KURIAKOSE ELIAS COLLEGE
MANNANAM

AUDIT REPORT (2022-23)
ENVIRONMENT, ENERGY AND GREEN INITIATIVES

Prepared by

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Executive Summary

An effective Environmental Audit plays a crucial role in shaping a vision of environmental sustainability for educational institutions, as Criterion VII of the National Assessment and Accreditation Council (NAAC) mandates. Kuriakose Elias (K.E.) College has embraced a commendable attitude of environmental stewardship through various green projects and eco-friendly activities. Although good progress has been made since the previous audit, there are still areas where environmental commitments could be strengthened.

The K.E College audit follows standard policy guidelines for higher education institutions aiming to achieve sustainability. The environmental audit process evaluates the institution's performance regarding the efficient use of natural resources, energy and waste management, and strategies to mitigate carbon emissions. The audit involved site visits, interviews, facility tours, surveys, questionnaires, and collecting existing records, reports, and documentation. Qualified personnel in each sector were interviewed to provide informed assessments.

Furthermore, official reports and data were collected from relevant sections. Environmental sampling and laboratory analysis were conducted to assess air and water quality. Meteorological data, including rainfall, temperature, and humidity, were gathered and analyzed over a stipulated period using advanced techniques like Remote Sensing (RS) and Geographic Information Systems (GIS) for air quality analysis. An extensive field study was carried out to examine faunal and floral variation to understand biodiversity better. The Environmental audit utilized specific performance indicators to monitor the College‘s progress toward environmental sustainability. The audit also looks into the performance of the College as per the policies set.

Energy Audit

The energy audit at K.E College aimed to assess and analyze the energy consumption patterns and practices on campus. The audit involved evaluating energy usage in different buildings and facilities, identifying areas of energy wastage, and recommending energy

conservation and efficiency strategies. The audit revealed that the College has already taken several initiatives toward energy sustainability, such as organizing energy conservation awareness programs, conducting workshops on energy-efficient lighting, and installing solar panels on the rooftop. These efforts have contributed to a significant reduction in energy consumption and reliance on traditional power sources. The audit highlighted the importance of adopting an Energy Management System (EMS) to enhance energy efficiency through continuous monitoring, measurement, and analysis. Implementing an EMS would enable the College to centralize energy consumption data, identify areas for improvement, and track progress toward energy reduction targets. Overall, the energy audit emphasized the significance of energy conservation, cost savings, and environmental impact reduction in creating a sustainable campus environment.

Waste Audit

The waste audit at K.E College revealed valuable insights into campus waste generation and management practices. The audit identified nine major waste categories: food, paper, plastic, glass, damaged furniture, e-waste, hazardous waste, biomedical waste, and other miscellaneous items. Food waste was the most significant contributor, followed by damaged furniture and paper waste. The audit also highlighted variations in waste generation among different blocks, with the canteen block generating the highest amount of waste. The classification of waste into biodegradable and non-biodegradable categories showed that biodegradable waste accounted for the majority of solid waste on campus. The audit emphasized the importance of waste reduction, resource conservation, cost savings, and environmental impact reduction through effective waste management practices. Additionally, it recognized the potential for educational and awareness opportunities, compliance, and sustainability reporting in waste management. These findings provide a foundation for K.E College to implement targeted waste management strategies toward an environment-friendly campus.

Water Audit

The water audit conducted at K.E College has revealed significant findings and recommendations for water management and conservation. The College has already

implemented measures such as rainwater harvesting, wastewater management, and installation of drinking water facilities, indicating that they are heading in the right direction. The campus effectively utilizes natural water sources and ensures proper maintenance of taps and faucets to prevent water wastage. Water treatment processes are in place to ensure clean and safe water distribution. Extending rainwater harvesting to other buildings is recommended to optimize further water usage, such as constructing separate tanks for different water sources and installing outlets for significant water storage tanks.

Additionally, implementing wastewater treatment plants and reusing treated wastewater for gardening can enhance water sustainability. Proposed measures were included in the report to enhance water efficiency, reduce wastage, and contribute to a more sustainable and responsible water management approach. By implementing these recommendations, K.E College can continue to improve its water management practices, ensure high-quality water for its occupants, and contribute to water conservation efforts. Regular monitoring and testing will be essential to maintain water quality standards and promptly address potential issues. The College's current efforts and the proposed measures demonstrate a commitment to water conservation and sustainability, setting an example for other institutions and contributing to a more responsible and efficient use of water resources.

Biodiversity Audit

The K.E. College campus, located near the Vembanad wetland system, exhibits remarkable biodiversity despite its limited size and terrain. A comprehensive biodiversity audit revealed 171 plant species belonging to 64 families. The faunal diversity recorded included 10 species comprising invertebrates, including butterflies, damselflies, and dragonflies, whereas the vertebrates include fishes, reptiles, birds, and mammals. Both floral and faunal composition showcases the campus's richness in biodiversity. While most of these plants are exotic garden species, the collection includes endemic plants, fruit-bearing trees, medicinal plants, and various flowering trees and shrubs that attract diverse pollinators and birds. It is worth noting that this assessment represents only a snapshot, and conducting periodic observations at different seasons is likely to unveil more species. Furthermore, the College's management deserves appreciation for their exceptional efforts in nurturing honey bees, which benefit the campus garden and contribute to pollination and enhanced agricultural

yields in the surrounding areas. The biodiversity audit highlights the K.E College campus's exceptional ecological value and underscores its conservation efforts despite its limited area.

Carbon Audit

The carbon audit conducted at K.E. College aims to address the impact of human activities on greenhouse gas emissions, mainly carbon dioxide (CO_2), and its environmental consequences. The increasing rate of gas emissions from various activities highlights the importance of raising awareness about these emissions and finding alternatives to mitigate their harmful effects. Climate change and global warming present significant challenges that require immediate attention. The carbon audit at K.E College determined the per capita carbon footprint, approximately 65.1421 TCO_2. Additionally, the audit identified the emission potential of major sources categorized under three scopes. The first scope includes LPG, diesel consumption, and fugitive emissions. The second scope focuses on purchased electricity consumption, which contributes significantly to emissions. The third scope encompasses waste disposal and other activities related emissions. By revealing the carbon footprint of K.E College, we can identify the sources and sinks of emissions, allowing us to pinpoint the most efficient measures to reduce carbon output.

Green initiatives

K.E College has exemplified its commitment to sustainability and environmental consciousness by implementing commendable green initiatives. Guided by the principles established by the Haritha Kerala Mission, the College has embraced a green culture encompassing various campus life aspects. K.E College prioritizes waste management through effective collection, segregation methods, and utilization, including vermicompost and biogas plants. Water conservation is a key focus, with efficient water utilization and sustainable practices implemented campus-wide. The College emphasizes energy conservation by installing solar panels and raising awareness about energy-saving practices. The green initiatives of the K.E College promote sustainable waste management, water conservation, and energy efficiency.

The campus boasts beautifully maintained gardens, and green classrooms, creating a pleasant and eco-friendly atmosphere. These green spaces not only enhance the aesthetic

appeal of the campus but also provide habitats for diverse flora and fauna, attracting pollinators and birds. Moreover, K.E College actively engages students in environmental conservation programs through various clubs and cells such as the Bhoomitrasena Club, Nature Club, Energy Club, NSS, and ENCON Club. These initiatives promote an appreciation for the environment and encourage students to participate in environmental conservation programs actively. The College organizes nature study programs, training sessions, awareness creation events, eco-friendly interactive sessions, cleaning programs, tree planting campaigns, and other social extension activities. The involvement of faculty and students in these initiatives fosters a sense of responsibility and empowerment in the campus community.

In summary, K.E College's green initiatives are a model for other institutions and communities, inspiring sustainable practices and a greener future. The comprehensive environmental conservation and resource management approach significantly impacts biodiversity preservation, water, and energy conservation, waste reduction, student empowerment, and community engagement. Through its commitment to sustainability and environmental awareness, K.E College is creating a sustainable and eco-friendly campus while nurturing a generation of environmentally conscious individuals.

The environmental audit conducted at K.E College showcases their commitment to sustainability and environmental stewardship, providing valuable insights into their green initiatives and highlighting areas for further improvement towards a greener and more sustainable campus.

I

INTRODUCTION

Education is vital in equipping individuals with knowledge, critical thinking abilities, attitudes, empowerment, and skills necessary to contribute to a better world. It serves as the foundation for building a strong nation with well-informed citizens. Educational institutions are responsible for transmitting cultural heritage and accumulated knowledge from one generation to another. In India, the development and governance of educational institutions are governed by the Indian constitution.

Audit functions in educational institutions are crucial for ensuring good governance. They ensure that processes and systems within these institutions produce outcomes that meet societal needs while optimizing resource utilization. Colleges and other higher education

institutions play a significant role in shaping future leaders. They should provide an understanding of environmental issues and sustainable development theoretically and by exemplifying best management practices. Incorporating a professional Environmental Audit (Green Audit) can be an integrative tool for sustainability training and operational management within educational institutions. This approach ensures that environmental concerns are integrated into the regulatory functions of the institute.

Background of Environmental Audit in higher education institutions

The background of environmental audits in colleges can be traced back to the growing recognition of the need for environmental protection and sustainable practices. As environmental degradation and climate change concerns increased, educational institutions, including colleges, began acknowledging their role in promoting sustainability and environmental stewardship. Implementing environmental audits in colleges gained momentum in the late 20th century. The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, highlighted the importance of incorporating environmental considerations into various sectors, including education. This conference inspired nations to evaluate their environmental practices and adopt policies and programs to protect and enhance the environment.

In India, the importance of environmental audits in colleges was recognized early. The Indian Constitution, specifically in Articles 48A and 51A(g), emphasizes the responsibility of citizens and institutions to protect and improve the environment. Judicial interpretations of Article 21 further reinforced the need for environmental accountability. As a result, environmental audit became mandatory for industries and was extended to educational institutions, including colleges. The National Assessment and Accreditation Council (NAAC), a statutory body under the University Grants Commission (UGC) in India, plays a significant role in endorsing and assessing the quality of higher education institutions. As part of this process, NAAC incorporated the concept of environmental audit to evaluate colleges' environmental performance and sustainability initiatives.

Today, Colleges recognize the importance of environmental audits as tools for assessing their environmental impact, identifying areas for improvement, and integrating sustainable

practices into their operations. It helps colleges measure their carbon footprint, water usage, waste management, energy consumption, and other environmental aspects. Environmental audits provide valuable insights and recommendations for colleges to adopt eco-friendly practices, reduce their environmental footprint, and promote environmental awareness among students and staff. Overall, the background of environmental audit in colleges stems from the global recognition of environmental concerns, the legal and constitutional frameworks promoting environmental responsibility, and the efforts of accreditation bodies to evaluate and endorse sustainable practices in higher education institutions.

The integrative role of environmental audits in higher educational institutions

Environmental audits play a crucial role in colleges by integrating sustainable practices, improving environmental performance, and nurturing a culture of environmental responsibility. These audits serve as a comprehensive tool that evaluates the college's environmental practices, identifies areas for improvement, and helps align operations with sustainable principles. The prominent integrative roles of environmental audits in colleges are:

- *Assessing Environmental Performance*: Environmental audits evaluate a college's environmental performance by assessing its policies, practices, and systems. They comprehensively review the College's resource consumption, waste management, energy efficiency, water usage, and other environmental aspects. This assessment helps colleges understand their current environmental impact and identify improvement areas.
- *Compliance with Regulations*: Environmental audits ensure colleges comply with environmental regulations and standards. They help colleges identify any non-compliance issues and take corrective actions. By adhere ng to environmental regulations, colleges demonstrate their commitment to environmental responsibility and avoid potential legal penalties.
- *Identifying Improvement Opportunities:* Audits help colleges identify opportunities for improving their environmental performance. They highlight inefficiencies, waste generation, and areas where resource consumption can be reduced. The audit

findings help colleges implement sustainable practices, such as energy conservation, waste reduction, recycling initiatives, and water conservation measures.

- *Integration of Sustainability into Operations:* Environmental audits facilitate the integration of sustainability principles into the daily operations of colleges. They help colleges develop and implement environmental management systems, policies, and action plans. Audits encourage colleges to adopt sustainable practices in procurement, transportation, building design, and curriculum development, promoting a holistic approach to sustainability.
- *Stakeholder Engagement*: Environmental audits involve various stakeholders within the College community. They provide a platform for students, faculty, staff, and administrators to participate in the audit process, share their perspectives, and contribute ideas for healthy initiatives. This engagement fosters a sense of collective responsibility and empowers stakeholders to contribute to the college's environmental goals actively.
- *Continuous Improvement and Monitoring:* Environmental audits support a continuous college improvement cycle. They establish benchmarks, set targets, and provide a mechanism for monitoring and evaluating sustainability efforts. Regular audits enable colleges to track their progress, assess the effectiveness of implemented measures, and identify further opportunities for improvement.

By fulfilling these integrative roles, environmental audits help colleges create a sustainable campus environment, instill environmental awareness among stakeholders, and contribute to a more environmentally responsible society. They serve as a vital tool for colleges to align their operations with sustainable practices and positively impact the environment.

Benefits of Environmental Audit

- Help to protect the environment and sustainability on the campus.
- Identify cost-saving methods through energy conservation, water conservation, and waste minimization.
- Enhancement of biodiversity resources.

- Reduction in carbon dioxide emission, making the campus climate-friendly.
- Impart a good image to the institution through its clean and green campus.
- Empower the college to evolve the right sense of nature stewardship and values.

About the College

Kuriakose Elias College, popularly known as K.E. College, is a prestigious higher education institution on the scenic Mannanam hills in Athirampuzha Panchayat, Kottayam district, Kerala. The College is dedicated to St. Kuriakose Elias Chavara, the co-founder of the Carmelites of Mary Immaculate (CMI), who believed in the transformative power of education. Kuriakose Elias College is a leading educational institution committed to providing advanced learning bound to a value-based approach.

Fig. 1 Overview of the College

Nestled amidst the picturesque surroundings of the Mannanam hills, the College provides a serene and conducive environment for students to learn and grow. Its primary focus is fostering holistic development by emphasizing character formation, academic excellence, and social responsibility. K.E. College is dedicated to equipping its students with the

necessary skills, knowledge, and values to succeed in their chosen fields and make meaningful contributions to society. The College creates an atmosphere that nurtures students' development by fostering intellectual curiosity, critical thinking, and personal growth.

Historical background

Established in 1964 as a junior college, K.E. College was founded to provide Catholic youth with higher education within a nurturing Catholic environment. Located on the Mannanam Hills, the College's campus holds historical significance as the site where Saint Kuriakose Elias initiated secular education by establishing the Sanskrit School in 1846. It was also home to the earliest press of the Catholic Church in India and the first English medium school for Catholics in Kerala.

Under the administration of St. Joseph's Monastery, the mother house of the CMI congregation, K.E College has made substantial contributions to cultural, educational, and spiritual spheres since the congregation's inception in 1831. The proactive efforts of Rev. Fr. Fabian CMI, the founder manager, and Rev. Fr. Papias CMI, the first principal, played significant roles in establishing and developing the College. Initially affiliated with Kerala University, K.E College became a degree college in 1967 and has been under the jurisdiction of Mahatma Gandhi University since 1983. Over fifty years, the College has emerged as a prominent center of learning and a source of inspiration for the people of Kottayam and Kerala. The College offers undergraduate (UG), postgraduate (PG), and research (Ph.D.) in arts, commerce, and science programs.

Overall, the College stands as a testament to the commitment of the CMI congregation to providing quality education and shaping the lives of students in a holistic manner.

Infrastructure

Kuriakose Elias College boasts a modern and eco-friendly campus equipped with state-of-the-art facilities. The campus features contemporary buildings with 75 technology-enabled classrooms, 14 well-equipped laboratories, two seminar halls, and an auditorium. Additionally, students have access to a central computer laboratry, a library, a research block, an examination hall, a statistical computing laboratory, a language laboratory, and a

media hub. The College also provides essential amenities like a hygienic canteen, a gymnasium, and a basketball and badminton court.

The institution has embraced a green protocol following the guidelines set by the Haritha Kerala Mission, Government of Kerala. The campus prioritizes environmental sustainability and offers purified drinking water, an uninterrupted power supply with the help of a solar power plant, and other necessary facilities. A dedicated team ensures cleanliness across the campus and maintains the College garden. The College has implemented integrated water, energy, and waste management systems, including rainwater harvesting, a biogas plant, a solar power plant, and a vermicomposting unit. The Chavara Park, Stone Park, and Sunbeam Garden enhance the campus, adding to its scenic beauty.

Kuriakose Elias College provides a modern, eco-friendly campus with advanced facilities for academic and non-academic activities. The College's commitment to environmental sustainability is evident through its green protocols and integrated management systems, ensuring a conducive and environmentally conscious learning environment for the students.

Indoor stadium

Library

Computer laboratory

Students co-operative society

Visitors lounge

Hostel facility


Chapel


Career cell


Seminar hall


Canteen


Sunbeam Garden


Outdoor classrooms


Chavara hall


Conference hall


Laboratory

Fig. 2 Facilities of the College

Academic and Allied Activities

The College is a prominent Arts and Science College affiliated with the Mahatma Gandhi University with 16 Aided programs (10 UG & 6 PG), 10 Self-financing Programmes (5 UG & 5 PG), three Research Centres, and 9 NSQF courses. Quite a good number of student support services like NSS, NCC, Women's Forum, Career Guidance Cell, Counseling Cell, Ek Bharat Shrestha Bharat, Entrepreneurship and Development Club, Equal Opportunity Cell, Young Innovators Programme, Encon Club, Tourism Club, Bhoomithrasena club, Anti Narcotic Cell, etc. work actively for the welfare of the students. Various scholarships, stipends, and awards are given to meritorious students as incentives for further achievement.

Teaching, Research, and Innovation

The teaching fraternity is a professional, competent, dedicated community comprising 118 qualified teachers. Many faculty members have served as members of the Board of Studies (BoS), Academic council, and College development council at Mahatma Gandhi University.

The Principal, teachers, and students have received meritorious awards in various fields for their achievements. The College has been recognized in the band PERFORMER under the category of "General (Non-Technical) in the Atal Ranking of Institutions on Innovation Achievements (ARIIA) in 2021. Recently, a student team was selected for the 'One District One Idea' Programme organized by Kerala Development for Innovation and Start-up Council. Entrepreneurship and Innovation are given added focus to the K.E College, which received good incentive funding from Kerala Startup Mission in 2020-21. An Institution Innovation Council (IIC) of the Ministry of Education, Government of India, also works actively in the College. The IIC and IEDC of the College also collaborate with the Business Innovation and Incubation Centre (BIIC) and Scheme for Trans-disciplinary Research for India's Developing Economy (STRIDE) under Mahatma Gandhi University, Kerala.

The faculty members of K.E College have actively engaged in research projects, showcasing their commitment to academic inquiry. The College has also carried out extension activities, including outreach programs of social dimensions. One notable initiative is the annual fair organized for mentally challenged children in the local community, demonstrating the College's dedication to social regeneration.

The College takes pride in its strong alumni association, which has five international chapters. This network highlights former students' global reach and impact in various service-oriented professions worldwide. The College has produced several notable alumni who have excelled in art, politics, administration, and academics.

Fig. 3 Academic Scenario

Vision

To become a center par excellence of learning, unique in experience, value-based approach, and committed in service for enriching and fulfilling life.

Mission

To facilitate the comprehensive and integral development of individuals who effectively function as instruments of social changes imbued with righteousness and courage of conviction, dare to dream and strive to achieve.

The process of NAAC accreditation has profoundly impacted the continuous improvement of K.E College, viewed from a systems perspective. Implementing various quality assurance systems by the Internal Quality Assurance Cell (IQAC) has shaped a standardized quality model for K.E College. These systems are being progressively implemented, enabling the College to enhance its capacity to become an exceptional learning center characterized by a unique experience, a value-based approach, and a steadfast commitment to service. The entire K.E family, including students, faculty, administrative staff, and other stakeholders, alongside the College's leadership, work in unity to uphold the motto of "***Tamasoma Jyotirgamaya***" (Lead me from darkness to light). With an unwavering dedication to academic excellence and integrity, the College proudly upholds this motto as it celebrates 59 years of imparting knowledge and ceaseless efforts to enrich and fulfilling lives.

Purpose of the present environmental audit 2022-23

The purpose of conducting an environmental audit in K.E College is to assess, evaluate the environmental practices, and identify areas for improvement towards sustainability. The audit aims to integrate sustainable practices, enhance environmental performance, ensure compliance with regulations, engage stakeholders, guide decision-making and planning, and drive continuous improvement. The audit process enables the College to align its operations with sustainable principles, reduce its environmental footprint, and foster a culture of environmental consciousness among the students, faculty, and staff. Thus the audit serves as a tool for the College to improve its environmental practices, contribute to a more sustainable future, and inspire its community to embrace and uphold environmental values.

II
METEOROLOGICAL STATUS
&
ENVIRONMENTAL QUALITY

Manannam, a village in the Kottayam district of Kerala, India, experiences a tropical climate characterized by distinct seasons and abundant rainfall. The climate features an oppressive hot season in the plains, lasting from March to May, accompanied by high temperatures. This is followed by the southwest monsoon from June to September, during which the region receives ample rainfall. October and November are the post-monsoon or retreating monsoon seasons, characterized by gradually increasing day temperatures nearly as intense as summer. The village experiences the northeast monsoon from October to December. On average, the district receives approximately 3130.33mm of rainfall annually.

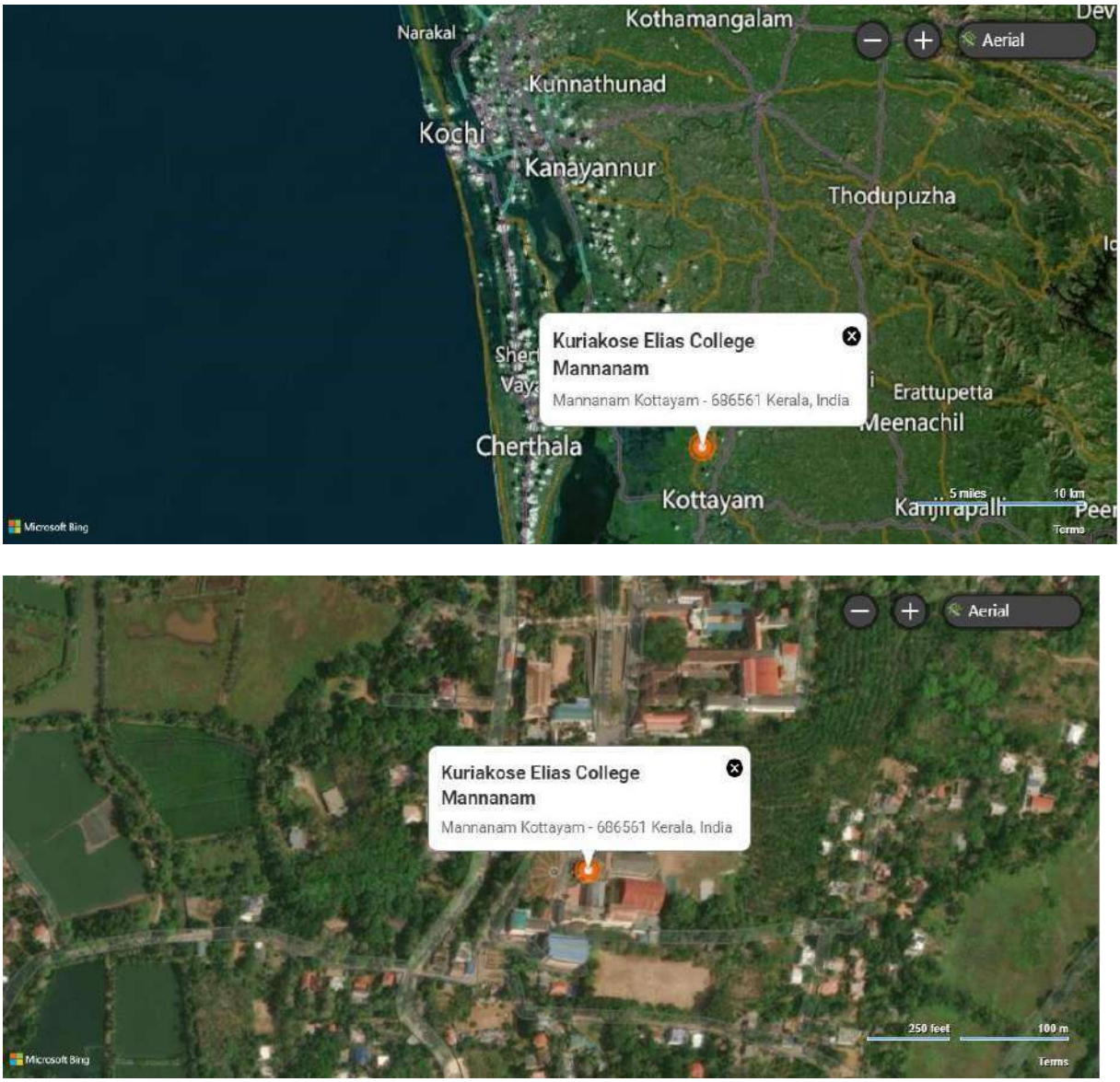


Fig. 1 The geographical location of K.E. College, Mannanam

The weather data for Mannanam, Kottayam, was obtained from the National Aeronautics and Space Administration (NASA) web portal, which provides global-scale observational data sets for understanding climate variability. Monthly average data with a resolution of 0.10 x 0.10° was downloaded for 2017-2022 and used to analyze weather conditions.

