various events. However, the University has

maintained its vibrance by keeping pace with various activities, setting up infrastructure to enhance the sustainable campus, organization of environment-related events, deciphering knowledge through awareness programs, and publishing popular articles. All these activities were performed by strictly following COVID-19 safety guidelines of the Government of India, Govt of Karnataka, and the World Health Organization.

### 1.3. Harnessing Solar Energy:

**Over the years, it has been well understood that solar energy** is a highly reliable, cost-effective and everlasting renewable source of energy. Further, unlike fossil fuels, harnessing solar energy for heat or electricity generation does not pollute the environment, and hence it is considered green and clean energy [3, 4]. It has been anticipated that solar power would serve as the world's largest source of electricity by 2050, with solar photovoltaics and concentrated solar power contributing 16 and 11 % to the global overall consumption [5]. On the campus, efforts were made to save energy by installing solar power panels for electricity generation, 362463.6 kWh (the ratio of renewable energy production divided by the total energy usage per year is currently, 22%).

Table 1. Percentage of Annual Power Requirement of the University Met By the Renewable Energy Sources for the Year 2020-21:

Total generation of solar energy source / month	= 30107.5 kWh
24 watts solar street lights – 210 Nos.	= 210x24 = 5040 watts = $\frac{5040}{1000} \times 12 = 60.48$ kWh
5 watts solar corridor lights – 222 Nos.	= 222x5 = 1110 watts = $\frac{1110}{1000} \times 12 = 13.32$ kWh
20 watts designer street lights for double road – 100 Nos.	= 100 x 20 = 2000 watts = $\frac{2000}{1000} \times 12 = 24.00$ kWh
Total – [30107.5+60.48+13.32+24] kWh	= 30205.3 kWh x 12 months = 362463.6 kWh
Total power requirements of the institution / month	= <b>23,13,311.00 kWh</b>
Annual Power requirement by renewable energy sources ----- x 100 $\frac{\text{Total power requirement of the Institution/ Month}}{\text{Total power requirements of the institution / month}} \times 100$ $= \frac{362463.6}{2313311} \times 100 = 15.66\%$	

Solar panels have been installed on the rooftop of almost all the major buildings and

the power is being supplied to the common grid which supplies the street lights and the lighting of the administrative and faculty buildings. Solar water heaters have been installed in all hostels. The hostel kitchens and cafeteria are managed with solar power. In addition to harnessing solar energy for electricity production, energy-saving is being done by replacement of incandescent light bulbs with LED bulbs with an energy saving of around 62% and procurement of most energy-efficient electronic & electrical appliances (47%).

#### **1.4. Strategies for Reduction of Carbon Footprint:**

##### **1.4.1. eGovernance and Reduction of Paper Usage**

According to the International Council of Museums, Committee for Conservation, a target of conservation is to slow down the deterioration and extend the useful life of the artifact; there are several strategies available for paper conservation which in turn contribute to the saving of trees [6]. The internet and associated information and communication technologies have created digital networks through which information flow helped in developing eGovernance. For the last few years, digital applications have gained prominence in nature conservation, in both number and diversity, and are progressively shaping conservation discourses and practices [7]. The University has effectively implemented eGovernance by adopting eOffice (a software developed by the National Information Centre) of Govt of Karnataka, and campus management system, social media, and email-based official communications that significantly reduced the usage of papers (>70%). Many strategies have been implemented to reduce the carbon footprint (CO<sub>2</sub> emission for the last 12 months was 1821 metric tons; the total carbon footprint divided by total campus, the population is currently in the range of 0.42 - 0.10 metric ton); a complete ban on single-use plastics; recycling of organic wastes through vermicomposting, pot-composting, biogas production; encouraging electric vehicles. Altogether these have significantly reduced the release of greenhouse gases in and around the campus in our efforts to join with global efforts to drop carbon footprint below 2 tons by 2050.