Mannanam, located in the Kottayam district of Kerala, experiences a tropical-type climate that is pleasant and moderate, with no distinct seasons. As part of the equatorial region, there is a slight variation in seasonal temperatures. The average annual temperature in the district

ranges from 20°C to 35°C, accompanied by high to moderate humidity levels. The warmer months in this district are March, April, and May, which also see pre-monsoon rainfall with lightning and thunder. The monsoon season occurs from June to September, bringing the heaviest precipitation through the southwestern monsoon. The rainfall decreases during October, November, and December, associated with the northeast monsoon.

The winter season in Kottayam extends from December to February. The mean monthly rainfall for the years under consideration ranged from 33.18cm to 55.2 cm, with the highest average rainfall recorded in 2018 and the lowest in 2017. The meteorological parameters, like rainfall, temperature, and humidity, were recorded from the K.E College area.

Table 1 Month & Year wise rainfall (cm)

Months	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
January	67.00	54.00	55.20	65.12	75.13	58.60
February	66.00	52.00	15.30	14.20	18.09	20.10
March	49.80	45.40	110.50	120.20	132.79	78.50
April	88.50	71.80	123.40	125.40	119.01	105.62
May	354.70	375.40	556.20	575.60	545.57	325.60
June	405.60	749.60	412.80	398.50	423.29	325.60
July	352.60	855.50	660.10	660.20	664.73	550.80
August	415.60	966.50	710.50	550.20	586.39	575.50
September	498.50	330.40	324.50	298.40	361.09	256.30
October	161.80	110.50	254.10	265.20	241.50	223.50
November	155.60	65.80	300.00	375.60	275.60	234.52
December	60.50	39.60	64.50	66.50	69.41	60.10

The mean monthly temperature for Mannanam, Kottayam, is presented in Table 2. The data analysis shows that the mean monthly temperature for the years under consideration ranged from 19.10°C to 34.30°C.

Table 2 Month & Year wise temperature (°C)

Months	2017	2018	2019	2020	2021	2022
January	24.20	25.10	24.10	23.20	24.50	24.20
February	25.10	26.50	23.40	27.10	26.95	25.40
March	33.70	34.30	32.90	31.90	33.50	31.50
April	27.80	26.50	27.50	26.50	27.60	27.10
May	28.00	28.60	27.20	25.20	26.30	27.06
June	24.84	23.48	22.12	22.56	27.15	24.03
July	20.20	19.10	21.40	21.30	22.30	20.86
August	22.60	19.73	21.53	23.33	23.40	22.12
September	31.20	30.10	30.30	28.36	26.40	29.27
October	28.50	27.10	28.40	28.79	26.53	27.86
November	22.60	24.10	25.20	26.30	26.20	24.88
December	21.30	22.30	20.10	24.30	24.10	22.42

The region experiences moderate to high humidity levels with some seasonal variation. The average annual humidity for the region is measured at 17.97 gram per kilogram (g/kg).

Table 3 Month & Year wise humidity (g/kg)

Months	2017	2018	2019	2020	2021	2022
January	15.97	16.47	16.10	16.10	16.07	15.90
February	14.03	14.53	14.33	14.20	14.13	14.10
March	14.84	15.34	15.20	15.20	14.94	14.90
April	18.05	18.55	19.10	18.60	18.15	18.20
May	19.09	19.59	19.39	20.10	19.19	19.20
June	19.12	19.62	19.42	20.40	19.22	19.30
July	18.81	19.31	19.11	20.11	18.91	18.40
August	19.25	21.30	20.13	19.54	19.35	19.25
September	18.67	19.17	18.97	20.93	18.77	18.70
October	18.74	19.24	19.04	20.03	18.84	19.10
November	18.03	18.53	18.33	19.32	18.13	18.40
December	15.88	16.38	16.18	17.14	15.98	15.70

Air Quality

Air quality data for the region was obtained from the NASA web portal, specifically from the Goddard Earth Sciences Data and Information Services Center (GES DISC) archives. These archives provide access to atmospheric composition data from various remote sensing instruments and model assimilations dating back to 1970. The data were procured from Orbiting Carbon Observatory 2 (OCO-2), Ozone Monitoring Instrument (OMI), Microwave Limb Sounder (MLS), High-Resolution Dynamic Limb Sounder (HIRDLS), Thermal And Near-infrared Sensor for carbon Observation (TANSO) Fourier Transform Spectrometer (TANSOFTS) on the Greenhouse gases Observing SATellite (GOSAT), and Atmospheric Infrared Sounder (AIRS) on EOS Aqua. Monthly average data with a resolution of 0.10 x 0.10° were downloaded and utilized to analyze air quality in the region. The downloaded weather and atmospheric data files in .netcdf format were processed using Arc GIS Software. The spatial position of K.E College was overlaid on the data to extract the corresponding pixel values at that location. Specifically, the analysis focused on air nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) levels.

Nitrogen dioxide (NO_2)

Nitrogen dioxide (NO_2) is an essential indicator of environmental quality due to its association with air pollution and its impact on human health and the environment. It is a significant component of air pollution, primarily from burning fossil fuels. High levels of NO_2 contribute to smog formation and can lead to poor air quality. Exposure to NO_2 can have adverse health effects, especially on the respiratory system, contributing to acid rain and ground-level ozone formation. Regulatory standards are in place to limit NO_2 levels, aiming to protect public health and maintain a clean environment. Monitoring and controlling NO_2 levels are essential for maintaining a healthy and sustainable environment.

The data analysis revealed monthly variations in nitrogen dioxide levels, ranging from 11.1 to 20.2 µg/m³. The average value calculated for the region was 14.6 µg/m³, well below the prescribed permissible limit of 40 µg/m³ set by the Central Pollution Control Board (CPCB) standard.

Table 4 Variations in NO_2 levels

Months	NO_2 (µg/m³)
January	15.2
February	14.3
March	16.2
April	18.5
May	20.2
June	16.4
July	11.1
August	11.2
September	10.6
October	14.2
November	13.1
December	14.2

* CPCB Standard of NO_2 level is (40µg/m³)

Sulphur dioxide (SO_2)

Sulfur dioxide (SO_2) is an important indicator of environmental quality due to its harmful effects on air pollution, human health, and the environment. It is primarily emitted during the combustion of sulfur-containing fossil fuels. High levels of SO_2 exposure can lead to respiratory problems and worsen existing respiratory conditions. SO_2 also contributes to the formation of acid rain, which can damage ecosystems and infrastructure. Monitoring and controlling SO_2 levels are crucial for maintaining good environmental quality and protecting human health.

The analysis of the monthly sulfur dioxide (SO_2) concentrations in the institutional area revealed that the values ranged from 1.5 to 2.7 µg/m³. The highest concentration was observed in October, while the lowest was recorded in June. The average SO_2 concentration in the area was found to be significantly lower at 2.14 µg/m³, well below the permissible limit set by the Central Pollution Control Board (CPCB) at 50 µg/m³. These findings indicate that the SO_2 levels in the area are within the acceptable range according to environmental standards, ensuring a good quality of air in the vicinity.

Table 5 Variations in SO_2 levels

Months	SO_2 (µg/m³)
January	2.3
February	2.4
March	1.8
April	2.5
May	2.1
June	1.5
July	1.8
August	2.1
September	1.6
October	2.7
November	2.4
December	2.5

* CPCB Standard of SO_2 level is (50µg/m³)

In contrast to the rapid urbanization observed in many other regions of Kerala, the study area of Mannanam does not face the same level of urbanization crisis which is advantageous for maintaining good environmental quality in the region. Green vegetation, especially trees, is a natural filter for various gases and particulate matter in the air. The strategic greening of open spaces and campus areas has significantly improved the ambient air quality within this locality. Furthermore, the geographical location of the region, combined with its unique meteorological characteristics, plays a role in preserving the tranquility and serenity of the area. These factors contribute to creating a favorable environment with better air quality in Mannannam, providing a pleasant and healthy living environment for its residents in the nearby area and the campus community.

III
COMPONENT AUDITS

1. ENERGY AUDIT

An energy audit is a systematic process of assessing and evaluating the energy performance and efficiency of a building, facility, or organization. It involves comprehensively examining energy-consuming systems, equipment, and processes to identify areas of energy waste, inefficiency, and potential energy-saving opportunities. During an energy audit, various aspects of energy consumption are analyzed, including lighting, heating, ventilation, air conditioning systems, insulation, appliances, and electrical systems. The audit may involve measurements, data analysis, equipment inspections, and interviews with facility occupants and operators.

An energy audit assesses and optimizes energy consumption within a facility or organization. Its objectives include identifying energy consumption patterns, detecting areas of waste and inefficiency, evaluating energy performance, quantifying potential energy savings, conducting financial analysis, considering environmental impact, raising awareness about energy conservation, and promoting a culture of sustainability.

College energy audits are crucial in achieving cost savings, reducing environmental impact, providing educational opportunities, meeting sustainability goals, and improving comfort and productivity on campus. By identifying areas of energy waste and implementing energy-saving measures, colleges can lower energy consumption, reduce greenhouse gas emissions, and allocate funds to other essential areas. Energy audits also offer educational experiences for students and help colleges track progress toward sustainability targets. Additionally, optimizing energy systems enhances the comfort and productivity of the campus environment. The audit is a foundation for implementing energy-saving measures and achieving long-term sustainability goals.

The objectives of the energy audit

- Generation of energy consumption profile of the campus
- Identification of major energy resources of the campus
- Identification of sustainable energy avenues existing on the campus
- Generation of an effective energy management strategy

Methodology

A team from ACESSD visited the K.E campus to assess the energy resources and the present consumption pattern. The teaching staff members and electrician of the College assisted the team with data collection. Information regarding energy sources, the quantity of consumption, its pattern of use and wastage, etc., were entered in the standard datasheets prepared. Besides, rigorous field visits, interviews, and discussions were conducted with the concerned authorities.

An energy analysis or energy audit includes the following steps:

1) Collection and analysis of data on energy use.

2) Study of the building and its operational tactics.

3) Identification of potential solutions that will reduce energy use and cost.

4) Preparation of an audit report to document the analysis process and results

The audit process (Figure 1) includes the following steps:

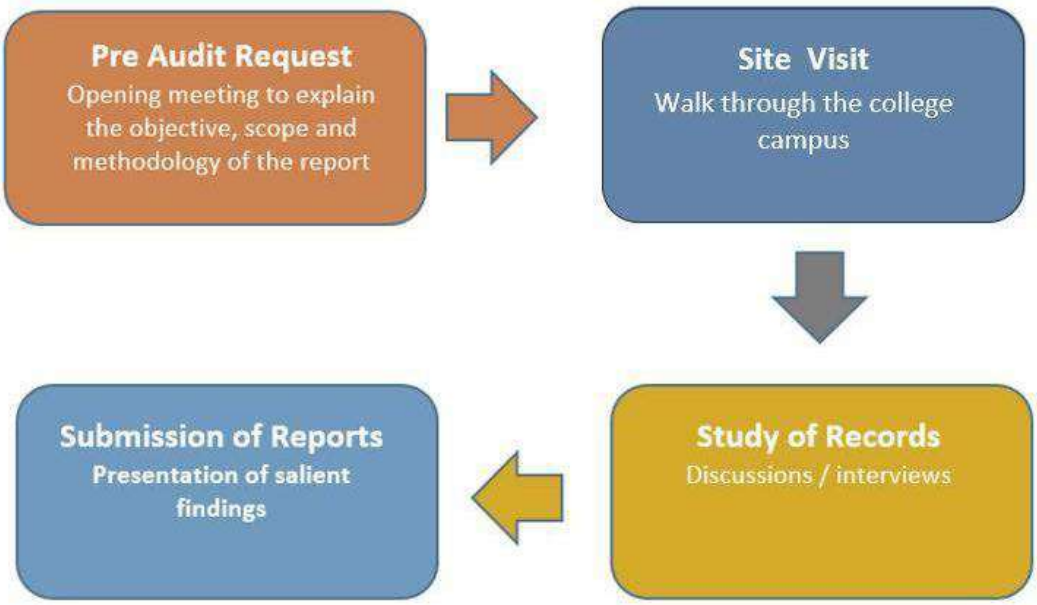


Fig. 1 Energy audit process – a flow chart

Data sources: Data were collected from K.E College. Besides, discussions were regularly held with concerned staff and electricians. This report presents the energy consumption profile of the college with a suggestion to sustain energy consumption on the campus. The methodology includes preparing and filling up questionnaires, physical inspection of the campus, observation, and review of the document, interviewing responsible persons, data analysis, and recommendations.

Data Analysis - Detailed analysis of data collected includes calculation of energy consumption, analysis of the latest electricity bill of the campus, and understanding of carbon emission potential from the current electricity utilization pattern.

Recommendations / Suggestions– Based on the data analysis and observation results, steps for reducing power consumption were recommended. To achieve energy sustainability, an energy efficiency management strategy is also fabricated.

Observations

1. Energy sources and consumption profile

The College relies on electricity as its primary energy source, supplied by the KSEB. To ensure uninterrupted power supply, the campus is equipped with Diesel Generators. Additionally, firewood is used for cooking purposes in the canteen. As part of its commitment to renewable energy, the institution has also implemented solar power panels, which contribute a portion of the campus's annual power requirements. The energy consumption scenario of K.E College from April 2022 to March 2023 is detailed in Table 1, providing a comprehensive overview of their energy usage.

Table 1 Annual energy consumption and expenditure of K.E College from April 2022 to March 2023

Sources of energy	Unit	Annual consumption	Energy equivalent		Average cost/unit	Annual expenditure	
			kWh	%	Rs	Rs	%
Electrical	kWh	66005	66005.00	58.35	9.47	6,25,067.35	74.48
Diesel	Litre	1056	13506.94	11.94	94.84	1,00,151.04	11.93
LPG	kg	1297.6 (71 cylinder)	18191.05	16.08	1,602/cylinder (19kg) 1150/cylinder (15 kg)	1,06,510	12.69
Firewood	kg	3000	15420	13.63	-	7,500	0.89
Total			113123.0	**100**		8,39,228.39	100

The energy consumption at K.E College is sourced from various energy types, including electrical energy, diesel, LPG (liquefied petroleum gas), and firewood. Electrical energy accounts for the most significant consumption, with an annual consumption of 66,005 kWh, equivalent to 48.44%. The average cost per unit of electrical energy is Rs 9.47, resulting in

an annual expenditure of Rs 6,25,067.35. Diesel consumption is 1,056 liters, representing 11.94 % of the total energy consumption. The average cost per diesel unit is Rs 94.84, leading to an annual expenditure of Rs 1,00,151.04. Annual LPG consumption is 1297.6 kg (71 cylinders), accounting for 16.08 % of the total energy consumption. The average cost per unit of LPG is Rs. 1602 / commercial cylinder and 1150 / domestic cylinder resulting in an annual expenditure of Rs. 1,06,510. Firewood consumption is 3000 kg, representing 13.63% of the total energy consumption, leading to an annual expenditure of Rs 7500. The annual energy consumption at K.E College amounts to 113123.0 kWh, with an annual expenditure of Rs 8,39,228.39.

Monitoring and managing energy consumption across these sources can help optimize costs and identify opportunities for energy efficiency improvements.

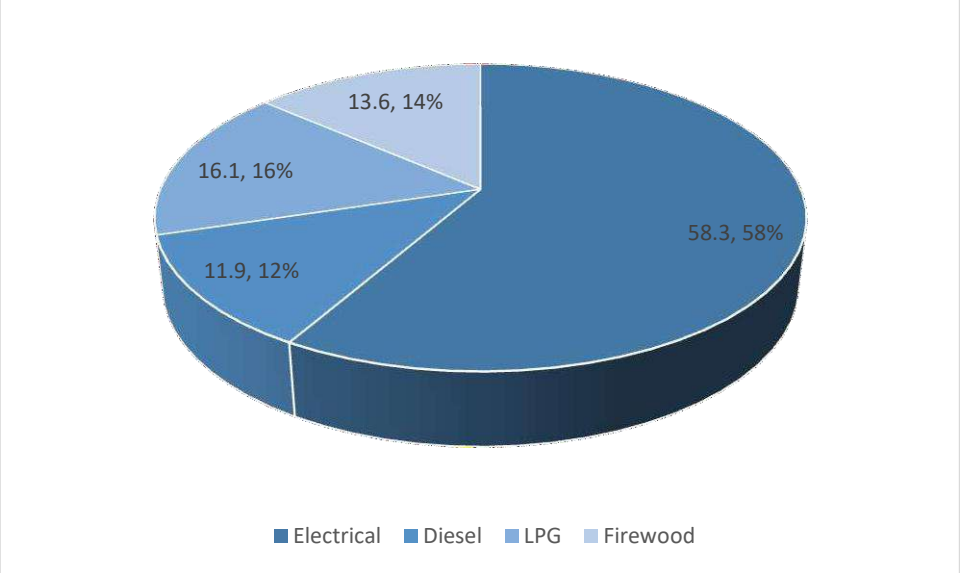


Fig. 1 Annual energy consumption profile of K.E College

Table 2 Summary of energy electricity consumption profile of the campus

Supply voltage	**11 kV**
Transformers	11000 V / 433 V
DG sets	40 kVA - 1 no & 20 kVA - 1 no
Contract Demand	750 kVA
Connected load	128897 Watts
Summary of energy consumption	
Annual electricity consumption	66005 kWh
Annual diesel consumption	1056 Litres
Annual LPG consumption	1297.6 kg
Annual firewood consumption	3000 kg
Annual total energy consumption	113123 kWh

K.E College relies on electrical energy as its primary energy input, supplied by the Kerala State Electricity Board Limited (KSEB), with a supply voltage of 11 kV. Transformers are used to step down the voltage to 433 V. The campus has backup power in the form of two diesel generators, one with a capacity of 40 kVA and the other with a capacity of 20 kVA, ensuring an uninterrupted power supply.

From April 2022 to March 2023, the College consumed 66005 kWh of electricity. Monthly electricity consumption (Figure 2) varies from 3789 kWh (minimum in April) to 7524 kWh (maximum in November).

In addition to electricity, the College also utilizes solar power panels as a renewable energy source, contributing to the annual electricity consumption. The contract demand for electricity is 750 kVA, with a connected load of 128897 Watts. The College consumes 66005 kWh of electricity annually, resulting in an average energy charge of Rs 8.33 per kWh. Apart from electricity, the College consumes 1056 liters of diesel and 1297.6 kg of

LPG (liquefied petroleum gas) each year. The total annual fuel cost, including LPG, diesel, and petrol, is Rs 2,14,161.

Monitoring and analyzing these energy consumption patterns can help the College identify opportunities for energy efficiency improvements, cost savings, and integration of sustainable practices.

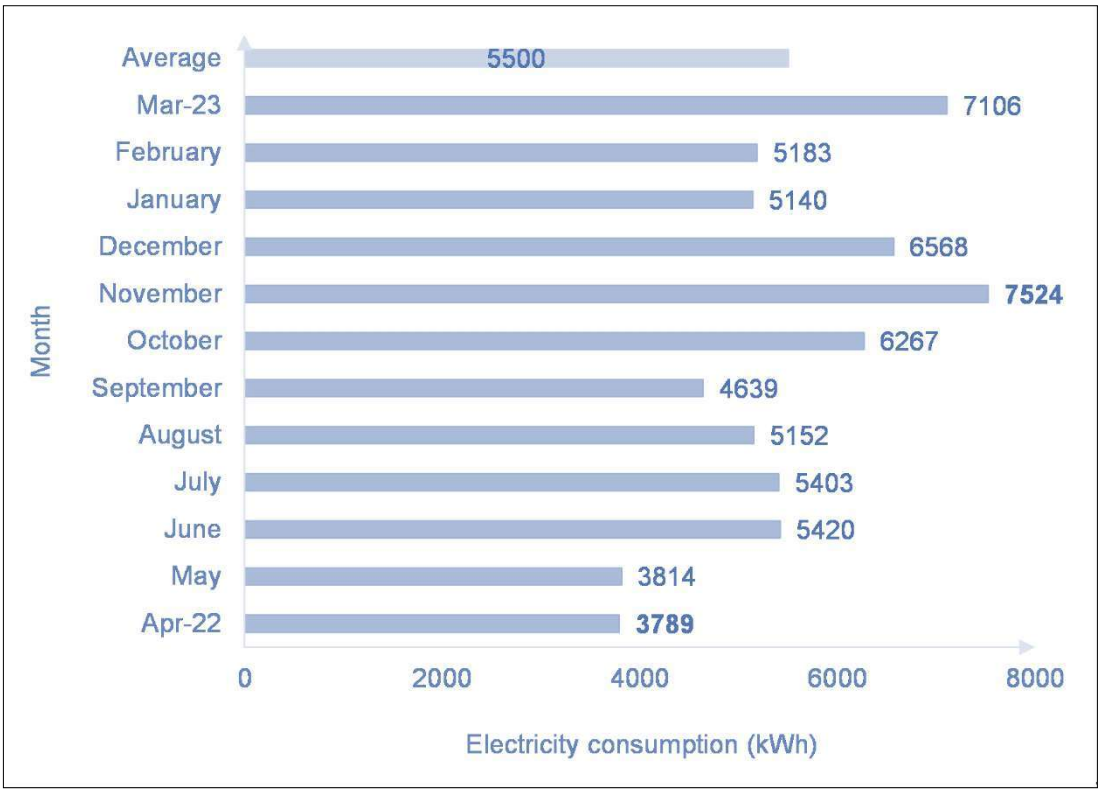


Fig. 2 Monthly electrical energy consumption (kWh) of K.E College (April 2022 to March 2023)

2. Specific electrical energy consumption

The specific energy consumption (SEC) of electrical energy at K.E College is measured per unit area and per capita. In order to calculate the specific energy consumption, the total number of persons present on the campus (including students, staff, and non-teaching staff) and the total built-up are considered.

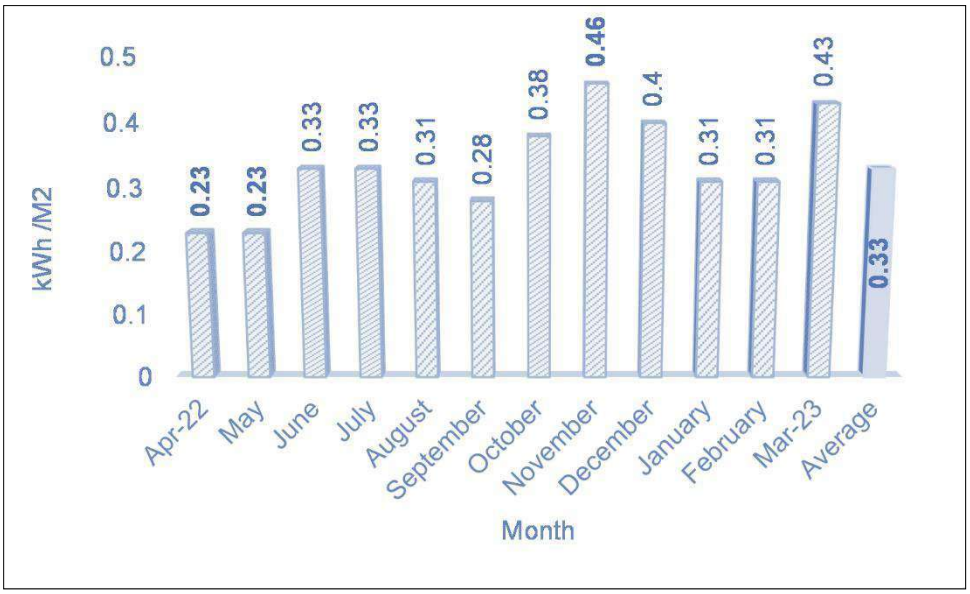


Fig. 3 Monthly specific energy consumption per area (kWh / m^2)

The total built-up area of the K.E campus is 16,516.37 m², and the SEC per unit area is calculated as 3.99 kWh/m²/year, with an average of 0.33 kWh/m² (Figure 3). The monthly variation in specific energy consumption indicates the fluctuating activities of the campus.

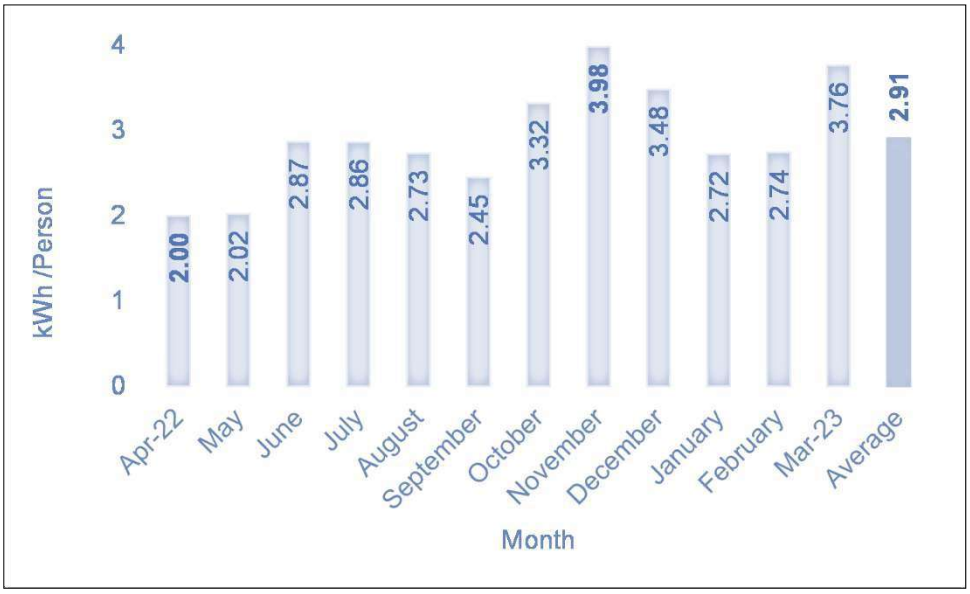


Fig. 4 Monthly specific energy consumption per person (kWh / m^2)

The annual average per capita electricity consumption is 34.92 kWh/person/year, with a monthly average of 2.91 kWh/person. The monthly variation in SEC per person reflects the changing activities on campus.

3. Power measurements

Power measurements were conducted in various buildings of the K.E campus during a typical working day, providing insights into energy consumption (Table 3). The measurements included voltage, current, power, and power factor. The main building's ground floor had a power consumption ranging from 4.02 kW in general areas to 6.89 kW in the Chemistry lab. The first floor consisted of the office (8.62 kW), Computer lab (10.34 kW), and Physics lab (8.62 kW). On the second floor, the power consumption in departments and the Bio-tec lab was 5.17 kW, while the Zoology lab and departments consumed 2.87 kW. The exam hall on the third floor utilized 2.3 kW. Other buildings such as the auditorium (4.02 kW), new seminar hall (11.49 kW), library (2.3 kW), and canteen (9.19 kW) also contributed to energy consumption. In the self-financing building, the ground floor consumed 2.87 kW, the computer lab consumed 9.76 kW, and the upper floors consumed around 2.3 kW each.

These power measurements provide valuable information about energy usage in different areas of the campus, which can be used to analyze and optimize energy consumption patterns. These calculations provide valuable insights into the energy consumption patterns at K.E College, allowing for analysis and identification of areas where energy-saving measures can be implemented. By monitoring SEC, the College can work towards optimizing energy use, reducing energy waste, and promoting sustainability in its operations.

Table 3 Power measurement of K.E College on a typical working day

No	Name of the Building	Voltage (V)	Current (A)	Power	Power Factor
1	Main building ground floor	415	7	4.02	0.8
2	Main building ground floor Chemistry lab	415	12	6.89	0.8
3	Main building first-floor office	415	15	8.62	0.8
4	Main building first-floor computer lab	415	18	10.34	0.8
5	Main building first-floor Physics lab	415	15	8.62	0.8
6	Main building second floor Departments, classes Bio-tec lab	415	9	5.17	0.8
7	Main building second-floor Zoology lab, departments	415	5	2.87	0.8
8	Main building third-floor exam hall	415	4	2.3	0.8
9	Auditorium	415	7	4.02	0.8
10	New seminar hall	415	20	11.49	0.8
11	Library	415	4	2.3	0.8
12	Main building Psychology, Maths etc	415	5	2.87	0.8
13	Main building Botany department SF	415	18	10.34	0.8
14	Seminar hall	415	5	2.87	0.8
15	Canteen	415	16	9.19	0.8
16	Indoor stadium	415	15	8.62	0.8
17	Self- Financing ground floor	415	5	2.87	0.8
18	Self- Financing computer lab	415	17	9.76	0.8
19	Self- Financing first floor	415	4	2.3	0.8
20	Self- Financing second floor	415	4	2.3	0.8
21	Self- Financing third floor	415	4	2.3	0.8
22	Self- Financing fourth floor	415	3	1.72	0.8

4. Electrical appliances details

The institution has a total of 704 lights, with 61% of them being tube lights. Among the lights, 67% are energy-efficient lights, including LED tubes (53%), LED bulbs (11%), and CFLs (3%). Additionally, there are 12 outdoor LED lights on the campus.

Fans are provided throughout the institution for the comfort of the occupants. There are 584 fans, with 95% of them being ordinary fans. Regarding air conditioners, the institution has 16 units distributed across various locations. Computers are present in different departments and labs, with LCD monitors being the predominant type. The administrative sector has a higher number of computers compared to the academic sector. There are 41 printers on the campus, with 88% of them being small printers. To ensure continuous power supply for computers and other loads, the institution has installed Uninterrupted Power Systems (UPS) in each building. The total installed capacity of the UPS systems is 56.5 kVA. Water pumping is essential to meet the water requirements of the campus. There are six pumping motors, one dedicated to water purification and the rest operating for one hour daily. The campus has 12 water tanks with varying capacities for water storage.

In summary, the institution has a significant number of lights, fans, air conditioners, computers, printers, and UPS systems to cater to the needs of the campus. Water pumping and storage systems are also in place to meet the water requirements of the institution.

5. Electrical Systems

K.E campus receives an 11 kV supply from KSEB, which is stepped down to 433V using a 160 kVA transformer. The transformer's output is connected to two Meter Panels, MSB-1 for the self-financing block and MSB-2 for the aided block. Load distribution is carried out through sub-switch boards at different load centers. The campus has three meters connected to the aided and canteen block, self-financing block, and gardening (motor). The main and canteen block account for 80% of the total electricity consumption, while the self-financing block and gardening share the remaining portion.

To address the high electricity consumption of the main and canteen block, a 20 kW Solar Power Panel was installed as a renewable energy source. The generated electricity is connected to the grid, and excess power is exported to KSEB. The main and canteen block's

electricity expenditure is consistently higher than the self-financing block and gardening from April 2022 to March 2023. However, the self-financing block and gardening have higher shares regarding consumption proportion.

K.E campus also has two diesel generators, one with a capacity of 40 kVA and the other with 20 kVA, serving as alternate power sources for uninterrupted. The efficiency of the D.G. sets is expressed in terms of Specific Power Generation, which represents the number of units generated per liter of diesel. The 40 kVA DG set is noted as overloaded, exceeding the desired specific power generation level, while the 20 kV DG set operates below the expected level.

K.E campus effectively manages energy consumption by stepping down the 11 kV supply and distributing loads through meter panels and sub-switch boards. The main and canteen block exhibit higher electricity consumption and expenditure, but installing a 20 kW Solar Power Panel helps offset the consumption. The campus also utilizes two diesel generators for backup power supply, with varying levels of specific power generation efficiency.

II Diesel consumption

K.E. institution relies on diesel generators (D.G.) for power generation and ensuring uninterrupted power supply. The campus consumes approximately 1056 liters of diesel annually, equivalent to 13506.94 kWh of energy. This diesel consumption constitutes around 11.96% of the total energy equivalent the institution consumes. In terms of expenditure, the annual cost of diesel amounts to approximately Rs. 1,00,151.

The use of diesel generators highlights the institution's reliance on this fuel source to meet its power needs. It is worth noting that diesel generators can provide backup power during times of electricity grid outages or as an alternative power source when needed. However, it is essential to consider the environmental impact of diesel consumption, including air pollution and greenhouse gas emissions associated with burning fossil fuels. Exploring renewable energy alternatives or implementing energy efficiency measures can help reduce reliance on diesel generators and promote sustainable energy practices.

Table 4 Number of DG sets, diesel consumption, and cost from April 2022 to March 2023

Details	DG No 1	DG No 2	Total
Rating (kVA)	40	20	-
Running Hours /month	9	5	-
Monthly fuel consumption (l)	63	25	88
Annual fuel consumption (l)	756	300	1056
Annual expense (Rs)	71759.5	28391.52	100151.04

III LPG consumption

LPG (liquefied petroleum gas) consumption plays a significant role in the energy utilization of the campus, contributing approximately 16.08 % or 18191.05 kWh of the total annual energy consumption. The campus primarily uses LPG for cooking purposes in the canteen and labs. A total of 71 LPG cylinders are utilized, accounting for about 1297.6 kg of total annual LPG consumption on the campus resulting in a total expenditure of Rs. 1,06,510.

The annual LPG consumption of the campus is calculated to be 1297.6 kg (Table 1). The substantial utilization of LPG highlights its significance as an energy source within the campus, supporting cooking activities and other lab-related functions. However, it is essential to consider the environmental impact associated with LPG usage, such as carbon emissions and the need for proper ventilation systems to ensure safety.

Exploring energy-efficient cooking alternatives, such as biogas or solar-powered cooking systems, could potentially reduce the reliance on LPG and promote sustainability in the campus's energy consumption.

Table 5 Number of cylinders, net weight, and cost from April 2022 to March 2023

Details	Cylinders capacity		Total
	19 kg	15.6 kg	
Canteen	55	-	55
Laboratory	-	16	16
Annual consumption	55	16	71
Cost/cylinder (Rs)	1602	1150	-
Annual expense (Rs)	88110	18400	**1,06,510**

IV Renewable Energy Sources

1. Solar Power

As part of its eco-friendly green initiative, the K.E campus installed and commissioned a 20 kWp grid-connected solar power plant in 2019. The solar panels are mounted on the rooftop of the building and were installed according to the specifications and guidelines provided by ANERT (Agency for New and Renewable Energy Research and Technology). The solar power generated by the campus is connected to the distribution system of KSEB (Kerala State Electricity Board).

From April 2022 to March 2023, the campus produced 4,050 kW of electricity using solar panels, with an average monthly production of 338 kW. The monthly electricity production details can be observed in the corresponding figure. This solar power generation initiative allows the campus to reduce its reliance on traditional electricity sources and contribute to using clean and sustainable energy.

Table 5 Solar P.V. panels' details

Description	Values
Maximum power P max	315 Wp
Voltage at max power (Vmpp)	37 V
Current at max power (Impp)	8.51
Open circuit voltage (Voc)	44.9 V
Short circuit current (Isc)	8.98

Fig. 5 Solar panel installed

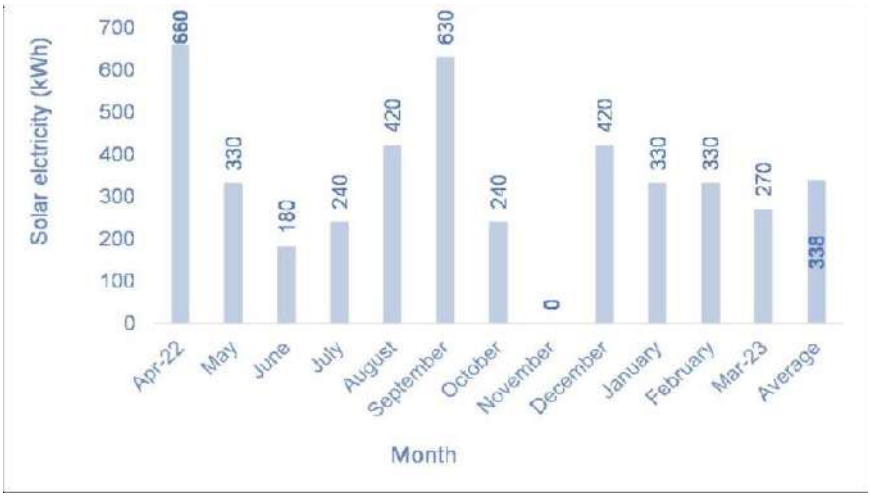


Fig. 6 Monthly solar electricity production from April 2022 to March 2023

2. Biogas

Biogas plant is an important sustainable technology implemented at the K.E campus, as it helps in waste management and provides a renewable source of fuel for cooking. The canteen block at the K.E campus has a waste absorption capacity of 6-7 kg per day for the biogas unit. As a result, the biogas unit generates enough gas to fuel a burner for approximately 4 hours each day. This sustainable process helps the campus manage its waste efficiently while simultaneously producing renewable energy for cooking purposes in the canteen.

Additionally, the organic waste residue from the biogas production process is utilized in the campus garden. This waste serves as a valuable source of nutrients, enhancing the soil's fertility and contributing to the overall environmental benefits of the campus. By utilizing biogas technology, the K.E. campus reduces the amount of waste generated and helps mitigate greenhouse gas emissions.

By recycling the food waste in the biogas plant and utilizing the by-products as organic manure, K.E College ensures a closed-loop system where waste is effectively managed, energy is generated, and resources are utilized sustainably.

Fig. 7 Biogas plant

Healthy Practices

The College has implemented several initiatives to promote energy conservation and sustainable practices. These include:

1. Energy Conservation Awareness Programme at schools in Idukki District: The Department of Physics with Applied Electronics organized a two-day campaign to raise awareness among school students about energy conservation. Faculty members visited 13 schools, reaching 800 students, and educated them on methods to reduce electricity consumption.

Fig. 8 Energy Conservation Awareness Programme at schools in Idukki Dist

2. Workshop on "Decoration Lights": In collaboration with various clubs, a one-day workshop was held to educate students about the efficiency of LED lights compared to traditional lighting options. The workshop aimed to promote energy-saving practices and equip students with skills in using LED lights. The decorated lights created by the students were sold and showcased during Christmas events, engaging both students and staff.

Fig. 9 Workshop on decoration lights

3. Solar panel installation and power generation: K.E College installed solar panels on its rooftop with a capacity of 20 kW. These panels capture solar energy and convert it into electricity fed to the state power grid. The solar power generated accounts for around 30% of the College's energy needs, reducing its carbon footprint and contributing to sustainable development.

These events demonstrate K.E.'s commitment to energy conservation and sustainability. By raising awareness among students, promoting energy-efficient practices, and utilizing renewable energy sources like solar power, K.E College sets a positive example for other institutions and encourages adopting eco-friendly practices in energy consumption.

Recommendations for a sustainable energy scenario for the College

Based on the observations and initiatives implemented by K.E College, here are some recommendations to further enhance energy sustainability for the future:

1. Expand renewable energy sources: While installing solar panels is a significant step, K.E College can consider expanding its renewable energy infrastructure. This may involve installing additional solar panels or exploring other renewable sources. The college can increase its overall energy sustainability by diversifying renewable energy generation.

2. Implement energy-efficient practices: Continuously promote and educate students, faculty, and staff about energy-efficient practices. Encourage using energy-efficient appliances, LED lighting, and smart energy management systems. Conduct regular energy audits to identify areas of improvement and implement energy-saving measures such as optimizing HVAC systems, improving insulation, and minimizing energy waste.

3. Foster a culture of conservation: Encourage a culture of energy conservation among the college community. This can be achieved through awareness campaigns, workshops, and incentives for energy-saving behaviors. Implementing energy-saving competitions, providing rewards, and recognizing individuals or departments with significant energy savings can motivate and engage everyone in sustainable practices.

4. Enhance energy monitoring and management: Invest in advanced systems to track and analyze energy consumption patterns across different departments and buildings. Real-time data can provide valuable insights into energy usage, identify high-consumption areas, and enable proactive energy management. Implement energy management software and systems that allow for remote monitoring, control, and optimization of energy usage.
5. Collaborate with local communities and organizations: Extend the energy conservation initiatives beyond the college campus. Partner with local communities, schools, and organizations to share knowledge, resources, and best practices in energy sustainability. Engage in community projects, awareness campaigns, and collaborative efforts to promote wider adoption of sustainable energy practices.
6. Continual improvement and innovation: Stay updated with the latest advancements in energy-saving technologies and practices. Keep an eye on emerging technologies such as energy storage solutions, smart grids, and energy-efficient building designs. Encourage research and innovation within the college to explore new ways to improve energy efficiency and sustainability.

By implementing these recommendations, K.E College can strengthen its commitment to energy sustainability, reduce its environmental impact, and inspire others to embrace sustainable practices.

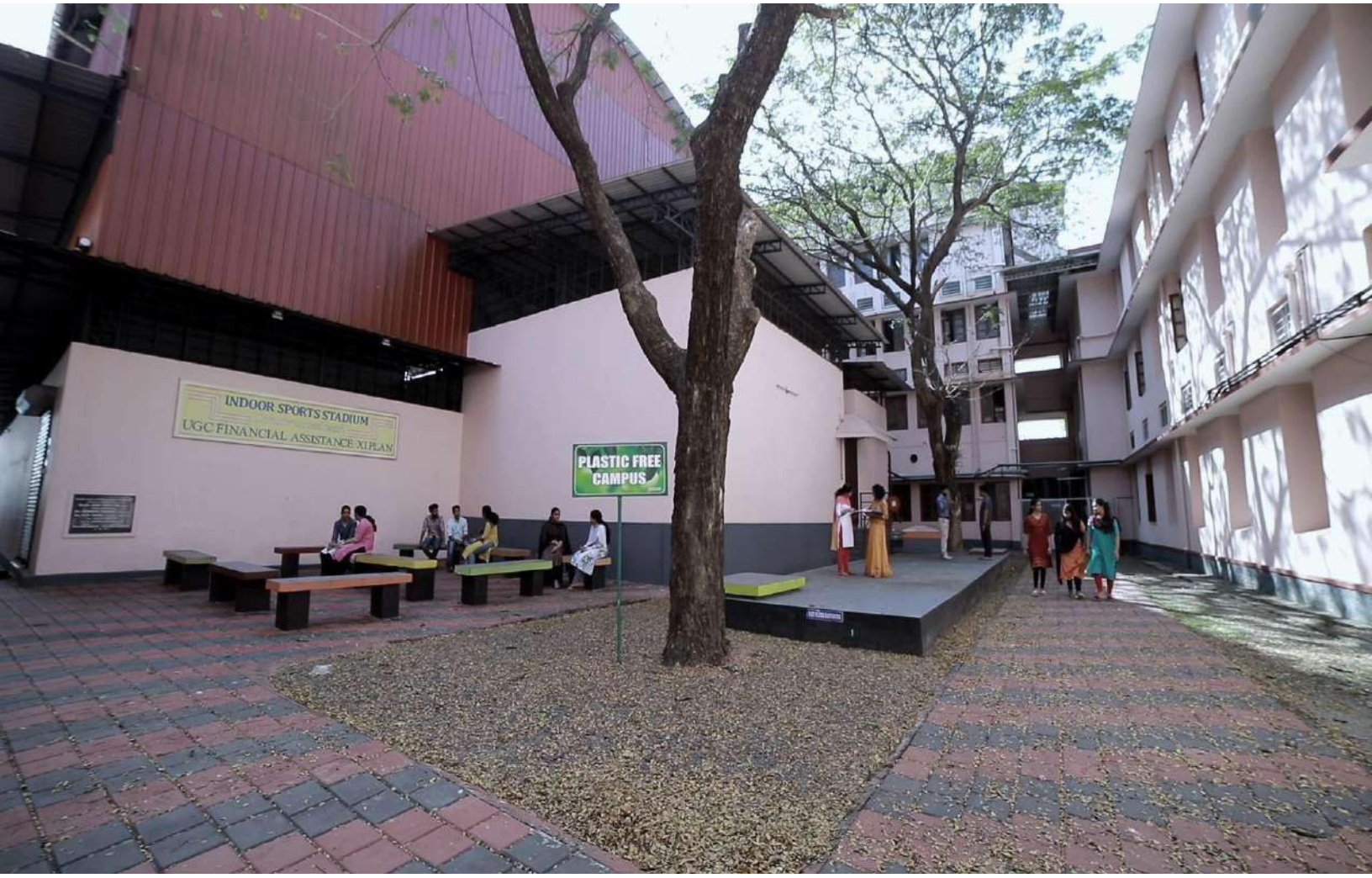
The introduction of an Energy Management System (EMS)

An EMS can improve energy efficiency, reduce costs, and enhance operational efficiency and management. Here are some key benefits and possibilities associated with implementing an EMS

1. Cost savings: An EMS can identify high energy usage and wastage areas by actively monitoring and analyzing energy consumption data. This information allows for targeted energy-saving measures, leading to significant cost savings in the long run. The EMS can provide real-time data and alerts, enabling quick responses to any abnormalities or energy inefficiencies.

2. Operational efficiency: An EMS facilitates centralized control and management of energy consumption data from various locations within the campus. This centralized approach enables better coordination and decision-making regarding energy usage. It allows the identification of areas or equipment that may require maintenance, replacement, or optimization to improve overall operational efficiency.
3. Continuous monitoring and analysis: With an EMS in place, continuous monitoring, measuring, and analysis of energy consumption become feasible. The system collects data from energy meters throughout the campus, which can be stored, processed, and analyzed for further insights. This information can guide future energy planning, identify trends, and support informed decision-making to enhance energy efficiency.
4. Compliance with ISO-50001 standard: Implementing an EMS aligns with the ISO-50001 standard, focusing on energy management and continuous improvement. Compliance with this standard demonstrates the institution's commitment to energy efficiency, sustainability, and responsible energy practices. It can also enhance the college's reputation and credibility regarding energy management.
5. Carbon footprint analysis: An EMS can facilitate calculating and analyzing the college's carbon footprint. By centralizing energy consumption data, the system can accurately measure greenhouse gas emissions associated with energy usage. This information is valuable for assessing the environmental impact of the campus and can support initiatives to reduce carbon emissions.

Thus introducing an efficient EMS on the campus of the K.E College can serve as a valuable tool for improving energy efficiency, reducing costs, and promoting sustainable energy practices. It enables continuous monitoring, analysis, and management of energy consumption, supporting informed decision-making and fostering a culture of energy efficiency within the institution.



2. WASTE AUDIT

A waste audit is a systematic process of assessing and analyzing the waste generated by an organization, such as a college or a company. It involves evaluating the quantity, composition, and sources of waste to gain insights into the organization's waste management practices. During a waste audit, trained personnel collect and categorize waste materials, typically over a specified period. The waste is then sorted into recyclables, organic, and non-recyclables. The audit may also include weighing and documenting the waste generated in each category. The collected data is analyzed to identify patterns, trends, and opportunities for waste reduction and improved waste management. The audit helps identify areas where waste can be minimized, recycling efforts can be enhanced, and more sustainable practices

can be implemented. It provides valuable information for developing waste reduction strategies, setting waste management goals, and tracking progress over time.

Waste audits promote environmental sustainability, resource conservation, and cost savings. They help organizations understand their waste generation patterns, assess the effectiveness of their current waste management practices, and identify areas for improvement. By conducting regular waste audits, organizations can make informed decisions and implement strategies to minimize waste, increase recycling rates, and promote a more sustainable approach to waste management.

Importance of waste audits in colleges

Conducting waste audits in colleges is crucial for various reasons. Waste audits help colleges identify the types and quantities of waste they generate, enabling them to implement waste reduction strategies and promote recycling. This not only conserves resources but also reduces environmental impact. Waste audits can lead to cost savings by identifying inefficiencies in waste management practices. They provide educational opportunities, raising awareness about waste management and encouraging sustainable behavior among students. Waste audits also help colleges track their progress towards sustainability goals, comply with regulations, and report on their sustainability efforts. Overall, waste audits are vital in minimizing waste, saving costs, reducing environmental impact, and fostering a culture of sustainability on campus.