##### **1.5. Water Conservation**

Water scarcity particularly during summer is a major issue in many countries, including India owing to population explosion, household size, overexploitation, and mismanagement of water sources. Water conservation includes all the policies, strategies and activities to sustainably manage the freshwater resources to conserve the hydrosphere, and to meet the current and future human necessities [8]. The key activities to conserve water include any beneficial reduction in water loss, use and waste of resources, avoiding any damage to water quality; and improving water management practices that reduce the use or enhance the beneficial use of water [9]. Rainwater harvesting offers an important alternative for lessening water scarcity in addition to providing stormwater control benefits and is also an effective way of groundwater recharge [10, 11]. On the campus, many strategies have been implemented for water conservation. The most important ones include rainwater harvesting through rooftop catchments and check-dams. Both together contributed to ≈ 50% of water conservation on the campus. The campus comprises 32.4% of its total area with natural vegetation (463192 m<sup>2</sup>) and currently with 30.8% planted vegetation (439670 m<sup>2</sup>) of the total area (1428540 m<sup>2</sup>). Two check dams and a reservoir with a capacity of 2,000 liters have been newly constructed to store the rainwater. The gardens and lawns are being maintained with drip irrigation and other water-saving sprinkler systems. The treated domestic wastewater is stored in infiltration ponds on the surface to increase the rate of water percolation into

the ground. Treated water is used for watering lawns, indoor and outdoor gardens, and hand washing taps, toilet flush, etc. on the campus. It is also being used for baths, toilets in all the hostels.

### **1.6. Enhancement of Campus Greenery and Biodiversity**

Man-made landscape degradation largely affected seed-deposition patterns by decreasing cover of woody vegetation or availability of fruit resources that attracted birds and promoted seed dispersal [12]. The campus biodiversity is further enriched by periodical tree plantation drives with special reference to the planting of edible fruit-yielding saplings. It has not only helped to enhance the green ambiance with the continuous release of fresh oxygen but also helped in increasing the biodiversity with special reference to birds, including migratory ones as witnessed by regular conduct of bird count. 'One-Student-One-Plant' a new initiative of our University was effective in making our students more sensitized about nature. Through this initiative, every student is shouldered with the responsibility of taking care of a minimum of one sapling on the campus during the period of their stay on the campus from day one to completion of their studies; they have been motivated for this by awarding an appreciation certificate. The documentation of campus biodiversity that has been periodically updated is made accessible in print and online: < <https://mangaloreuniversity.ac.in/sites/default/files/BioDiversity%20Complete.pdf> >

#### **1.6.1. Special Plantation Drive in the name of the Freedom Fighters:**

This year, India is celebrating its 75<sup>th</sup> year of Independence and is recognized as *Azaadi Ka Amrith Mahotsav*. The *Azadi Ka Amrit Mahotsav* is an intensive, country-wide campaign focussing on citizen participation, to be converted into a '*Janandolan*' (Public movement), where small changes, at the local level, will add up to significant national gains (<https://amritmahotsav.nic.in/>). In this purview, the University has organized a special plantation drive as a part of the Independence Day celebration on August 15<sup>th</sup>, 2021 by planting edible fruit-yielding trees. Planted saplings were tagged with a label composed of names of freedom fighters and information such as taxonomic names, common names, and economic importance of the plant in quick response (QR) code. Some of the important trees that were planted include Indian blackberry (*Syzygium cumini* L.); jackfruit (*Artocarpus heterophyllus* Lam.), mango (*Mangifera indica*), sapota (*Manilkara zapota*), Gua (*Psidium guajava*), Kokum (*Garcinia indica*) and other wild varieties.

#### **1.7. Organic Waste Management:**

Municipal solid waste management (MSWM) is a major challenge; the problem mainly lies in the mixing up of organic (biodegradable) and non-degradable wastes. As per 2019 statistics, India generates 62 million tonnes of waste each year; about 43 million tonnes (70%) are collected of which about 12 million tonnes are treated and 31 million tonnes are dumped in landfill sites [13]. Mismanagement of municipal solid waste in addition to adverse effects on the environment, it also causes the risk to public health and raises many other socio-economic issues [14]. A simple but effective way of MSWM is decentralized pot-composting with the help of Black soldier flies (*Hermetia illucens*). The larvae of the black soldier fly during its growth period degrade all kinds of organic wastes and produce nutritious manure [15]. The compost generated from kitchen wastes by employing the black soldier flies is composed of C-organic compost, nitrogen, and phosphor, and as per a study the total Nitrogen, total Phosphor, C/N ratio, and pH fulfill the requirements of the national compost