Objectives

- To estimate the current status of solid waste generated on the campus.
- To quantify biodegradable and non-biodegradable waste.
- To examine the status of current practices adopted for managing liquid waste and construction and demolition (C&D) waste.
- To review the prevailing waste disposal methods, healthy practices and suggest measures to improve the existing waste management strategies.

Methodology

Solid waste was identified and quantified through frequent field visits, direct observations and assessments, and communication with responsible persons. Besides, information was also collected using well-devised data sheets and from institutional reports. Photo documentation was also carried out to supplement the audit. The data collection for the audit was taken from the three main blocks on the campus: The Main block, the Self-financing block, and the Canteen block.

Observations

1. Status of waste generation in the College

From the audit, it is found that the significant solid waste generated on the campus comes under nine categories (Table 1, Fig. 1). The waste mainly comprises food, paper, plastic, glass, damaged furniture, e-waste, hazardous waste, biomedical waste and others (sandals, clothes, napkins, etc. The total waste generation from three main blocks (Main block, Self-financing block, and Canteen block) is estimated to be 8072.9 kg/year. Among the different waste categories, food waste tops the chart constituting almost 62% (4980.15 kg/year) of total waste produced, followed by damaged furniture (1221 kg/year), paper (963.9 kg/year), plastic (434.7 kg/year), glass waste (45 kg/year), hazardous waste (27 kg/year), e-waste (16 kg/year), and 'other waste' (10 kg/year) with bare minimum quantity observed in biomedical waste categories.

Table 1 Waste generation on the campus

Sl. No	Waste categories	Quantity (kg/year)	Percentage (%)
1	Food waste	4980.15	62
2	Paper waste	963.9	12
3	Plastic waste	434.7	5
4	Glass waste	45	1
5	Damaged furniture	1221	15
6	E-waste	391.2	5
7	Hazardous waste	27	0
8	Biomedical waste	0	0
9	Other waste	10	0
	Total waste	**8072.9**	100

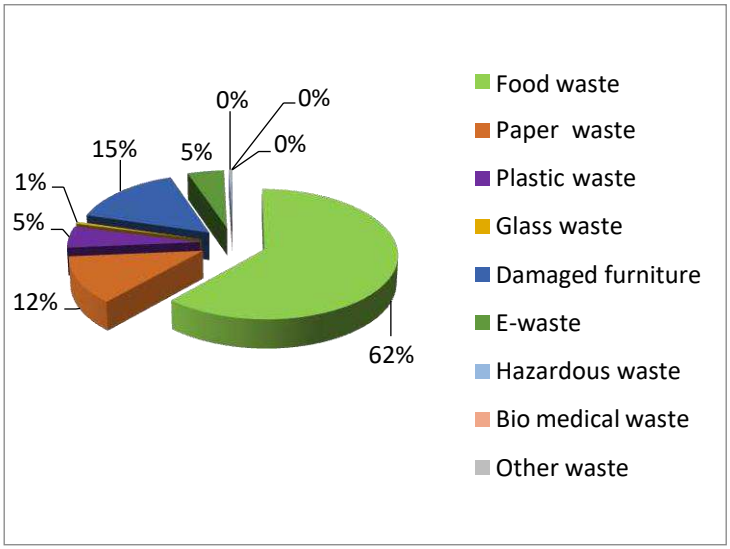


Fig. 1 Percentage (%) wise waste generation

2. Total solid waste generation from different buildings (blocks)

Regarding waste generation, the canteen block accounted for the largest share of waste, producing 3231.05 kg/year, representing 40% of the total waste generated. The main block followed closely behind, generating 3084.7 kg/year, 38% of the total waste. The self-

financing block produced 1757.2 kg/year of waste, constituting 22% of the total waste. It is important to note that the canteen block consists of the college canteen and a residential hostel, which likely contributes to its higher waste generation. (Table 2, Fig. 2). The College canteen plays a crucial role in catering to the daily food needs of hostel inmates and providing meals to many individuals, particularly during lunch hours and tea/snack breaks.

Table 2 Waste generation from different buildings

Sl No	Block	Total waste (kg/year)	Total waste (%)
1	Main block	3084.7	38
2	Self-financing block	1757.2	22
3	Canteen block	3231.05	40

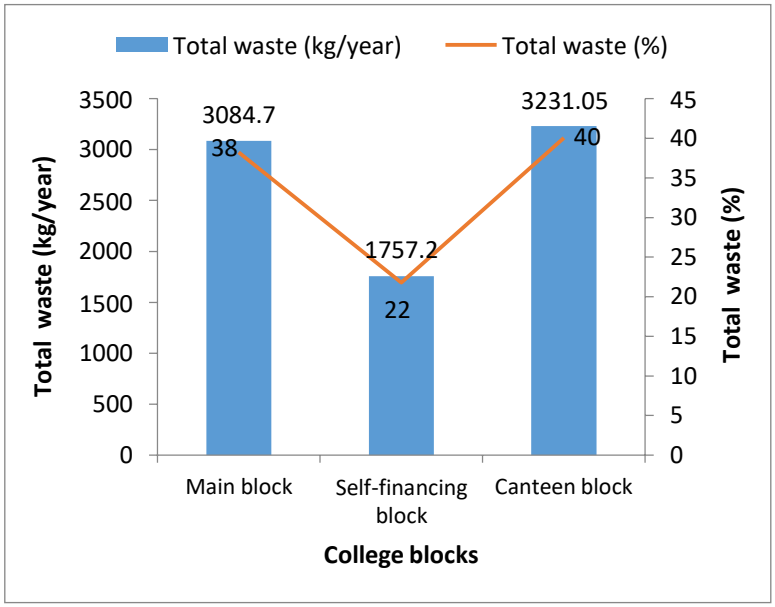


Fig. 2 Waste generation from different buildings (blocks)

Building (Block) - wise contribution of different categories of solid wastes

Waste generated in the main block of the College varies across different categories, each contributing to the overall waste in varying proportions. The food category contributes the highest amount of waste, accounting for 51% of the total waste generated in this block. On

the other hand, hazardous waste makes up a minor portion, constituting less than 1%. Other waste categories in this block include paper waste (27% of total waste), damaged furniture (16%), e-waste (8%), plastic waste (5% of total waste), glass waste (1%), and hazardous waste (10 kg/year).

Biomedical waste and "other waste" were not found in this block. In the self-financing block, damaged furniture is the leading category in waste generation, followed by food waste and e-waste. The canteen block has slight variations in waste generation compared to the main block. Plastic waste becomes the second major category after food waste, accounting for 6% of the total waste, while paper waste forms the third major category at 6%. Damaged furniture, biomedical waste, and e-waste were not reported from this building. The main block is one of the main centres of various academic and administrative activities contributing to the maximum paper waste among the three surveyed buildings. While in food and plastic wastes, the canteen block dominated the top position compared to the other two buildings on the campus. Considering the glass waste, e-waste, and hazardous waste generation, the main block showed supremacy, followed by the self-financing block and the canteen block, while the Self-financing block had the upper edge in damaged furniture categories (Table 3).

Table 3 Building (Block) wise contribution of different categories of solid waste (kg/year)

Sl No	Block	F.W.	PW	PLW	GW	DFW	e-W	HW	O.W.
1	Main block	1559.25 (51%)	642.6 (21%)	122.85 (4%)	20 (1%)	483 (16%)	247 (8%)	10 (0%)	-
2	Self-financing block	585.9 (33%)	141.75 (8%)	122.85 (7%)	15 (1%)	738 (42%)	144.2 (8%)	9.5 (1%)	-
3	Canteen block	2835 (88%)	179.55 (6%)	189 (6%)	10 (0)	-	-	7.5 (0)	10

FW-Food Waste; PW-Paper Waste; PLW-plastic Waste;GW-Glass Waste; DFW-Damaegd Furniture Waste; e-W-e-Waste; HW- Hazardous Waste; BMW-Biomedical Waste; OW-Other Waste

3. Details of biodegradable and non-biodegradable wastes

In the present audit, food, paper, and wooden damaged furniture waste were classified as biodegradable, while all other categories of waste were put under the non-biodegradable type. The results showed that biodegradable waste contributed almost 89% (7165.05 kg/year) of solid waste, while non-biodegradable components represented merely 11% (907.9 kg/year) in total waste generation. (Table 4, Fig. 3). In the building-wise classification also, the biodegradable waste type had an edge over others in the total waste production (Table 4, Fig. 4)

Table 4 Biodegradable and non-biodegradable wastes classification

Block	Biodegradable waste* (kg/year)	Non-biodegradable waste# (kg/year)	Total waste (kg/year)
Main block	2684.85	399.85	3084.7
Self-financing block	1465.65	291.55	1757.2
Canteen block	3014.55	216.5	3231.05
Total	2684.85	399.85	3084.7

*food, paper & wooden damaged furniture only # other waste categories

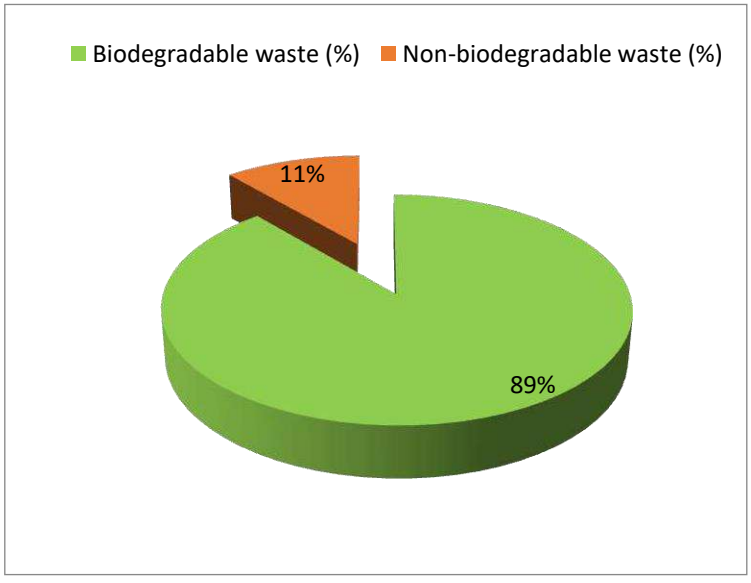


Fig. 3 Status of biodegradable and non-biodegradable waste (%)

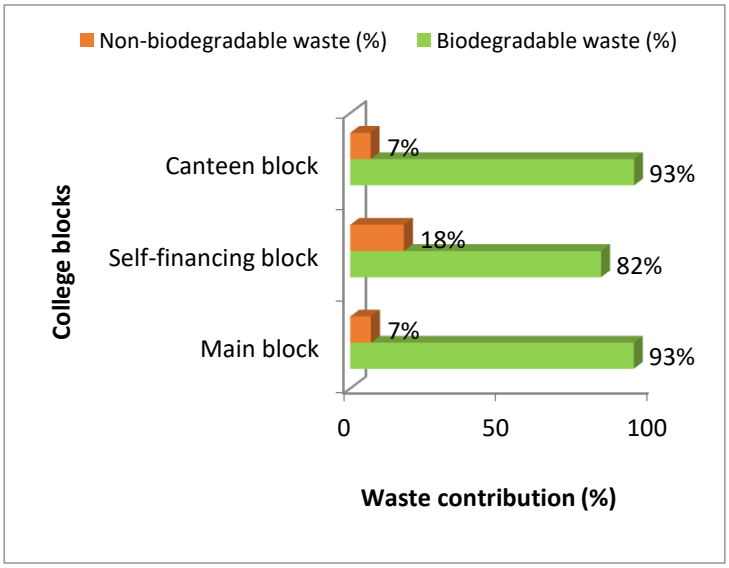


Fig. 4 Status of biodegradable and non-biodegradable waste from various buildings

4. Major waste categories and their disposal strategies

It is commendable that proper waste management strategies, including biogas and vermicompost unit for food waste, incinerators for sanitary napkins, common incinerator for controlled burning of paper, selling the plastic and glass waste to authorized scrap merchants (Harithakarma sena members), pen drop boxes for collecting used pens, neutralizing of chemicals and separate filtration system for treating liquid chemical waste in chemical lab, repair and reuse of damaged furniture have been adopted in the college. The gas produced from the biogas plant is used for cooking in the canteen kitchen (Table 5).

Even though the current system (waste collection safely built pits) seems to be satisfactory in the liquid waste generation and management in the college, improved waste management in the case of wastewater is highly essential because of its unexpected leaks, discharges, and runoff.

Table 5 Major waste categories and their disposal strategies

Sl No	Categories of waste	Particulars	Disposal strategies
I	Solid waste		
	Food waste	All types of food items	Food waste is effectively managed in biogas plants, vermicompost units and also sold to pig farms situated outside the college campus
	Plastic waste	Food wrappers, food containers, carry bags, bottles etc.	Collected by 'Haritha Karma Sena' members, a recognised body under local self-government (Panchayat), Government of Kerala, for recycling purpose
	Paper waste	Discarded paper materials, old newspapers, cardboard, cartons, magazines, envelopes, packages etc.	Paper waste undergoes controlled burning in Incinerator
	Glass waste	Broken glass wares, glass bottles, glass cups etc.	Hand over to 'Haritha Karma Sena' members, a recognized body under local self government (Panchayat), Government of Kerala for recycling purpose
	Damaged furniture	Wooden furniture	Repair and Reuse
	Construction and Demolition (C&D) waste	Concrete, cement, tiles, bricks, paint, insulation materials, cable and pipes etc.	Mainly used for landfilling and the rest are being sold to building contractors
	Electronic waste (e-waste)	Old computer, monitor, CPU, AC, printer, circuit board, clock, fridge, TV, calculator etc.	Maximize e-waste repair and allocate unrepairable items to computer maintenance and hardware certificate program students while storing the remaining items in a designated store room.

	Hazardous waste	Empty chemical bottles, Expired chemicals,	Collected and placed in the college compound
		Tube lights, LED, CFL bulbs, Batteries etc.	Sold to vendors
	Biomedical waste	Clinical specimens, soiled swabs, microbial cultures, syringes & needles, sanitary pads, diapers, gloves etc.	Considerably less quantity of waste is produced. Incinerators are installed (girls' washrooms) in every block and used for disposing of sanitary napkins.
	Other waste	Table cloths, towels, curtains, nonusable tyres, paint tin etc.	Sold in scrap
	Construction and Demolition (C&D) waste	Concrete, cement, tiles, bricks, paint, insulation materials, cable, pipes, etc.	Used for landfilling
II	**Liquid waste**		
		Sewage waste from toilets	Collected in Septic Tanks
		Wastewater from labs	Chemicals are collected in specified pits or tanks. The chemistry lab has a separate water drainage system beneath the lab floor before the liquid chemical waste gets collected into specified pits or tanks. Moreover, neutralizing of chemicals is followed in labs
		Wastewater from other wash areas	Collected in specified pits or tanks

Healthy practices implemented in the College

1. The college policy emphasizes the ideas of the three R's – *reduce*, *reuse*, *and recycle* which ensures cleanliness and protects the environment on the campus.
2. Appropriate mechanisms for collecting and treating solid and liquid wastes are effectively implemented on campus.
3. Waste bins (trash bins) are kept at appropriate campus locations to segregate solid waste at source properly.
4. An adequate number of cleaning staff for the collection, segregation, and disposal of waste in the campus plays a significant role in waste management efforts by keeping the establishment clean and tidy.
5. Green classrooms, outdoors under the shade of trees, are a notable initiative in creating a clean and healthy campus environment. They enhance the learning experience and create a neat, healthy environment for students and faculty.
6. The college has effectively used the outer space on campus by creating various gardens and parks, including a sunbeam garden, medicinal garden, Chavara Park, and Stone Park. Integrating these gardens and parks adds value to the campus and promotes a cleaner and healthier atmosphere.
7. Utilizing digital platforms for communication, e- filling, administration, class lectures, etc. gives rise to paperless culture on campus.
8. The campus has fostered a responsible dining culture that encourages individuals to make conscious choices, contributing to more sustainable and efficient use of food resources.
9. The college makes a conscious effort to avoid plastic wrapping for bouquets. By avoiding plastic wrapping, the college is committed to reducing plastic waste and minimizing its environmental impact. The extensive use of coir mats, boards, and screw pine mats as display boards are highly promoted on campus. This initiative aligns with the broader goal of creating a sustainable and eco-conscious campus environment.

10. Biogas plant is instilled to treat food waste generated on the campus which also supplements fuel for cooking in the canteen. The organic manure produced from the unit is used directly in the garden.
11. Wastewater discharged from the washrooms and laboratories is collected and disposed of properly by flowing it to safely built pits.
12. The chemistry laboratory has a separate wastewater draining system that channels the water to outside pits. Laboratory protocol follows the practice of neutralizing chemicals, which reduces the toxicity of chemicals to a certain extent.
13. Every block of the College is provided with drinking water facilities in the form of coolers and purifiers that considerably reduce plastic bottled water in the campus.
14. For the adequate segregation of different kinds of waste (Plastic, damaged furniture, e-waste etc.), a Materials Collection Facility (Warehouse) is provided in the college.
15. To cater to the needs of female students and staff, the college has equipped the ladies' and girls' restrooms with napkin vending machines and collection bins. Additionally, the college takes regular measures to clear and incinerate the waste daily. This initiative promotes cleanliness and hygiene in the restrooms, providing a convenient and environmentally conscious solution for female college community members.
16. Vermicomposting units are set up to utilize biodegradable waste effectively, and the manure produced is used for garden and vegetable growing purposes.
17. The laboratories have the facilities of a fume hood, blower, and exhaust fans to expel hazardous vapors, if any.
18. The college has introduced pen drop boxes in its main block for used pens in the box and later sent for recycling through scrap dealers.
19. It is highly admirable that the institution has active student clubs like National Service Scheme (NSS) and Bhoomithrasena, which help strengthen student commitment towards environmental protection.

20. Another positive approach is the popularization of eco-friendly banners, cloth-bag, paper pens, and paper files during seminars and conferences.

21. The College has a well-maintained canteen, ensuring the area is hygienic and safe.

22. The College has used cloth banners, metal boards, and electronic displays instead of flex and other plastic hoardings on the campus.

23. The College has taken appropriate steps to hand over the plastic and glass waste to Haritha Karma Sena (HKS), a government-approved body for waste collection. The solid waste management was executed with the support of Suchithwa Mission, Haritha Kerala Mission, Clean Kerala Company (CKC), local bodies, and Kudambashree Mission.

24. Various boards are placed in the College to spread awareness of waste management.

25. The college demonstrates commendable dedication to maintaining a clean environment by regularly organizing activities like cleaning drives, awareness programs on environmental issues, and even farming practices. These initiatives showcase the college's commitment to promoting a clean and sustainable environment both within and outside the campus. By actively engaging students and staff in these activities, the college fosters a sense of environmental responsibility and encourages active participation in creating cleaner and healthier surroundings.

Recommendations

1. For the effective implementation of waste management programmes in the campus, periodic assessments of different kinds of waste generated and its quantified data are required and recommended for the campus. This can be done with the help of \ student clubs functioning in the campus.

2. Green protocols should be strictly followed in the campus.

3. A sufficient number of colored bins with labels highlighting the waste category names should be placed on the campus. Cleanliness and maintenance of waste bins are to be assured.

4. The College needs to establish a waste management committee having representation from faculties, administrative staffs, non- administrative staffs and students. The committee is responsible for overseeing and coordinating the overall waste disposal activities in the campus through formulation of policies, goals and programmes that focus on waste management and minimization.

5. A proper register must be maintained to sell waste to scrap dealers and other waste collection agencies.

6. Since the College has a beautiful garden and farming areas, reuse of waste water from wash areas for gardening and farming practices is a good option.

7. The stack height of sanitary napkin incinerator and common incinerator should be increased so that the smoke emitted from the incinerators should go beyond the breathing range of humans. As per the Central Pollution Control Board (CPCB) norms stack height of incinerators shall not be less than 30 meters above the ground.

8. For the construction of new buildings in the future, it is advisable to follow a green buildings rating system that facilitate a holistic approach to create environment friendly buildings, through architectural design, water efficiency, effective handling of waste, energy efficiency, sustainable buildings, and focus on occupant comfort and well-being.

9. A proper waste disposal mechanism is required for treating ash remaining at the bottom of the combustion chambers of incinerators.

10. Since Construction and Demolition (C&D) waste constitute significant waste stream, a kind of accountability and provisions are required in handling waste in the college. The collection, transportation, processing and disposal of these wastes should be treated under the provisions of Construction and Demolition (C&D) Waste Management Rules, 2016.

11. Lab discipline has to be followed. Ensure safe handling and storage of chemicals and avoid unnecessary wastage in these laboratories. A tie-up with chemical suppliers is suggested for handling the chemical waste generated in the campus.

12. Cleaning staff working in waste management should be given more awareness on the various health issues related to their work and the importance of wearing the

safety materials. A periodic health check-up for these housekeeping staff is required as part of health and safety measures.

13. Appropriate training for teacher, staff, and students on waste management issues should be provided in the college.
14. More awareness programmes related to waste management should be conducted in the college.
15. More display boards highlighting the importance of waste management should be positioned more in the campus.
16. Regular monitoring and services are required for biogas plants and incinerators.
17. It is to be noted that electronic wastes and hazardous wastes (biomedical wastes, if there) generated should be handed over to authorized collection centres that are approved by Kerala State Pollution Board (KSPCB). Details can be obtained from the KSPCB website.
18. It is advisable to have equipment buy-back agreements with electronic dealers for technology upgradation as part of the e-waste minimization.
19. Proper cleanliness should be maintained at the material collection facility (MCF) premises, incinerator, biogas and vermi compost units.
20. Encourage the use of refillable pens instead of the disposable ball point pens,
21. To make best out of waste, various kinds of start-up programmes related to waste management can be initiated in the college (toy making from waste raw materials, decorative items and other fancy items from waste materials etc.).
22. Showcase the importance of various waste management act and rules, themes, days and years of importance, national level and state level campaigns (eg. *Swachh Bharat Mission, Suchithwa Keralam* etc.), and a slogan like _My waste, My responsibility', which is adopted from the –Polluter Pays Principle‖.

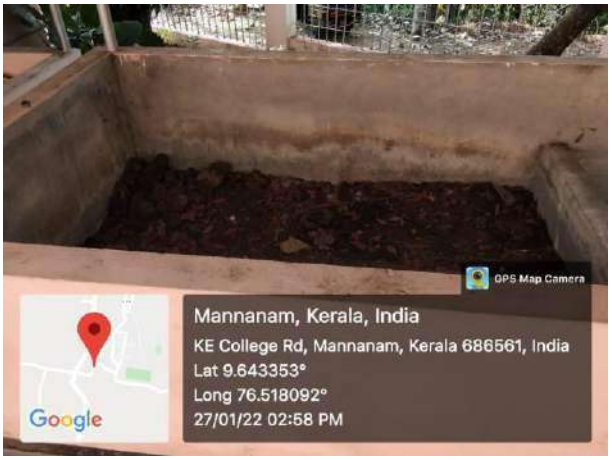
Waste Management Activities - K.E College

Common Incinerator

Biogas unit

Sanitary napkin vending machine

Sanitary napkin incinerator



Vermicompost Unit

Pendrop boxes



Awareness boards


Cleaning drives

Waste collection bins

Scarp collection activity


Sunbeam garden

Green classroom


Ecofriendly products exhibition

Usage of coir boards and screw pine mats

3. Water Audit

Introduction

Water is a valuable natural resource with a nearly fixed supply quantity and is inevitable for all living beings. However, we are facing water shortage due to population explosion and industrialization. Hence the conservation and safe usage of water in the future is vital. A water audit is a comprehensive and systematic process that examines various aspects of water usage and conservation within a particular system or organization. It involves gathering and analyzing data to understand how water is sourced, consumed, and managed.

A water audit begins with data collection, which involves compiling information on water sources, infrastructure, and usage through utility bills, meter readings, blueprints, and interviews. This data helps establish a baseline and identify areas for improvement. The next step is a water balance assessment, which evaluates the inflow and outflow of water to determine the overall balance. Discrepancies can be identified by comparing different

water sources to consumption and discharge. Additionally, a consumption analysis identifies high-consumption areas and inefficient practices, enabling targeted measures to increase efficiency. Overall, a water audit helps optimize water management and reduce consumption. Based on the audit findings, recommendations are developed to improve water management and conservation. These recommendations may include upgrading infrastructure to more water-efficient alternatives, implementing water-saving technologies, modifying operational practices, or raising employee and user awareness about water conservation practices. Finally, the implementation and monitoring stage ensures that the recommended measures are executed, and progress is tracked. This may involve working with relevant stakeholders to effect the proposed changes, establishing monitoring systems to track water usage, and evaluating the effectiveness of the implemented water management strategies over time.

Thus, a water audit provides valuable insights into water usage patterns, identifies areas for improvement, and offers practical solutions to optimize water management, reduce waste, and promote sustainability. It is a crucial tool for various entities, from large-scale industries to individual households, to enhance their water efficiency and contribute to a more sustainable future. National Mission on Water Conservation set up a campaign, _*Jal Shakti Abhiyan*‘ which urges all citizens to work collaboratively to overcome the problem of water scarcity by conserving every drop of water and suggests implementing water audits in every water use sector.

Importance and need of water audit in Colleges

Water audit is of significant importance in colleges and educational institutions. It helps colleges promote sustainability and reduce their environmental impact by identifying areas of water waste and inefficiency. By implementing conservation measures based on audit findings, colleges can effectively reduce water consumption and contribute to their sustainability goals. Furthermore, water audits enable colleges to save costs by uncovering hidden water leaks, inefficient equipment, or practices contributing to excessive water use. Compliance with water regulations is also ensured through audits, preventing penalties or fines, and maintaining positive relationships with regulatory agencies. Water audits offer educational opportunities, allowing colleges to engage students in auditing and raise awareness about water conservation.

Moreover, conducting water audits enhances the reputation of colleges as leaders in environmental initiatives and attracts environmentally conscious students and faculty. The data obtained from water audits facilitates data-driven decision-making, enabling colleges to make informed choices regarding infrastructure upgrades, equipment replacements, and operational changes. Overall, water audits support colleges in optimizing water management, reducing costs, ensuring compliance, promoting education, and establishing themselves as responsible and sustainable institutions.

Objectives

- To identify water consumption patterns
- To detect and address water losses
- To assess the current water quality status
- To assess water management practices
- To promote water conservation awareness
- To ensure regulatory compliance

Methodology

The audit team of ACESSD visited the college to collect data and evaluate the state of water resources. The team provided the College with standard datasheets and questionnaire for the data assortment. In addition to datasheets, supplementary information was procured through discussions with the College faculties. The datasheets comprise information on the sources, the pattern and quantity of water usage, and storage. The water samples from the College were taken to the ACESSD lab at Mahatma Gandhi University for physicochemical examination. Water samples from the campus were analysed for basic parameters such as pH, EC, TDS, alkalinity, chloride, salinity, iron, sulphate and MPN (Coliforms).

Observations

1. Source of water

The college primarily relies on three primary water sources: Kerala Water Authority (KWA), rainwater, a well, and ponds. The college relies primarily on well-maintained and hygienic pond water for daily activities, with KWA and rainwater systems serving as additional water sources. A large tank with a capacity of 1 Lakh liters is utilized for water storage. Before being pumped into the main tank, the rainwater undergoes filtration after being pumped into separate tanks to ensure quality. The well and one of the ponds are explicitly designated for gardening purposes.

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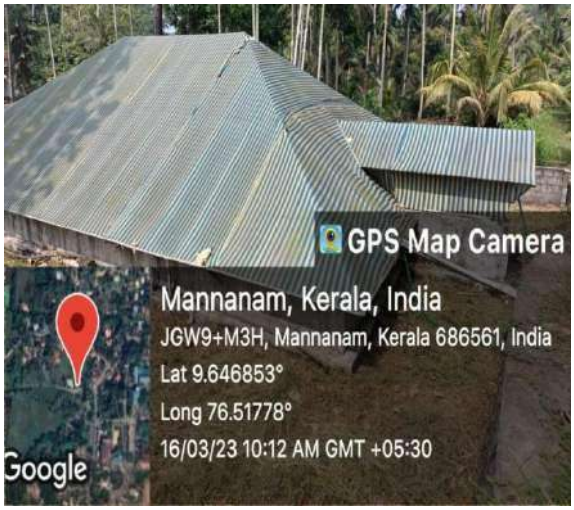
<tr><td> 
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<tr><td>Roofed main pond</td><td>Inner view of the pond</td></tr>
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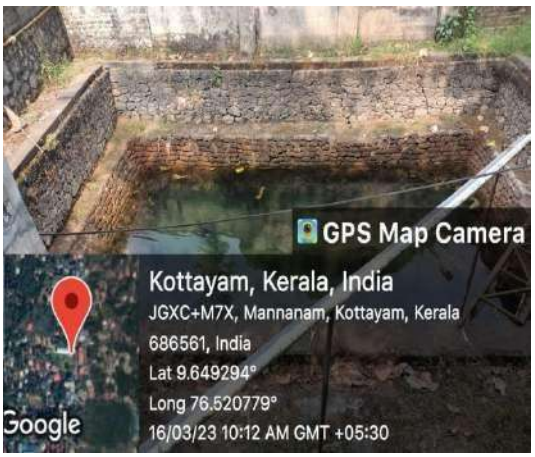
</td><td> 
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<tr><td>Main open well</td><td>Pond 2</td></tr>
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Pond for gardening

Fig. 1 Major water sources of the campus

2. Water distribution system

The water obtained from the ponds, rainwater harvesting (RWH), and Kerala Water Authority (KWA) are pumped into a primary tank with a capacity of 100,000 liters. From this primary tank, the water is pumped into two ground-level tanks, each with a capacity of 10,000 liters, before undergoing treatment. Once treated, the water is transferred to a 5,000-liter tank before being distributed to various tanks located throughout the campus for further utilization.

3. Water storage

Within the campus, there are a total of 12 tanks for water storage. The primary water tank in the blocks serves as the main collection point. Water is pumped from the primary sources into this tank. From there, it is further pumped to two ground-level tanks, each with a capacity of 10,000 liters. Subsequently, the water is transferred to the treatment plant for the necessary treatment processes. It is important to note that the water intended for gardening is stored separately on the top of the main block and is not subjected to treatment.

Table 1 Details of storage tanks in the college

Sl. No	Location	Capacity (L)	Type of water
1	Main block (Ground)	1 Lakh	Pond+Rainwater+KWA (Untreated)
2	Behind Chemistry dept (Ground)	10,000	Untreated
3	Behind Chemistry dept (Ground)	10,000	Untreated
4	Behind Chemistry dept (Ground)	5,000	Treated
5	Main block (Rooftop)	50,000	Treated
6	Main block (Rooftop)	10,000	Untreated
7	Above Principal‘s office	5,000	Treated
8	Auditorium	10,000	Treated
9	Auditorium	10,000	Treated
10	Near indoor stadium (Fire & Safety)	10,000	Untreated
11	Self-financing block	50,000	Treated
12	Canteen & Boy‘s hostel	5,000	Treated

4. Water outlets

Across the three blocks are 223 taps, 8 showers, 98 faucets, 98 flush tanks, 9 purifiers, 4 coolers, 30 urinals, 60 laboratory taps, and 34 wash basins. The main block houses laboratories and administrative offices and has more outlets than the other buildings. Fortunately, the campus has minimal water loss as all the taps are in good working condition. For more detailed information on the specifications of the outlets, please refer to Table 2.

Table 2 Details of main outlets in the college

Main outlets	Total number
Main Block	
Taps	106
Shower	2
Faucets	53
Flush tanks	53
Purifiers	6
Urinals	9
Laboratory taps	60
Wash basin	34
Coolers	3
Canteen block	
Taps	23
Shower	6
Faucets	12
Flush tanks	12
Purifiers	2
Self Financing block	
Taps	94
Coolers	1
Faucets	33
Flush tanks	33
Purifiers	1
Urinals	21

5. Water consumption

K.E College Mannanam, being a residential campus, has more significant water requirements than non-residential campuses. Water consumption encompasses using water from multiple sources, including the three blocks within the campus. The water is used for drinking and non-drinking purposes like toilet usage, urinals, showers, gardening, and general washing. For drinking purposes, water is obtained exclusively from the purifier and cooler. Table 3 provides information on block-wise water consumption and the approximate number of people utilizing water on campus.

Table 3 Block-wise usage of water on the campus

SL No.	Sector	Total Daily Use (L)	Approx. number of people used
Main block			
1	Toilet	7000	600
2	Urinals	3000	400
3	Guest room	50	2
4	Laboratory	4000	100
5	Teacher‘s room	150	70
6	Other wash areas	4000	1250
7	Water cooler & purifier	2000	700
Canteen block			
1	Bathroom	3000	26
2	Toilet	1000	35
3	Kitchen	3000	6
4	Garden	2000	2
5	Dining area	1000	750
Self Financing block			
1	Toilet	3000	600
2	Urinals	2000	300
3	Dining area	1000	1300
4	Teacher‘s room	1000	50
5	Water cooler & purifier	3000	600
Total		**40,200 L**	

When there is a shortage of water from natural sources, the college relies on the Kerala Water Authority as an alternate water source. The data in Table 4 summarizes the campus's water consumption pattern and associated charges. It helps track and analyze the water usage trends over time and enables the college to manage its water resources efficiently and monitor any fluctuations or irregularities in consumption.

Table 4 Details of KWA bills of the campus

Month	Consumption (kL)	Water charge (Rs.)
May 2022	45	
July 2022	77	3,710
September 2022	4	445
November 2022	3	435
January 2023	31	1,089
March 2023	68	3,023
May 2023	47	1,447
Total consumption	**275 kL**	
Average consumption	**39.28 kL**	

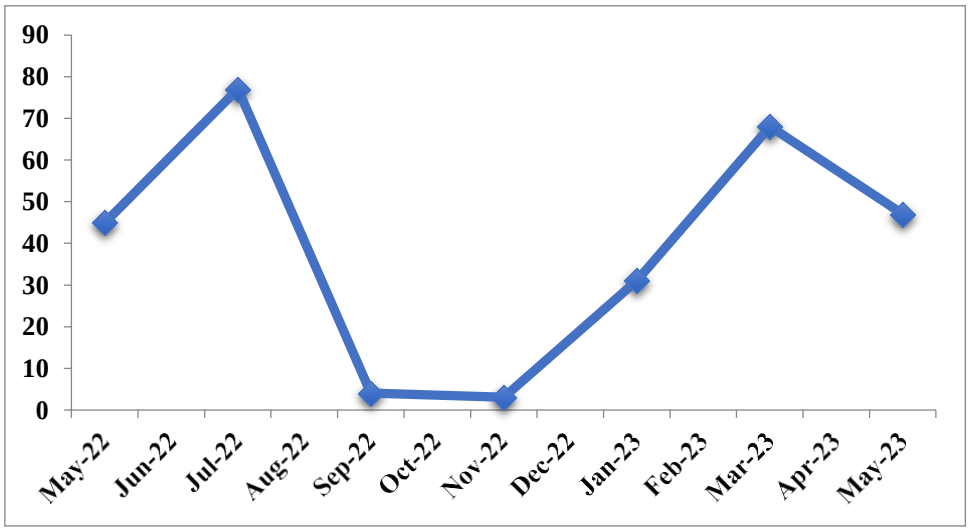


Fig. 2 KWA water consumption

5. Water quality

The consumption of KWA water shows a decline from mid-July to November. As per the affirmations, the College utilizes KWA water as a supplementary source only when there is a water shortage from their natural sources. This explanation likely accounts for decreased KWA water consumption during the specified period.

Sampling sites and sample codes

Water samples from 15 representative sites are collected for analysing physico-chemical parameters, and 7 samples for the microbiological analysis. The collected samples are brought to the ACESSD lab for analysis. The sampling sites and sample codes for physico-chemical analysis are as follows:

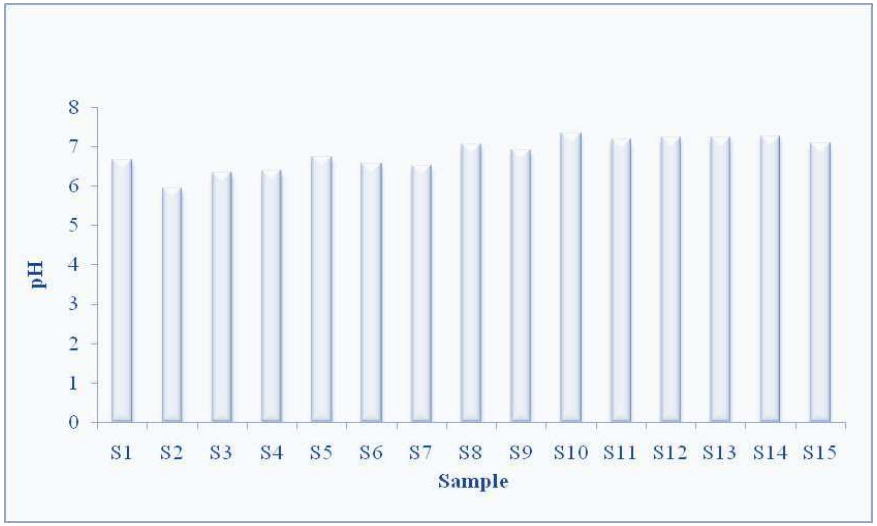
Table 5 Sampling sites and codes for physico-chemical analysis

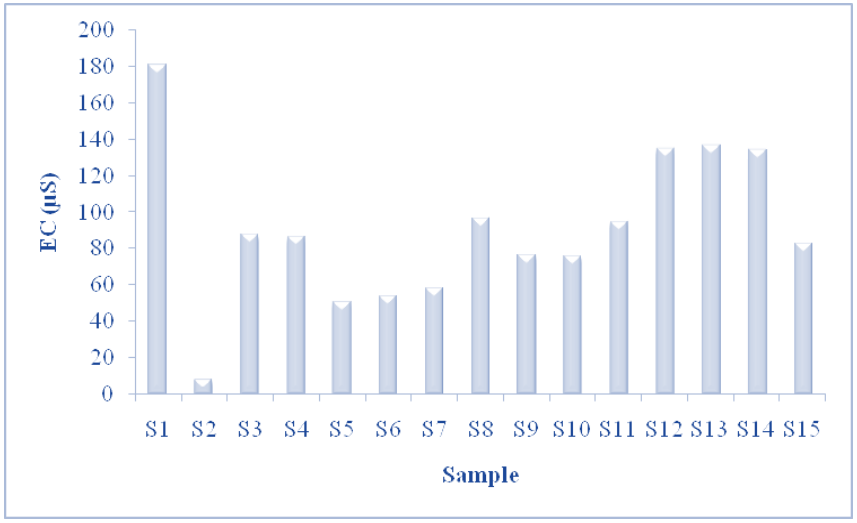
Sampling sites	Sample code
Well	S_1
Rain Water Harvesting	S_2
Main Pond	S_3
Pond (Gardening)	S_4
KWA	S_5
After Treatment	S_6
Tap water (Aided)	S_7
Tap water (Self)	S_8
Tap water (Canteen)	S_9
Tap water (Hostel)	S_{10}
Purifier (Aided)	S_{11}
Purifier (Self)	S_{12}
Purifier (Canteen)	S_{13}
Purifier (Hostel)	S_{14}
Cooler	S_{15}

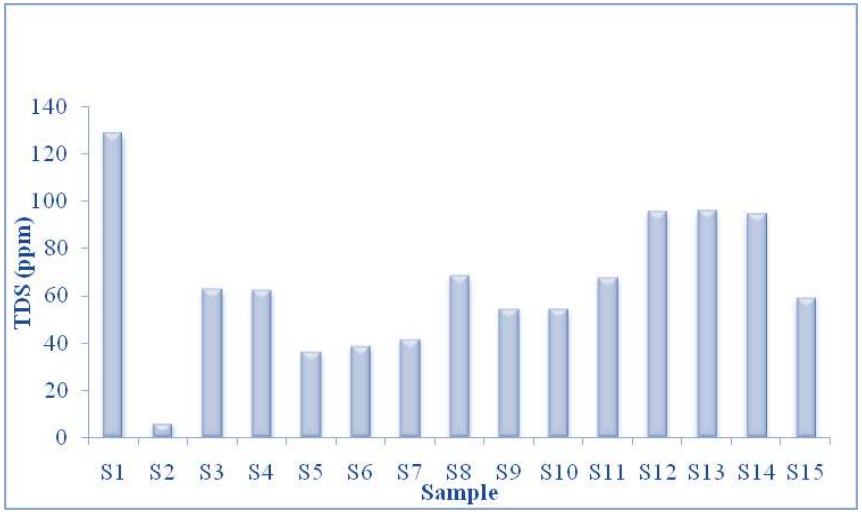
The results of the physicochemical analysis of the water samples give an overview of the quality of the samples from the college. The pH, EC, TDS, alkalinity, chloride, salinity and sulphate of all the samples are within the permissible limit of the World Health Organisation. Concerning the WHO-permitted limit for iron, S_1, S_2, S_3, S_4, and S_5 have high iron concentrations.

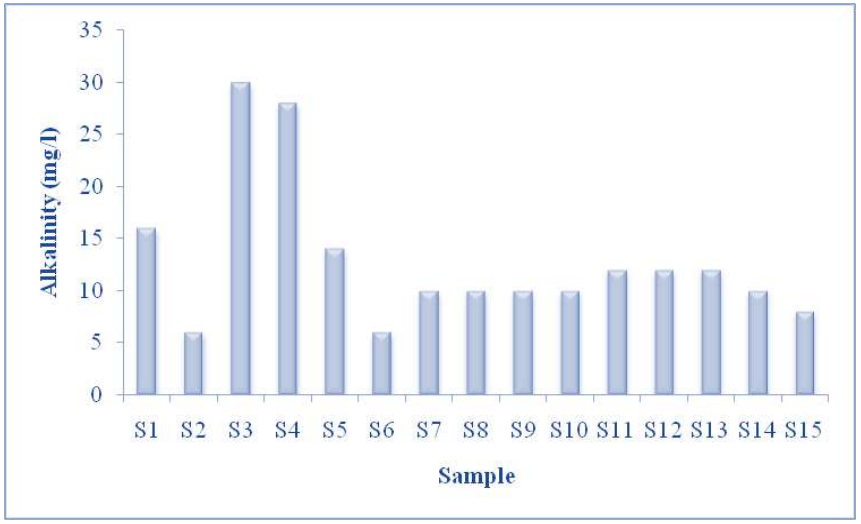
Table 6 Results of physico-chemical analysis of water samples

Sample	pH	EC (µS)	Alkalinity (mg/L)	Chloride (mg/L)	Salinity (ppt)	Iron (mg/L)	Sulphate (mg/L)
WHO standard	**6.5 – 8.5**	**2500 µS**	**200 mg/L**	**250 mg/L**	**500 ppt**	**0.3 mg/L**	**200 mg/L**
S_1	6.68	181	16	24.03	0.043	0.3	9.62
S_2	5.96	8.6	6	4.81	0.009	0.5	4.11
S_3	6.35	88.2	30	12.01	0.022	1.3	5.77
S_4	6.4	86.8	28	9.01	0.016	1.6	0.78
S_5	6.75	51.1	14	11.01	0.020	0.43	2.11
S_6	6.58	54.4	6	10.01	0.018	0.09	4.84
S_7	6.53	58.7	10	12.01	0.022	0.05	4.43
S_8	7.07	97	10	12.01	0.022	0.04	4.74
S_9	6.93	77.1	10	13.01	0.024	0.086	6.92
S_{10}	7.35	76.6	10	19.02	0.034	0.091	6.71
S_{11}	7.2	95.5	12	17.02	0.031	0	7.12
S_{12}	7.24	135.2	12	14.02	0.025	0	7.02
S_{13}	7.25	137.4	12	14.02	0.025	0	9.62
S_{14}	7.28	134.9	10	14.02	0.025	0	9.41
S_{15}	7.09	83.5	8	15.02	0.027	0.02	9.72


pH
0
1
2
3
4
5
6
7
8
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15
Sample


EC (µS)
0
20
40
60
80
100
120
140
160
180
200
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15
Sample


TDS (ppm)
0
20
40
60
80
100
120
140
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15
Sample


Alkalinity (mg/l)
0
5
10
15
20
25
30
35
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15
Sample

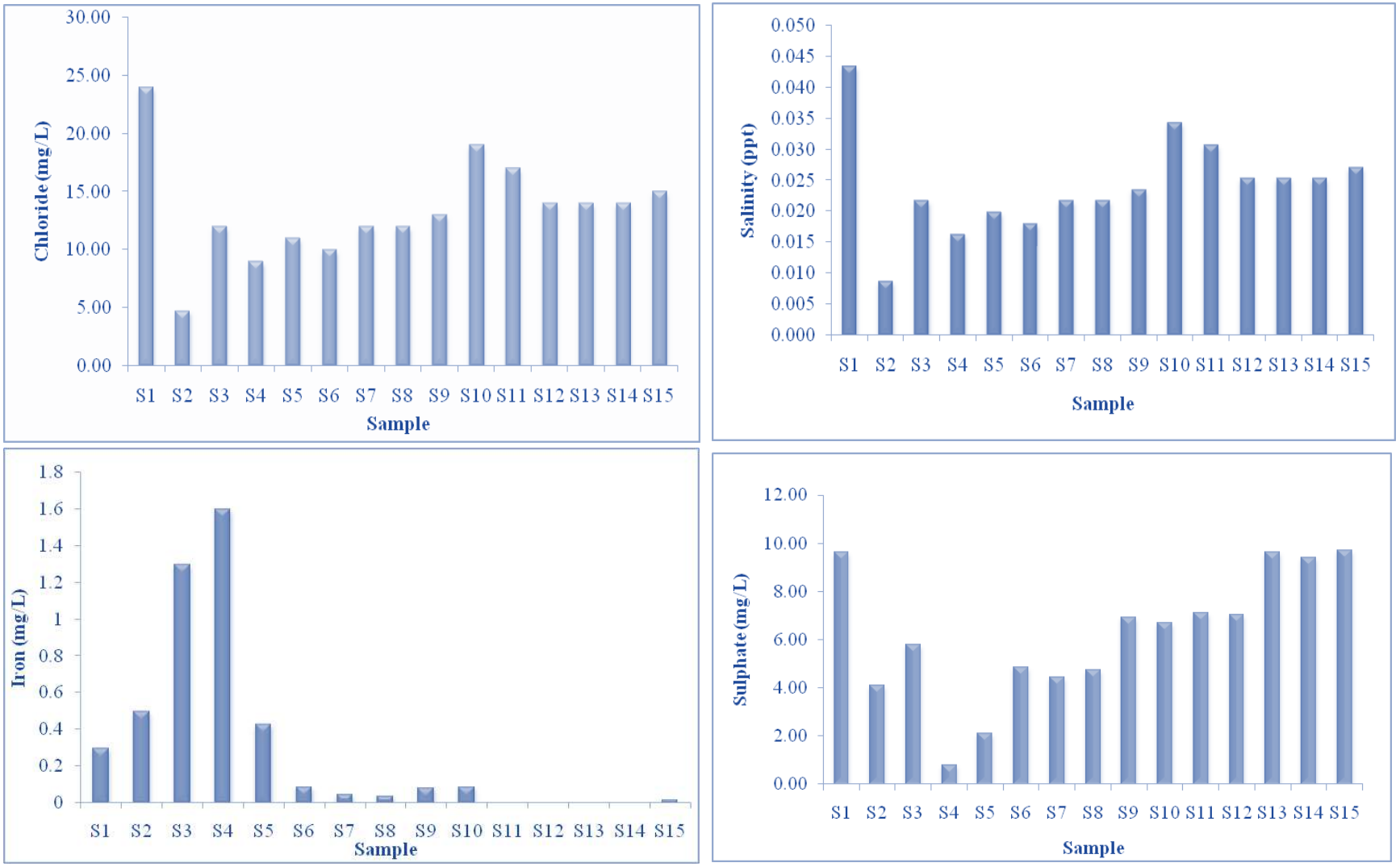


Fig. 3 Graphical representation of physico-chemical analysis of water samples

Microbiological Analysis

Eight representative samples were collected for the microbiological analysis. The samples were collected in sterilised bottles and brought to the ACESSD lab for further analysis. The sampling sites and the sample codes are figured in Table 7.

The MPN test identifies the presence or absence of fecal coliforms, which can contaminate water and make it unfit for human consumption. A zero percent E. coli level per 100 ml of water is considered safe by the World Health Organisation (WHO). The range of 1-10 MPN/100 ml is considered low risk, whereas 11-100 MPN/100 ml is considered medium risk, and the count of coliforms greater than 100 MPN/100 ml signifies high risk.

Out of eight samples, six samples show the presence of coliforms. The samples from the RWH tank (93MPN/100mL) and main pond (43MPN/100mL) show a medium risk.