standard [16]. Pot-composting, a simplified method that has been indigenously developed can be used in every home and restaurant to produce manure. Pot-composting is an easy method of waste management that does not require a machine, fuel, electricity, investment, and a big space. A resource person has given hands-on training on how to do the pot-composting of kitchen wastes. In this context, Ramakrishna Mission Swacch Mangalooru Abhiyan, an NGO involved in social welfare activities has been successfully involved in motivating residents of Mangalore to make use of pot-composting by employing *H. illucens*. It significantly reduced the volume of the municipal solid wastes collected by Mangalore City Corporation. Mangalore University under the head of VijayaBankChaironEcologyandEnvironment in association with Ramakrishna Mission Swacch MangalooruAbhiyan has organized a workshop on Eco-Friendly Pot-composting, at Mangalagangothri. The whole program was live-streamed via [www.youtube.com/abakkatv](http://www.youtube.com/abakkatv) The workshop was helpful to learn the pot-composting and economic empowerment can be watched at: <https://www.youtube.com/watch?v=ZCl8KM1wEy4>; <https://youtu.be/-8GHNi6GbxA>

As a result of the event, many people have got inspired and adopted pot-composting at their residents. On the campus, the organic waste produced from working women's hostels, men's hostels, and canteen are subjected to vermicomposting and pot-composting. The so produced biofertilizers are used for the maintenance of the garden and nursery. It also helped in avoiding the dependence on chemical fertilizers and enhancing soil fertility.

### 1.8. Campus Bird Count:

Seed dispersal by animals is considered a pivotal ecosystem function that drives plant-community dynamics in natural habitats and vegetation recovery in human-altered landscapes [12]. Birds, an important part of the ecosystem play a vital role in sustaining the lives on the earth. The periodical bird count is helpful in evaluating and understanding the decline and enrichment of campus biodiversity. Hence, in this context, the Department of Applied Zoology has carried out a Campus Bird Count: 2021 from 12-15<sup>th</sup> February 2021 on the campus. It is a participation in the Campus Bird Count (CBC), a sub-event of 'Great Backyard Bird Count (GBBC) organized by Bird Count India, for the past 6 years. As a part of this, four days event was successfully conducted with the sightings of 108 species of birds from various locations across the campus spread on 353 acres. Some of the birds recorded include Black Drongo (*Dicrurus macrocercus*); Black Kite (*Milvus migrans*), Common Iora (*Aegithina tiphia*), Green warbler (*Phylloscopus nitidus*), Purple-rumped Sunbird (*Leptocoma zeylonica*), Red-whiskered Bulbul (*Pycnonotus jocosus*), White-cheeked Barbet (*Psilopogon viridis*, Boddaert, 1783), Jungle Babbler (*Argya striata*), and Plum-headed parakeet (*Psittacula cyanocephala*). The observation also included nest and nestlings of House crow, prey caught by Shikra, and Indian Nightjar (nocturnal bird) activity during the day time. Ashy Drongo, Booted Eagle, Grey Wagtail, Indian Pitta are migratory birds. Grey-headed Bulbul (Near Threatened bird), Rufous Babbler and Flame-throated Bulbul is the endemic bird of the Western Ghats and Barn Owl, Spotted Owlet, Nightjars (Savanna, Indian, and Jerdon's) and Sri Lanka Frogmouth, the nocturnal birds were recorded. The rare birds, Yellow-billed Babbler, Green Sandpiper and Grey-necked Bunting is the new addition to the avian list of the campus.



Figure 1. Campu Bird Count Over the Years

### 1.9. Institutional Social Responsibility (ISR)

As an Institutional Social Responsibility (ISR), the university has been making its efforts to disseminate the knowledge of eco-friendly practices, by conducting public awareness programs (street play, processions, book publications, handbill distribution, etc.), workshops, training, seminars, and conferences.

#### 1.9.1. Observing Special Days and Organization of Sustainable-Related Programs:

Technology solutions exist for households, commercial and agricultural applications. Water conservation programs involved in social solutions are typically initiated at the local level, including public outreach campaigns [17]. The Department of Geography, under the University's government school adoption program organized an event to celebrate World Water Day in Govt. Dakshina Kannada Zilla Panchayath High School, Pavur on 22<sup>nd</sup> March 2021. The event included lectures on the importance of water sources, conservation strategies, and a demo of water conservation by experts in the field. Local public and school pupils have participated in the event. The majority of the participants have applied simple solutions of water conservation to their residents. Many other events such as webinar on 'Sustainable Engineering' in association with Bamboo Society of India, by the Department of Materials Science on 3<sup>rd</sup> Aug. 2021; two days national webinar on 'Animal Diversity and Conservation' as a part of Celebration of National Wildlife Week – 2020, by the Department of Applied Zoology on 7-8 Oct. 2021; National webinar on Climate Change, Agriculture and Disaster Management - Geospatial Remedy, by the Department of Geography on 25-26<sup>th</sup> Feb. 2021; the celebration of World Environment Day on 5<sup>th</sup> June 2020 (plantation drive, distribution of saplings, felicitation of an environmentalist for the service of snake conservation, lectures) and 2021 (plantation drive, a special lecture, by resource person, essay competition for students) by the Department of Biosciences have been successfully organized. All these events were organized online and in blended mode (online and offline) in view of COVID-19 pandemic.