Table 7 Sampling sites and codes for microbiological analysis

Sampling sites	Sample code
Rain Water Harvesting	M_1
Main pond	M_2
After Treatment	M_3
Tap water (Canteen)	M_4
Tap water (Hostel)	M_5
Purifier (Aided)	M_6
Purifier (Canteen)	M_7
Purifier (Hostel)	M_8

Table 8 Results of microbiological analysis of water samples

Sample code	Coliforms (MPN/100mL)
WHO standard	**Shall not be detectable in any 100 ml sample**
M_1	93
M_2	43
M_3	4
M_4	7
M_5	9
M_6	3
M_7	0
M_8	0

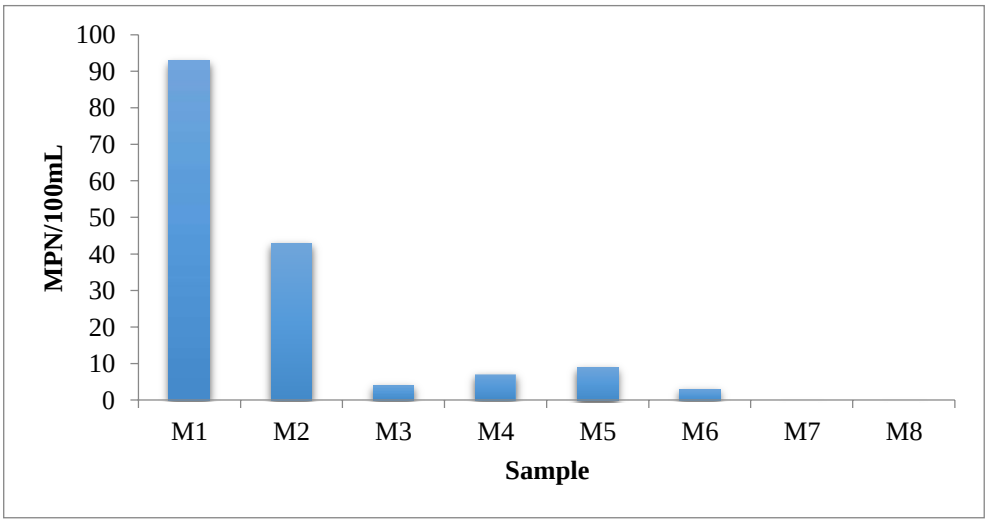


Fig. 4 Graphical representation of coliform concentration in water samples

Healthy practices

1. Water treatment

The College has installed two water treatment plants to ensure clean and safe water. These plants are strategically located in the main block and self-financing block. The purpose of these treatment plants is to treat the water before it is distributed throughout the campus. Each treatment plant consists of three filters. The first filter is a multigrade sand filter, which removes more significant impurities and sediments from the raw water. The water then passes through an iron removal filter, eliminating any iron traces present. Finally, the water is directed to an activated carbon filter, which further purifies the water by removing organic compounds, odors, and residual contaminants. Once the water has undergone this comprehensive treatment process, it is considered safe. The treated water is utilized for drinking, cooking, cleaning, sanitation, and other general purposes. These water treatment plants demonstrate the College's commitment to providing high-quality water to its students and staff, ensuring a healthy and hygienic environment.

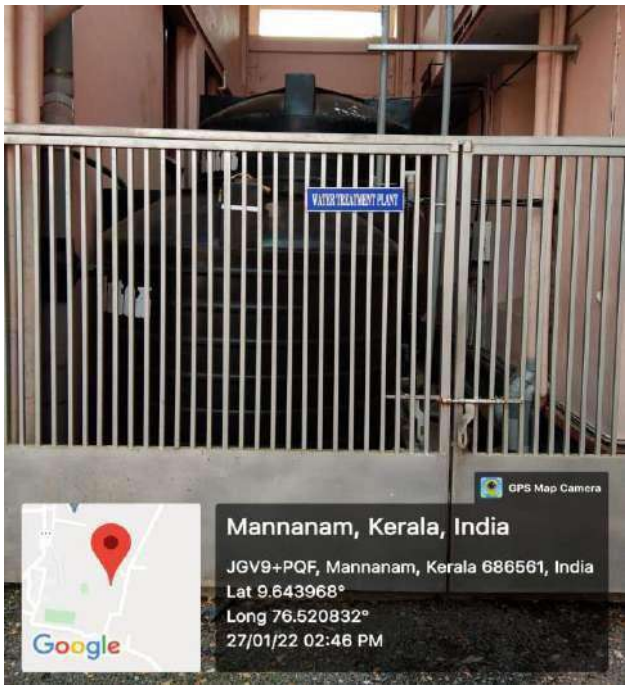


Fig. 5 Water treatment plant

2. Rainwater Harvesting system

The College has implemented a rainwater harvesting (RWH) system that collects rainwater from the rooftop of the indoor stadium. The harvested rainwater is then transferred to the main water tank, which has a capacity of 1 Lakh liters, after which it is transferred to other tanks with a capacity of 5000 liters each and undergoes filtration. This filtration system is crucial as it helps minimize the chances of leaves and other debris entering the tank, ensuring the collected rainwater remains clean and free from contaminants.

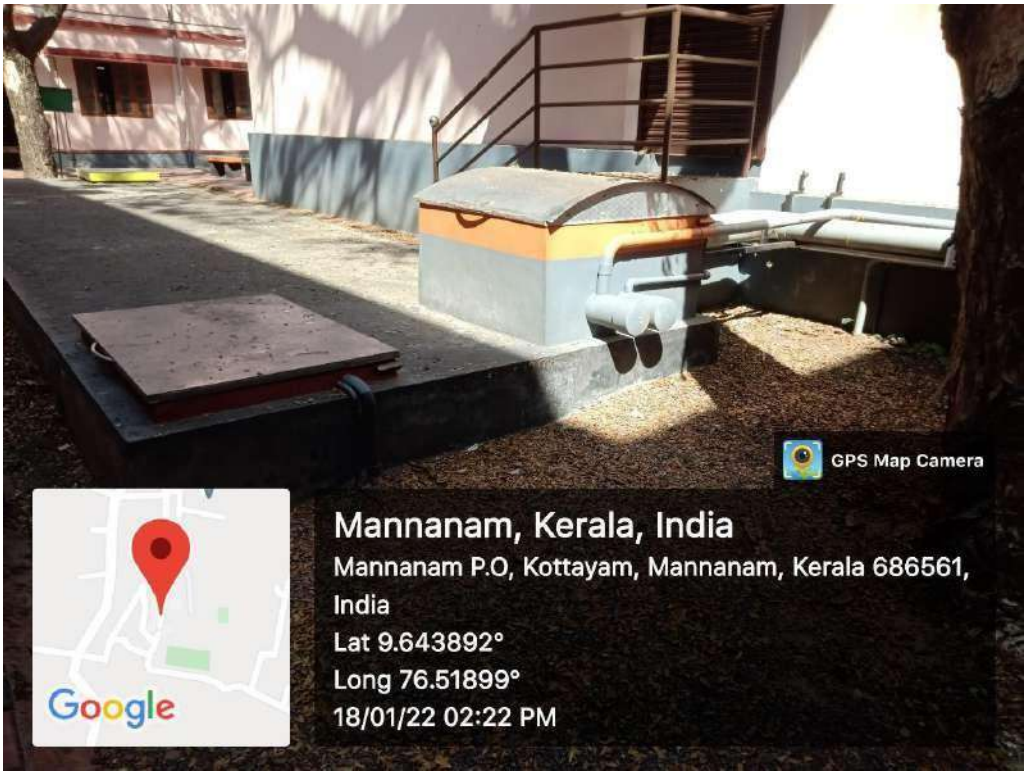


Fig. 6 Rainwater Harvesting

3. Waste water collection pits

The primary source of wastewater in the College is the wash area, and to manage this wastewater, the College has constructed three dedicated tanks.

The first tank is located near the canteen and collects wastewater from the canteen and the boys' hostel. The second tank is situated at the backside of the indoor stadium and is specifically designed to collect wastewater from the main block of the college. Lastly, a tank within the self financing block collects wastewater from that area. Once the wastewater is collected in these tanks, it is stored in pits before being discharged into the ground. This system ensures proper management of the wastewater generated in the College, allowing for environmentally responsible disposal.

4. Efficient drinking water facility

The College has implemented drinking water facilities across its three blocks. Sixteen drinking water facilities are available, consisting of nine purifiers and four coolers. These facilities are strategically placed throughout the college to ensure convenient access to clean and refreshing drinking water for students, faculty, and staff.

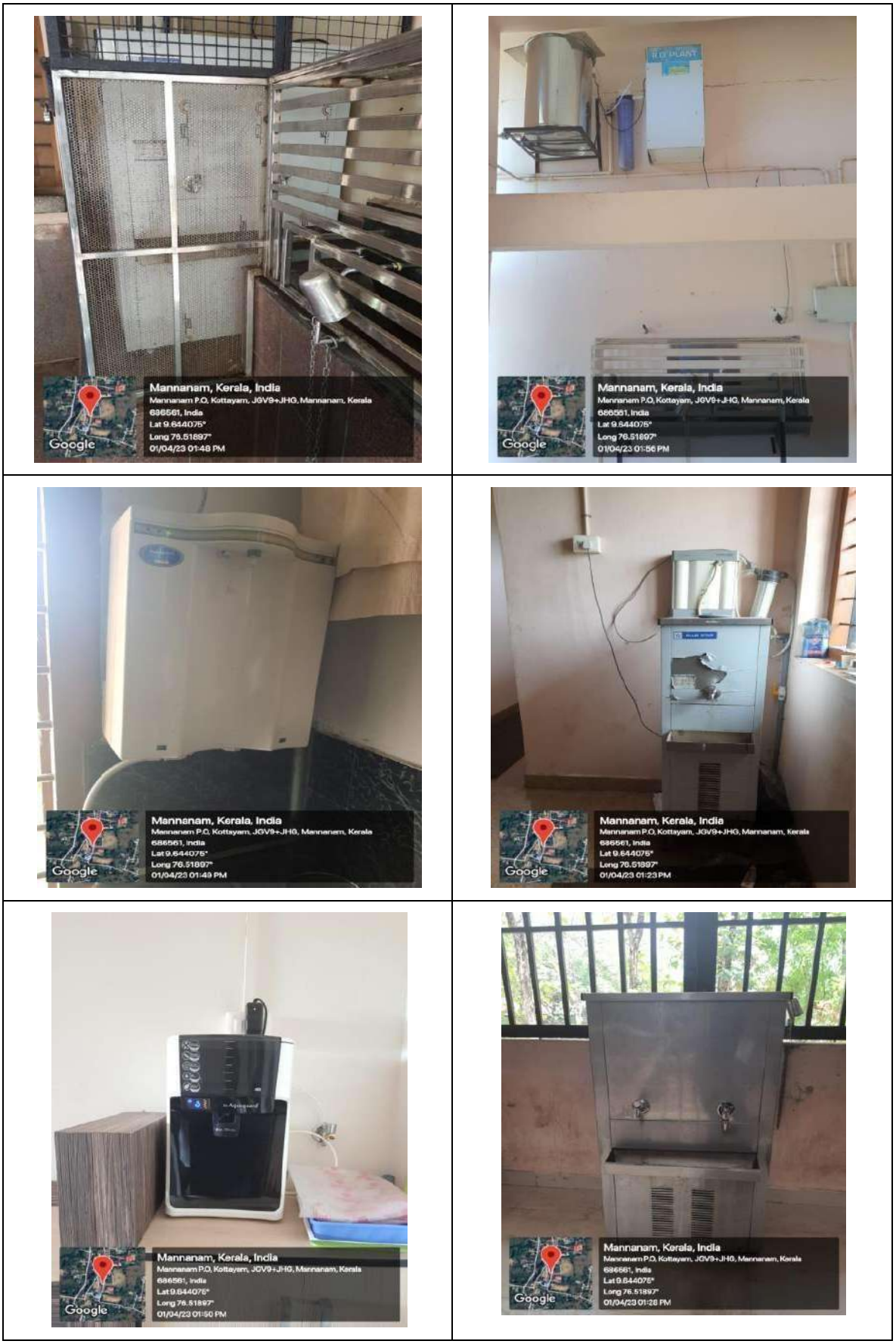


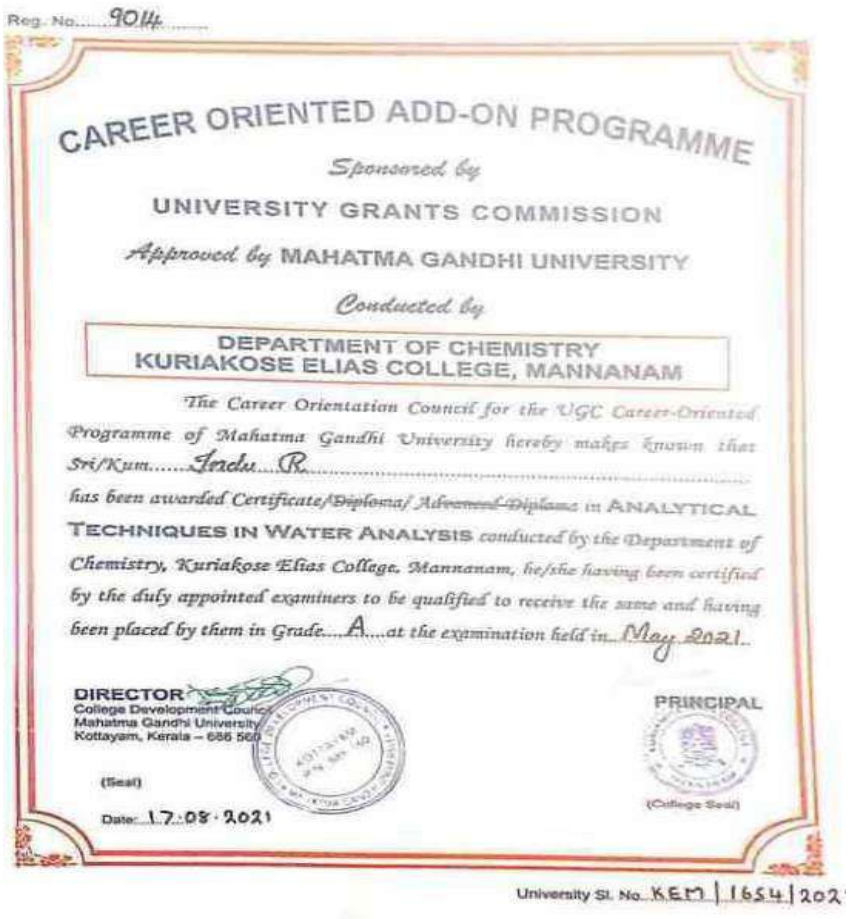
Fig. 7 Drinking water facilities in college

5. Chemical neutralization in the lab

In the chemistry laboratory, acids and bases were used for neutrilisation purposes. These neutralised solutions and other laboratory washings were drawn to a sand-filled drainage system built within the lab. After sand filtration the solutions were swept into the ground.

6. Add-on certificate course : Analytical Techniques in Water Analysis

Under the Department of Chemistry, the College conducted a certificate course on Analytical Techniques in Water Analysis, which was granted by the UGC (University Grants Commission). This course aimed to provide students with specialized knowledge and skills in water analysis. Upon successfully completing the program, students acquired expertise in various analytical techniques for assessing water quality.


Reg. No. 9014

CAREER ORIENTED ADD-ON PROGRAMME

Sponsored by

UNIVERSITY GRANTS COMMISSION

Approved by MAHATMA GANDHI UNIVERSITY

Conducted by

DEPARTMENT OF CHEMISTRY
KURIAKOSE ELIAS COLLEGE, MANNANAM

The Career Orientation Council for the UGC Career-Oriented Programme of Mahatma Gandhi University hereby makes known that Sri/Kum. Jerdu R has been awarded Certificate/~~Diploma/ Advanced Diploma~~ in ANALYTICAL TECHNIQUES IN WATER ANALYSIS conducted by the Department of Chemistry, Kuriakose Elias College, Mannanam, he/she having been certified by the duly appointed examiners to be qualified to receive the same and having been placed by them in Grade A at the examination held in May 2021.

DIRECTOR
College Development Council
Mahatma Gandhi University
Kottayam, Kerala – 686 560

(Seal)

Date: 17.08.2021

PRINCIPAL

(College Seal)

University Sl. No. KEM | 1654 | 202

Fig. 8 A sample certificate of Add on course

Fig. 9 Hands-on training for students

7. Awareness programmes on water conservation

The Chemistry Department of the College organised a water conservation awareness programme for the residents of Vechoor Gramme Panchayat on March 22, 2023, in collaboration with the M.S. Swaminathan Research Foundation and the Haritha Keralam Mission. The college faculty members provided technical training and an awareness session on water conservation and they expressed their preparedness to monitor the water quality in Vechoor Gramme Panchayat.

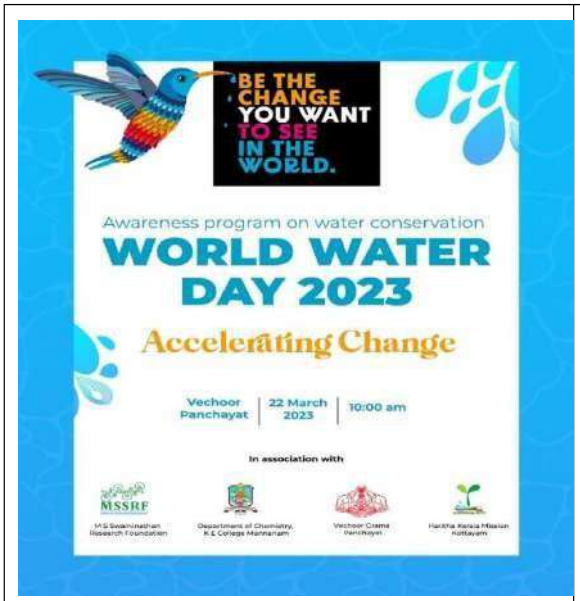


Fig. 10 Water resource awareness programme

8. World water day observance

In connection with World Water Day, the Department of Psychology (SF) organized a program called "Jalam Choreography" at the college. As part of this initiative, a dance video was created to convey the message of the necessity and significance of water conservation.

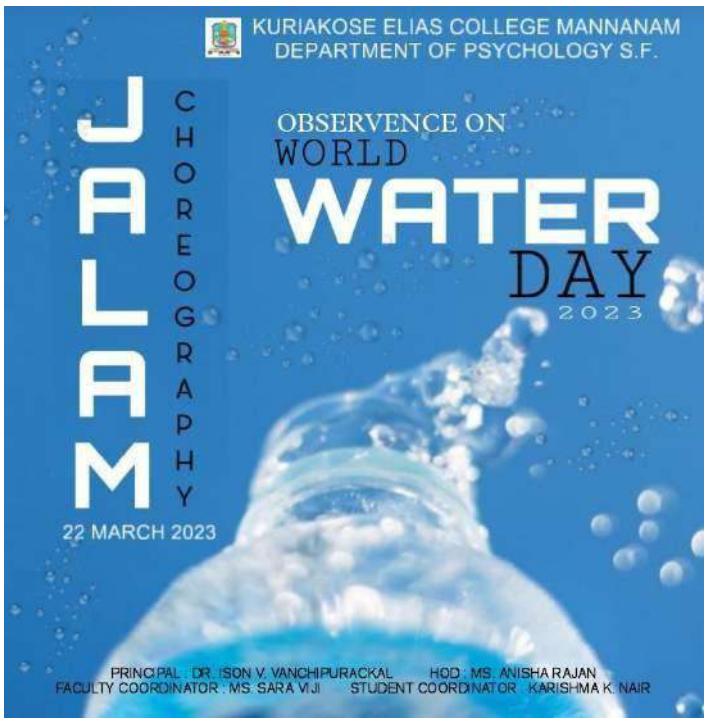


Fig. 11 World water day observance

9. Poster designing competition – World Water Day 2023

The College has organised a poster design competition for the students on water conservation as part of World Water Day. The event's main goal was to create awareness among students about the importance of water conservation and the need for everyone to contribute to this cause. The event highlighted the importance of water conservation and the consequences of its depletion.

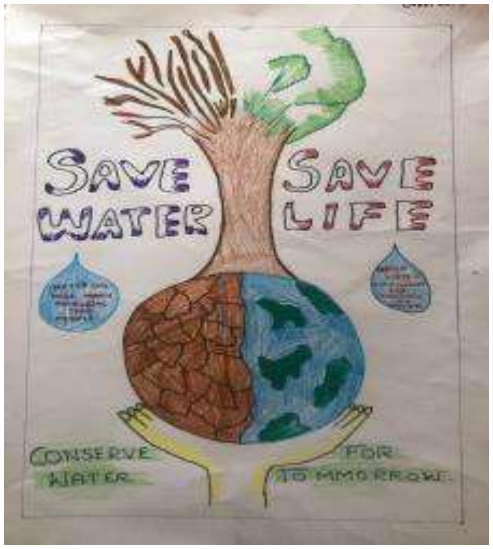


Fig. 12 Poster designing competition on water conservation

Recommendations

- Exhibit boards regarding water conservation: The college can create and display exhibit boards throughout the campus, educating students, staff, and visitors about the importance of water conservation. These boards can provide information on water-saving tips, the significance of water conservation, and the impact of individual actions on water resources.
- Extend rainwater harvesting to other buildings: To further maximize water conservation efforts, the college can expand the implementation of rainwater harvesting systems to other buildings on campus. This will help capture and utilize rainwater for various purposes, reducing dependence on external water sources.

- Build separate tanks for rainwater harvesting, KWA, and natural sources: Constructing separate tanks for rainwater harvesting, Kerala Water Authority (KWA) water, and water from natural sources will facilitate efficient management and utilization of different water sources. This segregation will enable better control and distribution of water based on its source and purpose.
- Install outlets for major water storage tanks: Installing outlets for major water storage tanks will allow for easy access to the stored water. These outlets can be strategically positioned to enable convenient water withdrawal for various campus activities, ensuring efficient and organized water distribution.
- Install wastewater treatment plants: Implementing wastewater treatment plants within the college premises will enable the proper treatment and purification of wastewater before its discharge. These treatment plants will help remove pollutants and contaminants, ensuring the discharged water is environmentally safe and can be reused or returned to natural water bodies responsibly.
- Reuse treated wastewater for gardening: The treated wastewater from the wastewater treatment plants can be utilized for gardening purposes. This practice reduces the need for freshwater in maintaining the college's gardens and landscapes, promoting sustainable water use and conservation.
- Chlorinate sources annually: To ensure the quality and safety of water sources, an annual chlorination process can be implemented. Chlorination helps eliminate harmful bacteria and microorganisms, minimizing the risk of waterborne diseases and maintaining the overall cleanliness of water sources.
- Plant Vetiver zizanioides along the banks of ponds and wells: Vetiver zizanioides, commonly known as Vetiver grass, can be planted along the banks of ponds and wells. This grass has deep roots that help stabilize the soil, prevent erosion, and filter contaminants, thus improving the overall water quality in these areas.
- Install dual flush systems in toilets: Installing dual flush systems in toilets can significantly reduce water consumption. These systems offer full or partial flush options, depending on the waste disposed of, thereby conserving water with each flush.

- Install spray tap systems on common taps: Equipping common taps with spray tap systems can help minimize water wastage. These systems regulate water flow and provide a fine mist or spray, ensuring efficient water use while fulfilling the required tasks.

Implementing these measures at K.E College will contribute to a comprehensive water conservation strategy, promoting responsible water usage, reducing water wastage, and fostering a sustainable campus environment.

4. BIODIVERSITY AUDIT

The Biodiversity audit highlights observations and analytic findings of a rapid assessment of biotic components, protective measures, and threat factors in a specific area. The Biodiversity Inventory Cell of the ACESSD conducted the current assessment in the K.E College campus. The report highlights the site history of the area, current status of flora and fauna, best practices of the institution in the management of campus biodiversity and the recommendations of the assessment team.

Landscape and geography

The College campus is situated on the South-west facing slopes of the Mannanam hills in Athirampuzha panchayat of Kottayam district. The Mannanam watershed drains directly into the low-lying marshy wetlands and extended canals of the Vembanad Lake. The Indian Council of Agricultural Research (ICAR) categorized the area under the

agroecological subregion of western ghats and coastal plains, hot and humid regions. The Planning Commission considered it as an area of West coast plains and Ghats region Zone (XII) of the Agro-climatic Zones. The campus has a total area of about 7.5 acres, 10 km from Kottayam town.

Objectives

- To assess the vegetation and floral components of the campus
- To enumerate the invertebrate fauna (dragonflies/damselflies and butterflies)
- To document the vertebrate fauna (reptiles, birds and mammals)
- To highlight the best practices and suggest measures for improvement

Methods

The biodiversity assessment team perambulated the campus covering all the paths, roads and crisscrossed the habitats wherever necessary for detailed or specific observations of flora and fauna. Standard protocols were followed for the assessment of faunal and floral components. Visual encounter, point count and visual estimation, transect walk etc., are the specific assessment methods followed. Informal talks with the staff, inmates, security personnel, and gardeners were made to get additional information.

Visual estimation of vegetation cover was made during the transect walks across the campus. Individual species of trees, shrubs, herbs, climbers, garden species; alien and exotic species were noted and categorised into native and introduced species and the invasive-exotic species. Photographs were taken in some instances for identification and confirmation of species. Faunal components were recorded by direct observations and indirect evidences. Regional flora, field guides and authentic online resources were used for the identification and confirmation of species. Field gadgets such as Eagle Optics 10x40 binoculars, Nikon D5600 SLR camera, Garmin Global Positioning System (GPS) were used in the field assessment. Staff members and student volunteers were also accompanied in the field assessment.

Observations and Findings

a) Vegetation composition

Floristic diversity

The K. E. College campus has a total area of about 3.036 ha on the Mannanam hills. More than half of the area (56.3%) is occupied by the building blocks and other College constructions. Excluding the College ground and few other open areas, the vegetation cover may be less than 20 % of the campus area. Based on our observation, the vegetation cover of the campus is categorised mainly into a) Garden species which are mostly the exotic ornamental ones, and b) Trees of the fringe areas. The vegetation is further categorised into cultivated and wild species. Based on the general usage pattern, the plants are further categorized into a) Edible, b) Garden, c) Medicinal, d) Timber, e) Invasive and f) Other native species. The diversity of species is analysed at the family level and habit categories.

Fig. 1 General view of the campus flora

Table 1 List of Plants in the Campus

Sl. No.	Scientific Name	Common Name	Family	Habit
1	*Acacia baileyana*	Garden mimosa	Fabaceae	Shrub
2	*Acacia mangium*	Mangium	Fabaceae	Tree
3	*Acalypha lanceolata*	Indian copperleaf	Euphorbiaceae	Herb
4	*Achyranthes aspera*	Kadaladi	Amaranthaceae	Herb
5	*Adenanthera pavonina*	Manchadi	Fabaceae	Tree
6	*Aegle marmelos*	Koovalam	Rutaceae	Tree
7	*Aerva lanata*	Cherula	Amaranthaceae	Herb
8	*Agave vivipara*	Dwarf Aloe	Asparagaceae	Shrub
9	*Allamanda blanchetii*	Purple Allamanda	Apocynaceae	Climber
10	*Allamanda cathartica*	Golden Trumpet wine	Apocynaceae	Climber
11	*Alocasia macrorrhiza*	Aanachembu	Araceae	Herb
12	*Aloe vera*	Kattarvazha	Xanthorrhoeaceae	Herb
13	*Alternanthera bettzickiana*	Calico plant	Amaranthaceae	Herb
14	*Alternanthera ficoidea*	Sanguinarea	Amaranthaceae	Herb
15	*Amherstia nobilis*	Simsapa Tree	Fabaceae	Tree
16	*Araucaria heterophylla*	Arakaria Pine	Araucariaceae	Tree
17	*Artocarpus hirsutus*	Anjili	Moraceae	Tree

18	*Artocarpus heterophyllus*	Jack Fruit	Moraceae	Tree
19	*Axonopus compressus*	Kaalappullu/Carpet Grass	Poaceae	Grass
20	*Azadirachta indica*	Arya vepu/Neem	Meliaceae	Tree
21	*Bambusa ventricosa*	Buddha's-belly bamboo	Poaceae	Grass
22	*Bambusa vulgaris*	Common Bamboo	Poaceae	Grass
23	*Bauhinia acuminata*	Vella Mandaram	Fabaceae	Shrub
24	*Bauhinia purpurea*	Purple Bauhinia	Fabaceae	Tree
25	*Bauhinia variegata*	Mandaram	Fabaceae	Tree
26	*Biophytum intermedium*	Mukkutti	Oxalidaceae	Herb
27	*Brahea armata*	Mexican blue palm	Arecaceae	Tree
28	*Briedelia retusa*	Mulluvenga	Euphorbiaceae	Tree
29	*Bougainvillea spectabilis*	Great Bougainvillea	Nyctaginaceae	Climber
30	*Caesalpinia coriaria*	Divi divi	Fabaceae	Tree
31	*Caesalpinia pulcherrima*	Rajamalli/ Peacock Flower	Fabaceae	Shrub
32	*Canna indica*	Canna	Cannaceae	Herb
33	*Canthium angustifolium*	Kattakara	Rubiaceae	Shrub
34	*Capsicum frutescens*	Kantharimulaku	Solanaceae	Herb
35	*Cardiospermum halicacabum*	Uzhinja	Sapindaceae	Climber
36	*Caryota urens*	Fish-tail Palm/ Ulatti Pana	Arecaceae	Tree
37	*Cascabela thevetia*	Manja-arali	Apocynaceae	Shrub
38	*Cassia fistula*	Kanikonna/Indian Laburnum	Fabaceae	Tree
39	*Catharanthus roseus*	Periwinkle	Apocynaceae	Herb
40	*Cayratia mollissima*	Curry GMrape	Vitaceae	Climber
41	*Cenchrus clandestinus*	Kikuyu grass/lawn grass	poaceae	Grass
42	*Centrosema molle*	Kattupayaru	Fabaceae	Climber
43	*Cereus pterogonus*	Columnar Cacti	Cactaceae	Shrub
44	*Chassalia curviflora*	Curved flower chassalia	Rubiaceae	Shrub
45	*Chromolaena odorata*	Communist Pacha	Asteraceae	Shrub
46	*Cissus latifolia*	Chunnambu valli	Vitaceae	Climber
47	*Cissus quadrangularis*	Piranda/Veldt Grape	Vitaceae	Climber
48	*Cleome rutidosperma*	Purple Cleome	Cleomaceae	Herb
49	*Cleome viscosa*	Spider flower	Cleomaceae	Herb

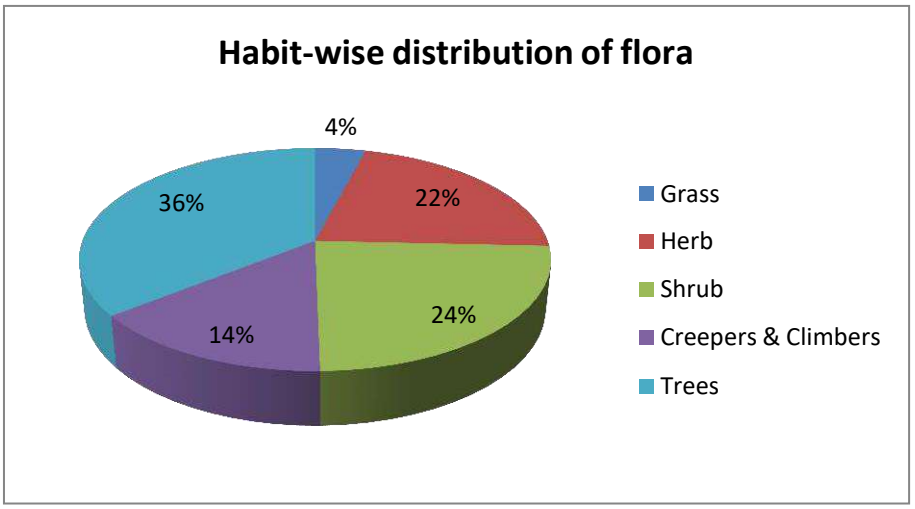
50	*Clerodendrum thomsoniae*	Bleeding-heart	Lamiaceae	Climber
51	*Clitoria ternatea*	Butterfly Pea	Fabaceae	Climber
52	*Codiaeum variegatum*	Croton	Euphorbiaceae	Shrub
53	*Colocasia esculenta*	Chembu	Araceae	Herb
54	*Combretum constrictum*	Powderpuff	Combretaceae	Shrub
55	*Combretum indicum*	Rangoon creeper	Combretaceae	Climber
56	*Corypha umbraculifera*	Kodappana	Arecaceae	Tree
57	*Crotalaria retusa*	Rattleweed	Fabaceae	Herb
58	*Costus pictus*	Insulin plant	Zingiberaceae	Herb
59	*Cucurbita maxima*	Pumkin	Cucurbitaceae	Climber
60	*Cyanthillium cinereum*	Poovamkurunthala	Asteraceae	Herb
61	*Cycas circinalis*	Enthu/Queen Sago	Cycadaceae	Tree
62	*Cycas revoluta*	Sago Palm	Cycadaceae	Tree
63	*Cyclea peltata*	Padathali	Menispermaceae	Climber
64	*Cynodon dactylon*	Karukapullu	Poaceae	Grass
65	*Cyperus distans*	Slender Sedge	Cyperaceae	Grass
66	*Cyrtostachys renda*	Red palm	Arecaceae	Tree
67	*Dalbergia latifolia*	Indian Rosewood	Fabaceae	Tree
68	*Dendrophthoe falcata*	Ithilkanni/Mistletoe	Loranthaceae	Epiphytic
69	*Dracaena marginata*	Madagascar Dragon Tree	Asparagaceae	Shrub
70	*Dracaena Surculosa*	Gold dust dracaena	Asparagaceae	Shrub
71	*Drynaria quercifolia*	Oakleaf Fern	Polypodiaceae	Herb
72	*Duranta erecta*	Gold spot	Lamiaceae	Shrub
73	*Dypsis lutescens*	Butterfly Palm	Arecaceae	Tree
74	*Elaeis guineensis*	Oil Palm	Arecaceae	Tree
75	*Eleutheranthera ruderalis*	Ogiera	Asteraceae	Herb
76	*Emilia sonchifolia*	Muyalchevi	Asteraceae	Herb
77	*Euphorbia hirta*	Attuvattappala	Euphorbiaceae	Herb
78	*Excoecaria cochinchinensis*	Chinese croton	Euphorbiaceae	Shrub
79	*Ficus auriculata*	Elephant Ear Fig	Moraceae	Tree
80	*Ficus hispida*	Kattathi/Hairy Fig	Moraceae	Tree
81	*Ficus microcarpa*	Chinese banyan	Moraceae	Tree
82	*Ficus tinctoria*	Kallathi	Moraceae	Tree
83	*Flueggea virosa*	Perimklavu	Euphorbiaceae	Shrub
84	*Furcraea foetida*	Mauritius Hemp	Asparagaceae	Shrub

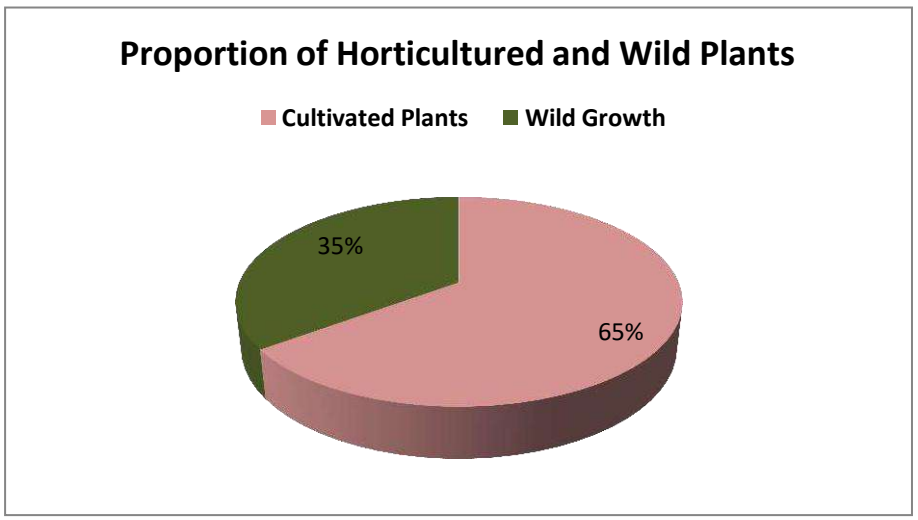
85	*Gardenia jasminoides*	Cape jasmine	Rubiaceae	Shrub
86	*Gliricidia sepium*	Seema Konna	Fabaceae	Tree
87	*Glycosmis pentaphylla*	Kuttippannel	Rutaceae	Shrub
88	*Grewia flavescens*	Shenkadasi	Tiliaceae	Shrub
89	*Hibiscus rosa-sinensis*	Chemparuthi/China Rose	Malvaceae	Shrub
90	*Hyophorbe lagenicaulis*	Bottle Palm	Arecaceae	Tree
91	*Ichnocarpus frutescens*	Palvalli	Apocynaceae	Climber
92	*Ipomoea cairica*	Morning Glory/ Kolambipoovu	Convolvulaceae	Climber
93	*Ixora coccinea*	Thetti Poovu	Rubiaceae	Shrub
94	*Jasminum multiflorum*	Common jasmine	Oleaceae	Climber
95	*Lagerstroemia speciosa*	Poo Maruthu/ Crape Myrtle	Lythraceae	Tree
96	*Lantana camara*	Unnichedi	Lamiaceae	Shrub
97	*Leea indica*	Maniperandi	Leeaceae	Shrub
98	*Loropetalum chinense*	Chinese fringe flower	Hamamelidaceae	Shrub
99	*Macaranga peltata*	Vatta	Euphorbiaceae	Tree
100	*Magnolia champaca*	Champakam	Magnoliaceae	Tree
101	*Malpighia emarginata*	West Indian Cherry	Malpighiaceae	Shrub
102	*Manilkara zapota*	Sapota	Sapotaceae	Tree
103	*Mangifera indica*	Mango	Anacardiaceae	Tree
104	*Mansoa alliacea*	Garlic vine	Bignoniaceae	Climber
105	*Melaleuca citrina*	Bottle Brush Tree	Myrtaceae	Tree
106	*Mesosphaerum suaveolens*	Naithulasi	Lamiaceae	Herb
107	*Microstachys chamaelea*	Kodiyavannakku	Euphorbiaceae	Herb
108	*Millettia pinnata*	Pungu/Pongam	Fabaceae	Tree
109	*Mimosa pudica*	Thottalvadi	Fabaceae	Herb
110	*Mimusops elengi*	Elangi	Sapotaceae	Tree
111	*Muntingia calabura*	Jamaica Cherry	Muntingiaceae	Tree
112	*Murraya koenigii*	Karivepu	Rutaceae	Shrub
113	*Murraya paniculata*	Maramulla	Rutaceae	Shrub
114	*Mussaenda erythrophylla*	Red Mussanda	Rubiaceae	Shrub
115	*Mussaenda frondosa*	Vellila	Rubiaceae	Shrub
116	*Myxopyrum smilacifolium*	Chathuravalli	Oleaceae	Climber
117	*Nelumbo nucifera*	Indian lotus	Nelumbonaceae	Herb
118	*Nephelium lappaceum*	Rambuttan	Sapindaceae	Tree

119	*Nyctanthes arbor-tristis*	Parijatham/ Coral Jasmin	Oleaceae	Shrub
120	*Nymphaea micrantha*	Ashithambel	Nymphaeaceae	Herb
121	*Nymphaea nouchali*	Aambal	Nymphaeaceae	Herb
122	*Ocimum tenuiflorum*	Krishnathulasi	Lamiaceae	Shrub
123	*Olea dioica*	Edala	Oleaceae	Tree
124	*Oldenlandia corymbosa*	Parpadakapullu	Rubiaceae	Herb
125	*Opuntia cochenillifera*	Cochineal cactus	Cactaceae	Shrub
126	*Otacanthus caeruleus*	Brazilian snapdragon	Plantaginaceae	Shrub
127	*Pachystachys lutea*	Golden Candle plant	Acanthaceae	Shrub
128	*Pandanus baptistii*	Variegated Dwarf Pandanus	Pandanaceae	Tree
129	*Pandorea jasminoides*	Bower Plant	Bignoniaceae	Climber
130	*Paraserianthes falcataria*	Albizia	Fabaceae	Tree
131	*Passiflora caerulea*	Passion vine	Passifloraceae	Climber
132	*Passiflora edulis*	Passion fruit	Passifloraceae	Climber
133	*Peltophorum pterocarpum*	Copper Pod	Fabaceae	Tree
134	*Pennisetum polystachyon*	Mission Grass	Poaceae	Grass
135	*Phyllanthus emblica*	Indian Gooseberry	Phyllanthaceae	Tree
136	*Phyllanthus rheedei*	Keezhar nelli	Phyllanthaceae	Herb
137	*Pilea microphylla*	Artillery Plant	Urticaceae	Herb
138	*Plumeria pudica*	Fiddle Leaf Plumeria	Apocynaceae	Tree
139	*Plumeria rubra*	Velachampakam	Apocynaceae	Tree
140	*Pongamia pinnata*	Pungu	Fabaceae	Tree
141	*Portulaca oleracea*	Common purselane	Portulacaceae	Herb
142	*Pothos scandens*	Varivalli	Araceae	Climber
143	*Psidium guajava*	Common Guava	Myrtaceae	Tree
144	*Pueraria phaseoloides*	Thotta-payar	Fabaceae	Creeper
145	*Ravenia spectabilis*	Ravenia	Rutaceae	Shrub
146	*Ricinus communis*	Aavannakku	Euphorbiaceae	Shrub
147	*Ruellia tuberosa*	Meadow weed	Acanthaceae	Herb
148	*Salvinia molesta*	African payal	Salviniaceae	Herb
149	*Samanea saman*	Rain Tree	Fabaceae	Tree
150	*Saraca indica*	Ashoka Tree	Fabaceae	Tree
151	*Saribus rotundifolius*	Java Palm	Arecaceae	Tree
152	*Scoparia dulcis*	Kallurukki	Scrophulariaceae	Herb

153	*Sida acuta*	Anakurunthotti	Malvaceae	Shrub
154	*Simarouba glauca*	Lakshmitharu/ Bitterwood	Simaroubaceae	Tree
155	*Spathodea campanulata*	African Tulip	Bignoniaceae	Tree
156	*Spondias pinnata*	Ambazham	Anacardiaceae	Tree
157	*Swietenia mahagoni*	American Mahagoni	Meliaceae	Tree
158	*Syzygium cumini*	Njaval	Myrtaceae	Tree
159	*Tabernaemontana divaricata*	Nandiyarvatta/Crape Jasmine	Apocynaceae	Shrub
160	*Tecoma fulva*	Cahuato	Bignoniaceae	Shrub
161	*Tecoma stans*	Yellow bells	Bignoniaceae	Tree
162	*Tectona grandis*	Teak wood	Lamiaceae	Tree
163	*Terminalia arjuna*	Neermaruthu	Combretaceae	Tree
164	*Terminalia catappa*	Indian Almond Tree	Combretaceae	Tree
165	*Thuja arborvitae*	Pyramid tree	Cupressaceae	Tree
166	*Tradescantia spathacea*	Rheo	Commelinaceae	Herb
167	*Tragia involucrata*	Indian stinging nettle	Euphorbiaceae	Climber
168	*Tridax procumbens*	Mukkutti poovu	Asteraceae	Herb
169	*Xanthostemon youngii*	Crimson Penda	Myrtaceae	Shrub
170	*Ziziphus mauritiana*	Elentha	Rhamnaceae	Tree
171	*Ziziphus oenopolia*	Cheruthudali	Rhamnaceae	Climber

A total of 171 species representing 64 families are recorded during the rapid assessment of the campus. Fabaceae, Apocynaceae, Arecaceae and Poaceae are the dominant families among campus vegetation. More than 65 percent of the vegetation is planted as garden species or timber and shade species. Trees such as Divi-divi, Elengi, Mahagony, Teak, Poomaruthu and copper-pod are prominent on the campus. Wild and native species represents less than 20 per cent of the total plant species. Saplings of few (15%) native wild trees such as *Artocarpus heterophylla, Corypha umbraculifera, Bridelia retusa, Caryota urens, Artocarpus hirsutus*, etc. and regeneration of other wild shrubs and herbs are observed in the campus. As the rapid assessment is conducted during peak summer months, most of the grasses, seasonal ephemerals, herbal members and certain delicate creepers were dried off and not included in the list.





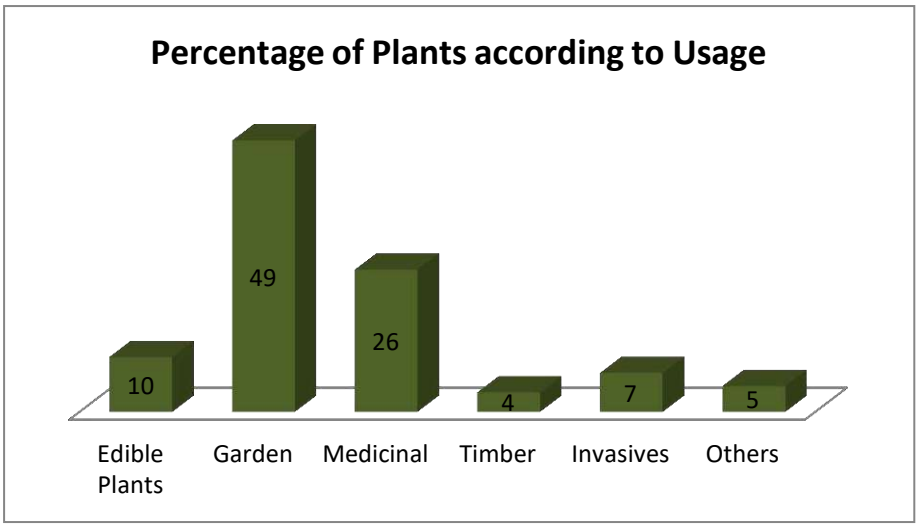


Fig. 2 Distribution status of the flora

Garden Plants

Garden plants predominate the vegetation composition of the campus. It includes rare exotic palms, creepers and flowering shrubs. About 49% of the plants belong to the exotic garden varieties, most of which are found in the famous College garden called the –*Sun Beam*.‖

Garden Plants

			
Ravenia spectabilis	***Thunbergia erecta***	***Combretum indicum***	***Combretum constrictum***
			
Pachystachys lutea	***Dracaena marginata***	***Allamanda blanchetii***	***Codiaeum variegatum***
			
Nymphaea micrantha	***Phalaris aurindinaceae***	***Tradescantia spathacea***	***Pandorea jasminoides***

Fig. 3 The common garden plants on the campus

Useful and Medicinal Plants

The campus flora includes many useful plants such as fruit yielding trees such as rambuttan, sapota, passion-fruit, guava, njaval and highly valuable timber species such as teak, rosewood, mangium, mahagony, etc. In addition to these, a good number of plants with known medicinal value are also listed from the campus. About 44 species have known medicinal value among the total 171 species. Many under-utilized edible and nutritious herbs such as *Alternanthera sp*. were also noticed among the wild growth. Saplings of native species such as Jack fruit, Anjili, Mulluvenga, Kudapana, fish-tail palm, etc, are coming around the playground area.

	
Cyperus distans	***Cardiospermum halicacabum***
	
Cyclea peltata	***Aegle marmelos***
	
Canthium angustifolium	***Glycosmis pentaphylla***

Fig. 4 Some Plants with Medicinal Value

Weeds and Invasive species

Some exotic plants tend to spread prolifically, undesirably, or harmfully and are considered invasive species or weeds. During the rapid survey, about 12 species of exotic invasive plants were spotted. Comparing to the nearby landscapes, the management of invasive species on the campus is good, and the number of weeds is restricted to the playground and parking areas only.

	
Alternanthera ficoidea	*Pueraria phaseoloides*
	
Mikania micrantha	*Eleutheranthera ruderalis*
	
Pilea microphylla	*Ruellia tuberosa*

Fig. 5 Alien and Invasive Species

Invertebrate fauna

The invertebrate fauna includes a large group of organisms, though the present assessment chose a few important groups simultaneously convenient to the rapid assessment. The butterflies and the odonates are the invertebrate fauna included in the study.