### 1.9.2. Creating Awareness on Environment Conservation through Popular Article

#### Publications:

During the COVID-19 pandemic and lockdown effect, the general public had to spend their time at homes only. The usage of electronic media, particularly online news magazines that are accessible on smartphones became a part of updating the information and distance learning. The University has published many articles during this pandemic to create awareness among the general public on various issues of environment and conservation. The timely publication of popular articles in Kannada (a national language spoken in Karnataka) on World Water Day (22 March 2021; <https://www.kannadapress.com/2021/03/22/special-article-on-world-water-day-by-dr-prashanth-naik/>); World Environment Day (5 June 2021; <https://www.kannadapress.com/2021/06/05/special-articele-on-world-environment-day-2021/>); International Day for the Preservation of the Ozone Layer (16 Sept. 2020; <https://www.kannadapress.com/2020/09/17/special-article-about-international-ozone-day/>); World Food Day (16 October 2021; <https://www.kannadapress.com/2020/10/16/world-food-day-a-lesson-to-be-learned-from-polyphemus-larvae/>); World Nature Conservation Day (28 July 2021; <https://www.kannadapress.com/2021/07/28/article-about-world-nature-conservation-day/>), and many other articles on nature and conservation; <https://www.kannadapress.com/2020/11/26/article-about-golden-poison-frog-by-dr-prashanth-naik/>; <https://www.kannadapress.com/2020/10/19/article-about- euthalia-aconthea-by-dr-prashanth-naik/>; <https://www.kannadapress.com/2020/08/31/how-to-convert-wet-waste-into-compost-without-any-machinery/>; International women's Day (8 March 2021; <https://www.kannadapress.com/2021/03/08/role-of-women-in-environment-conservation-womens-day-spl-article/>) helped in creating awareness about those important days and make the general public more sensitized about their role in the conservation of nature.

#### 1.9.3. A Program for Empowering the General Public:

The COVID-19 pandemic in addition to health issues has paved the way for many problems, including economic crises worldwide, including India. There is a need to economically empower people who lost their jobs, not getting a salary, loss in business, etc. In this context, small scale home-based enterprises will be useful for the general public. Grafting and farming of some commercial crops are one such home-based business venture. A program was conducted for the benefit of the general public. A resource person from the Horticulture Department, Udupi demonstrated the method of grafting some commercial crops and their farming with the aid of vermicomposting.

#### 1.9.4. Other Environment Initiatives:

Some of our initiatives reflecting the institutional social responsibility undertaken during the COVID-19 pandemic received appreciation from all corners such as village adoption, adopting 10 government schools in the neighborhood under the Education Reforms – Govt of Karnataka; Construction of 'Vatsalya Nidhi' (Wall of Kindness) a place for charity work encouraging people to donate miscellaneous useful things; construction and



maintenance of the public restroom facility sponsored by the Bank of Baroda under CSR funding, the mid-day meal scheme for the poor students on the campus. All these activities and projects were implemented giving priority to environment-friendly approaches. Among the new infrastructure set up, 'Vatsalaya Nidhi' is not only helping the general public but also contributed to nature conservation in terms of freecycle. Thereby, 4 R's (reduce, reuse, recycle and recover) of waste management are effectively practiced on the campus. Our community engagement in sustainable development is guided by the philosophy of 'taking the University to the villages' with the active involvement, support, and commitment of NSS, Youth Red Cross, NGOs, and our Study Centres and Chairs.

## 2. Summary and Conclusions:

Overall, our holistic approaches to various eco-friendly strategies, in terms of the utility of advanced technologies, eGovernance, solar energy, and rainwater harvesting, organic wastes management, recycling of solid wastes, and many others, which have been implemented since its inception have significantly helped in saving energy and reducing in the emission of greenhouse gases. Our enthusiasm to contribute to the mitigation of climate change by the implementation of eco-friendly strategies and programs on the campus will continue with still more collective efforts.

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