Odonates (Damselflies and Dragonflies)

Odonates are flying insects that include dragonflies and damselflies. They are important bio-indicators as well as bio-control agents of any ecosystem. The study recorded sixteen species of odonates, including damselflies and dragonflies, from the campus (Table 2). They were found along the shady, moist, and wet parts of the campus, particularly near the small ponds in the garden area. The list of species observed from the campus premises is given below:

Table 2. List of Odonates (damselflies and dragonflies)

Sl. No.	Scientific name	Common Name
A. **Damselflies**		
1	*Ceriagrion cerinorubellum*	Orange-tailed Marsh Dart
2	*Ceriagrion coromnadelianum*	Coromandel Marsh Dart
3	*Copera marginipes*	Yellow Bush Dart
4	*Pseudagrion rubriceps*	Saffron-faced Blue Dart
5	*Pseudagrion microcephalum*	Blue Grass Dartlet
B. Dragonflies		
1	*Brachythemis contaminata*	Ditch Jewel
2	*Pantala flavescens*	Wandering Glider
3	*Orthetrum sabina*	Green Marsh Hawk
4	*Orthetrum pruinosum*	Crimson-tailed Marsh Hawk
5	*Orthetrum luzonicum*	Tricoloured Marsh Hawk
7	*Trithemys aurora*	Crimson Marsh Glider
8	*Rhyothemis variegata*	Common Picture Wing
9	*Neurothemis tullia*	Pied Paddy Skimmer
10	*Bradinophyga geminate*	Granite Ghost
11	*Brachydiplax chalybea*	Rufous-backed Marsh Hawk

	
Brachydiplax chalybea	*Brachythemis contaminata* male
	
Copera marginipes - male	*Ceriagrion coromandelianum* - male
	
Rhyothemis variegata	*Neurothemis tullia*

Fig. 6 Dragonflies and Damselflies

Butterflies

Butterflies are important pollinators and colourful representatives of the biodiversity. The study recorded twenty species of butterflies from the campus. The list of observed species is given in Table 3. Due to the absence of associated native vegetation and microhabitats, the butterfly diversity observed on the campus is relatively lower than in

the nearby Mahatma Gandhi University Campus and the Kuttanad wetlands. This may be due to the paucity of many larval food plants in the campus area.

Table 3 List of butterflies

Sl.No.	Scientific name	Common Name
1	*Catopsilia pomona*	Common Emigrant
2	*Danaus chrysippus*	Plain Tiger
3	*Papilio polymnestor*	Blue Mormon
4	*Papilio polytes*	Common Mormon
5	*Eurema hecabe*	Common Grass Yellow
6	*Mycalesis perseus*	Common Bushbrown
7	*Moduza procris*	Commander
8	*Parthenos sylvia*	Clipper
9	*Ariadne aridnae*	Angled Castor
10	*Neptis hylas*	Common Sailor
11	*Junonia iphita*	Chocolate Pansy
12	*Junonia atlites*	Grey Pansy
13	*Tirumala limniace*	Blue Tiger
14	*Euploe core*	Common Crow
15	*Chilades trochylus*	Grass jewel
16	*Ypthima huebneri*	Common four-ring
17	*Euthalia aconthea*	Common Baron
19	*Graphium sarpedon*	Common bluebottle
19	*Matapa aria*	Common Redeye
20	*Udaspes folus*	Grass Demon

	
Monkey Puzzle	Grey Pansy
	
Indian Common Crow	Blue Tiger
	
Plain Tiger	Common Sailor

	
Common Baron	Common Cerulean
	
Psyche	Slate Flash
	
Small Cupid	Chocolate Pansy

Fig. 7 Some of the Butterflies in the Campus

Vertebrates

Fishes

During the assessment, only one fish species, Guppy (*Poecilia reticulate*), a common ornamental and larvicidal species, was found on the campus. It is an exotic fish introduced into the artificial tanks within the campus garden.

Reptiles

The reptiles recorded from the site include Common Garden Lizard *Calotes versicolor*, Coastal day gecko *Cnemasis littoralis*, Indian Monitor Lizard *Varanus bengalensis*, Skink sp., Common Rat-snake *Ptyas mucosus*, Wolf snake sp., etc. (Table 4). Owing to its closeness to Kuttanad wetlands many species of snakes and lizards can be found in this campus.

Fig. 8 ***Eutropis carinata***

Table 4. List of reptiles

Sl. No	Scientific name	Common Name
1	*Calotes versicolor*	Common Garden Lizard
2	*Cnemasis littoralis*	Coastal Day Gecko
3	*Hemidactylus* sp.	Gecko
4	*Eutropis carinata*	Keeled Indian Grass skink
5	*Varanus bengalensis*	Indian Monitor Lizard
6	*Ptyas mucosa*	Common Rat-snake
7	*Lycodon* sp.	Wolf snake sp.

Birds

Birds are the most important and sensitive indicators of a healthy environment. Birds were recorded based on actual sightings and calls along the four transects within the campus. A total of 45 species of birds belonging to 27 families were listed (Table 5). Blyth's Reed Warbler, Indian Paradise Flycatcher, Barn Swallow, Green Warbler, and Grey Wagtail are the migratory species recorded from the campus. Most of the species found on the campus belong to land birds, even though seven wetland and wetland-dependent species were recorded. Six migrant species were found on the campus. Two near-threatened species of birds were observed. However, being its proximity to the wetlands of Kuttanad, many wetland species can be observed flying above the campus. Compared to the bird diversity of the adjoining wetlands, the campus holds only about 20% of species recorded from the Kuttanad wetlands.

Table 5 List of birds

Sl. No.	Common name	Scientific name	Status
	Family Anatidae		
1	Lesser Whistling-Duck	*Dendrocygna javanica*	Resident
2	Cotton Pygmy-Goose	*Nettapus coromandelianus*	Resident
	Family Columbidae		
3	Rock Pigeon	*Columba livia*	Resident
	Family Cuculidae		
4	Greater Coucal	*Centropus sinensis*	Resident
5	Asian Koel	*Eudynamys scolopaceus*	Resident
6	Common Hawk-Cuckoo	*Hierococcyx varius*	Resident
	Family Apodidae		
7	Indian Swiftlet	*Aerodramus unicolor*	Resident
8	Little Swift	*Apus affinis*	Resident
	Family Phalacrocoracidae		
9	Little Cormorant	*Microcarbo niger*	Resident
10	Indian Cormorant	*Phalacrocorax fuscicollis*	Resident
	Family Anhingidae		
11	Oriental Darter	*Anhinga melanogaster*	Resident
	Family Ardeidae		
12	Cattle Egret	*Bubulcus ibis*	Local migrant
13	Little Egret	*Egretta garzetta*	Resident
14	Intermediate Egret	*Ardea intermedia*	Resident
15	Great Egret	*Ardea alba*	Resident
16	Indian Pond-Heron	*Ardeola grayii*	Resident
17	Purple Heron	*Ardea purpurea*	Resident
18	Black-crowned Night-Heron	*Nycticorax nycticorax*	Resident
	Family Threskiornithidae		
19	Black-headed Ibis	*Threskiornis melanocephalus*	Resident
	Family Accipitridae		
20	Eurasian Marsh-Harrier	*Circus aeruginosus*	Migrant
21	Shikra	*Accipiter badius*	Resident
22	Brahminy Kite	*Haliastur indus*	Resident

	Family Alcedinidae		
23	White-throated Kingfisher	*Halcyon smyrnensis*	Resident
	Family Megalaimidae		
24	White-cheeked Barbet	*Psilopogon viridis*	Resident
	Family Picidae		
25	Black-rumped Flameback	*Dinopium benghalense*	Resident
	Family Psittacidae		
26	Rose-ringed Parakeet	*Psittacula krameri*	Resident
	Family Dicruridae		
27	Black Drongo	*Dicrurus macrocercus*	Resident
28	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	Resident
	Family Monarchidae		
29	Indian Paradise Flycatcher	*Terpsiphone paradisi*	Migrant
	Family Corvidae		
30	House Crow	*Corvus splendens*	Resident
31	Large-billed Crow	*Corvus macrorhynchos*	Resident
	Family Cisticolidae		
32	Common Tailorbird	*Orthotomus sutorius*	Resident
	Family Acrocephalidae		
33	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Migrant
	Family Hirundinidae		
34	Barn Swallow	*Hirundo rustica*	Migrant
	Family Pycnonotidae		
35	Red-vented Bulbul	*Pycnonotus cafer*	Resident
36	Red-whiskered Bulbul	*Pycnonotus jocosus*	Resident
	Family Phylloscopidae		
37	Green Warbler	*Phylloscopus nitidus*	Migrant
	Family Leiothrichidae		
38	Jungle Babbler	*Argya striata*	Resident
	Family Sturnidae		
39	Common Myna	*Acridotheres tristis*	Resident
40	Jungle Myna	*Acridotheres fuscus*	Resident

	Family Muscicapidae		
41	Oriental Magpie-Robin	*Copsychus saularis*	Resident
	Family Dicaeidae		
42	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	Resident
	Family Nectariniidae		
43	Purple-rumped Sunbird	*Leptocoma zeylanica*	Resident
44	Loten‘s Sunbird	*Cinnyris lotenius*	Resident
	Family Motacillidae		
45	Grey Wagtail	*Motacilla cinerea*	Migrant

	
Brahminy Kite	**Red-whiskered Bulbul**
	
Purple-rumped Sunbird	**Common Tailorbird**

	
Jungle Babbler	**White-cheeked barbet**
	
Common Myna	**Oriental Magpie-Robin**

Fig. 9 Common birds

Mammals

Active movements of student inmates and the limited space for diverse habitats on campus naturally restrict the movements of many mammalian species. However, the proximity to the wetlands and nearby habitats, some animals temporarily visit the campus and others resides in the premises. The fruit trees of the campus may also attract palm civets, squirrels, and bat species in season. Feral cats and free-ranging dogs were also observed on the campus.

Sl. No.	Common Name	Scientific Name	Family
1.	Palm Civet	*Paradoxurus hermaphroditus*	Viverridae
2.	Grey Mongoose	*Herpestes edwardsii*	Herpestidae
3.	Jungle striped Squirrel	*Funambulus tristriatus*	Sciuridae
4.	Lesser Bandicoot-Rat	*Bandicota bengalensis*	Muridae
5.	House Rat	*Ratus rattus*	Muridae
6.	House mouse	*Mus musculus*	Muridae
7.	Indian Flying Fox	*Pteropus giganteus*	Pteropodidae
8.	Fulvous Fruit Bat	*Rousettus leschenaulti*	Pteropodidae
9.	Feral Cat	*Felis catus*	Felidae
10.	Free-ranging Dog	*Canis lupus familiaris*	Canidae

Healthy practices

- Maintenance of the rich garden with diverse flora at the entrance of the campus
- The artificial pond that attracts many dragonflies and damselflies, which also harbours many species.
- Honey bees in the houses kept in the garden area help better pollination of the flowers in the campus as well as adjacent areas.
- Wide varieties of garden plants attract many pollinators
- Large trees planted along the boundary of the playground and adjoining the building blocks

Recommendations

- The butterfly garden has to be re-structured with sufficient host plants, and proper care should be given.
- Periodic monitoring and removal of alien and invasive species is required around the ground and parking areas.
- Careful monitoring of the natural regeneration of the endemic and native species around the ground is highly recommended.
- Systematic and periodic harvesting of matured exotic trees with timber value and replanting with rare native plants is recommended.
- Members of Nature Clubs may be encouraged to contribute and update the birds, butterflies, and other faunal check lists.
- Garden wastes out of trimming and disposal of excess seedlings should be done carefully to avoid further invasion into the natural areas and the neighbourhood.
- Care should be taken to control the free-ranging, feral or stray dogs within the campus.

5. CARBON AUDIT

Experts have a growing consensus that human-generated greenhouse gas (GHG) emissions are causing climate change, which negatively affects the natural environment. The Inter-governmental Panel on Climate Change (IPCC) has released a special report outlining the importance of limiting global temperatures to 1.5°C and various temperature scenarios' economic, environmental, and social consequences. To achieve this goal, taking urgent action and reducing global GHG emissions by 45% below 2010 by 2030 is crucial, ultimately reaching net-zero emissions by 2050. This requires a collaborative effort from governments and the public to bring about necessary changes in all areas of society.

Many educational institutions worldwide have recognized the need to limit their environmental impact and have implemented measures to become more sustainable. Educational institutions have a share in greenhouse gas emissions and the subsequent

impacts of climate change. Therefore, it is essential to accurately assess their carbon footprints by conducting efficient carbon audits to account for their institutional GHG emissions.

The role of colleges in carbon auditing

Environmental Responsibility: Colleges have responsibility for mitigating climate change. Carbon auditing helps institutions understand their greenhouse gas emissions and identify areas where they can reduce their carbon footprint.

Setting Targets and Monitoring Progress: By conducting carbon audits, colleges can establish baseline emissions data and set targets for emissions reduction. Regular auditing allows them to monitor their progress, identify trends, and make informed decisions on implementing sustainability measures.

Educational Opportunity: Carbon auditing allows educational institutions to raise awareness about climate change and sustainability among students, faculty, and staff. It can be incorporated into curriculum and research, fostering a culture of environmental stewardship.

Cost Savings: Identifying and reducing carbon emissions have cost benefits. Energy efficiency measures, waste reduction, and sustainable transportation options can help reduce operational expenses in the long run.

Reputation and Stakeholder Engagement: Public perception and stakeholder expectations are increasingly focused on environmental sustainability. Colleges can enhance their reputation as environmentally responsible institutions by conducting carbon audits and implementing emission reduction strategies. It can also engage the college and the local community in sustainability efforts.

Regulatory Compliance: Carbon auditing can help colleges comply with environmental regulations and reporting requirements imposed by governments and accrediting bodies. It ensures transparency and accountability in terms of carbon emissions.

College carbon auditing is vital for measuring, managing, and reducing greenhouse gas emissions. It supports environmental stewardship, aligns with educational goals, and contributes to the broader global efforts in addressing climate change.

Carbon footprint refers to the potential impact on global warming resulting from the direct emissions of greenhouse gases (GHGs). The primary GHG contributing to global warming is carbon dioxide (CO_2), accounting for approximately 30% of GHG emissions. Other significant GHGs include methane (CH_4) and nitrous oxide (N_2O). GHG emissions are often measured in carbon dioxide equivalent (CO_2-eq) or Global Warming Potential (GWP), which combines the radiative forcing capacity and the duration of GHGs in the atmosphere.

Educational institutions need to disclose their carbon footprint as it allows them to identify the sources and sinks of emissions and determine the most effective mitigation measures for carbon reduction. By conducting a carbon footprint assessment, educational institutes can identify the areas on campus that contribute the most to emissions and implement immediate mitigation strategies. Furthermore, assessing the carbon footprint of an educational institution supports the transition to a more sustainable campus and fosters an environmentally conscious student community. In summary, identifying the carbon footprint of an educational institution is crucial for understanding emissions sources, implementing effective mitigation measures, and creating a more sustainable campus environment. It also plays a significant role in promoting environmental awareness among the college community.

Limitation

The lack of precise data on factors like travel details, newly installed devices, and the floating population on campus is a significant limitation when calculating the carbon footprint of an educational institution. The accuracy of the carbon footprint assessment relies on the information provided by the institution, and any missing data can result in omissions during the evaluation. To overcome this challenge, a methodology is followed for calculating the carbon footprint, involving several steps.

Methodology

Several steps are followed to calculate an institution's carbon footprint, including considering the institution's context, establishing a framework for calculation, and identifying environmental aspects. Following the ISO 14001 standard, it is crucial to identify activities that could have negative environmental effects, such as resource depletion, waste generation, water pollution, and increased emissions. The significant

environmental aspects identified in the carbon footprint assessment include the consumption of various resources like water, energy, and materials, as well as waste generation, including non-hazardous (e.g., paper, packaging) and hazardous waste (e-waste, chemicals). Regarding calculation boundaries, the carbon emission assessment is conducted for the entire campus, considering all relevant departments. Primary and secondary sources of carbon emitters are identified through on-site visits, consultations, data gathering from official records, and other sources.

The assessment follows the GHG protocol, which includes three scope definitions:

Scope 1: Accounting for direct GHG emissions from campus-owned facilities.

Scope 2: Accounting for indirect GHG emissions from electricity consumption.

Scope 3: Accounting for other indirect GHG emissions not covered by scope 1 or 2.

To calculate CO_2 emissions, activity data (e.g., electricity consumption, fuel usage) is multiplied by conversion factors to obtain values in kilograms of CO_2 equivalent ($kgCO_2e$). Emission factors from national and international standards are utilized, and missing information provided by the institution is omitted during the assessment. Conversion factors are used to calculate CO_2 emissions by converting activity data into $kgCO_2e$. These factors consider the global warming potential (GWP) of CO_2 and are selected based on criteria such as accessibility, consistency, and transparency in revisions and updates.

GHG (kg CO_2e) = aspect quantity data X conversion factor

In summary, the carbon footprint calculation involves understanding the institution's context, establishing a framework, identifying environmental aspects, and applying conversion factors to calculate CO_2 emissions. The process follows the ISO 14001 standard and considers various scopes of emissions

Observations and findings

1. Scope 1

The Scope 1 assessment revealed that the annual equivalent CO_2 emission from fuel consumption on the campus was estimated to be 7.4 TCO_2. The majority of GHG emissions were attributed to the usage of LPG. Specifically, LPG consumption accounted for a significant portion of the annual equivalent emissions, totaling 4.02

TCO_2. Diesel is primarily used in diesel generators to provide backup power during power cuts, ensuring the uninterrupted functioning of campus activities.

Table 1 Energy consumption and equivalent Carbon emissions

Sl. No	Particulars	Annual consumption	Emission Factors with Unit	Annual Eqvt. CO_2
1	LPG consumption (kg)	1297.6	0.0031 (tCO_2e/kg)	4.02
2.	Diesel & petrol consumption (kg)	1056	0.0032 (tCO_2e/kg)	3.37
Total				**7.40**

Table 2 Summary of energy consumption

Annual electricity consumption	66005 kWh
Annual diesel consumption	1056 Litres
Annual LPG consumption	1297.6 kg

2. Scope 2 Emissions

Within the Scope 2 emission category, the most significant contribution to GHG emissions was from the total electricity consumed by the campus. The annual electricity consumption was approximately 66,005 kWh, resulting in an estimated emission of 54.1241 TCO_2 for the specific year under consideration. It was observed that the highest GHG emissions occurred during the active academic period, primarily due to electricity consumption. However, it is noteworthy that the campus has made efforts to reduce electricity consumption by implementing solar panel installations, which has led to a significant decrease in overall electricity usage.

3. Scope 3 Emissions

The Scope 3 emissions assessment for K.E College considered the commuting activities of students, teachers, and non-teaching staff, as well as the college's total vehicular fleet. Over five days, the observations revealed that the college had a total of 884 conventional vehicles, out of which 12 were electric vehicles, representing approximately 1.2% of the total vehicle composition. During peak hours, an average of 168 two-wheelers (regular staff) and 7 two-wheelers (visitors) were observed. For four-wheelers, there were 169

regular vehicles and 27 visitor vehicles. The number of electric vehicles noted was minimal, with only 2 observed. To accurately estimate the carbon footprint of commuting activities and the vehicular fleet, additional information such as average daily mileage, fuel efficiency, and fuel type of the vehicles are needed. Without this data, it is challenging to calculate CO_2 emissions precisely. However, the college has implemented measures to manage vehicular inflow into the campus effectively.

In terms of waste generation, including food, paper, and plastic, it contributed 0.69 TCO2 emissions, a negligible proportion of the overall CO_2 emissions on the campus. K.E College maintains a well-operated waste management system that effectively utilizes biodegradable wastes such as food waste, sweepings, and garden waste. These wastes are efficiently used as substrates for compost and biogas production, reducing the environmental impact associated with waste disposal.

4. CARBON EMISSION PROFILE 2022-23

The carbon emissions from the various activities of the entire campus are calculated and discussed as follows.

Table 3 Carbon Foot Print (2022-23)

Sl. No	Particulars	Consumption	Tonnes of CO_2e
1	Annual Electricity Consumption (kWh)	66005	54.1241
2	Annual LPG Consumption (kg)	1297.6	4.02
3	Annual Diesel Consumption (kg)	1056	3.168
4	Food Waste (kg/yr)	4980.15	3.14
5	Paper Waste (kg/yr)	963.9	0.54
6	Plastic waste (kg/yr)	434.7	0.15
	Toral Carbon Foot Print (tCO_2e/yr)	**65.1421**	

Table 4 Emission Factors		
Item	**Factor**	**Unit**
LPG	0.0031	tCO_2e/kg
Electricity	0.00082	tCO_2e/kWh
Diseal	0.0032	tCO_2e/kg
Food waste	0.00063	tCO_2e/kg
Paper Waste	0.00056	tCO_2e/kg
Plastic waste	0.00034	tCO_2e/kg

The carbon emission profile of K.E College for the year 2022-23 is summarized as follows:

- *Annual Electricity Consumption*: The college consumed 66,005 kWh of electricity, producing approximately 54.1241 tonnes of CO_2e emissions.
- *Annual LPG Consumption:* The college used 1,297.6 kg of LPG, contributing approximately 4.02 tonnes of CO_2e emissions.
- *Annual Diesel Consumption:* The college consumed 1,056 kg of diesel, producing approximately 3.168 tonnes of CO_2e emissions. Diesel was primarily used in generators for backup power during power cuts.
- *Food Waste:* The college generated 4,980.15 kg of food waste, contributing approximately 3.14 tonnes of CO_2e emissions. Effective waste management practices were implemented to utilize this waste for compost and biogas production.
- *Paper Waste:* The college produced 963.9 kg of paper waste, producing approximately 0.54 tonnes of CO_2e emissions. Proper waste management and recycling measures were in place to minimize the environmental impact of paper waste.
- *Plastic Waste:* The college generated 434.7 kg of plastic waste, contributing approximately 0.15 tonnes of CO_2e emissions - appropriate waste management practices aimed to reduce plastic waste and promote recycling.

The total carbon footprint of K.E College for the year was calculated to be approximately **65.1421** tonnes of CO_2e. It is important to note that these figures represent the emissions associated with various activities on the campus and provide a baseline for assessing the College's environmental impact. Measures can be implemented to reduce carbon

emissions through energy conservation, waste reduction, and promoting sustainable practices across the campus.

5. CARBON SEQUESTRATION

The Kyoto Protocol, implemented in 1997 under the United Nations Framework Convention on Climate Change (UNFCCC), aims to reduce greenhouse gas (GHG) emissions by setting binding targets at the country level. Carbon sequestration involves capturing and storing atmospheric CO_2 for the long term, which is crucial for mitigating significant GHG emissions, especially CO_2, and combating global warming and climate change, as recognized by the IPCC.

Carbon capture and storage (CCS) technology plays a crucial role in carbon sequestration by capturing, transporting, and storing carbon emissions through photosynthesis to create "carbon sinks." The objective is stabilizing carbon in stable forms, preventing its contribution to atmospheric warming. CCS has promising potential in reducing the carbon footprint, and emission trading schemes, such as the one implemented by the European Union following the Kyoto Protocol, enable organizations to offset their emissions liabilities through various methods, including carbon sequestration and has led to a new "carbon economy" within the private sector.

The private and public sectors increasingly recognize the importance of managing carbon emissions. Colleges can adopt carbon sequestration as part of their sustainability approach to offset carbon emissions. This approach can be more cost-effective compared to offsetting through third-party payments. However, it is essential to note that carbon sequestration in trees and soils alone may not be sufficient and should be complemented with other tools to manage carbon footprints effectively. Colleges face both pressures and opportunities regarding sustainability practices due to their public funding and the awareness of sustainability issues among students and staff, some of whom specialize in sustainability.

a. Normalised Difference Vegetation Index (NDVI)

The Spectrally-based Normalized Difference Vegetation Index (NDVI) derived from RS platforms, is a standard indicator for monitoring biophysical conditions and vegetation cover. NDVI is computed using the following formula:

NDVI= (NIR-Red) / (NIR+Red)

b. Estimation of change in Carbon sequestration potential and Carbon dioxide emission

Carbon sequestration is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide. The Carbon sequestration potential of the study area can be estimated through the regression equation of the carbon storage and the vegetation index:

$$\textbf{Carbon} = 107.2e^{(\text{NDVI} \times 0.0194)}$$

The Quantification of CO_2 is done by multiplying carbon storage by 3.67; it is the ratio between Carbon dioxide mass and Carbon mass.

c. Estimation of above-ground biomass

The above-ground biomass is estimated as doubled the value of Carbon.

The primary carbon sinks of the campus identified are:

- **VEGETATION**

The College recognizes the potential of vegetation and related biomass carbon in offsetting its carbon footprints through increased carbon sequestration. The Sunbeam Garden and its diverse collection of ornamental and medicinal plants showcase the college's understanding of the importance of vegetation on the campus. The college also pays special attention to filling unconstructed barren areas with green cover, creating spaces that the college community can utilize. Students have taken the initiative to plan, design, and plant various plants in this space while preserving the natural surroundings.

The College campus spans 7.23 acres (approximately 2.9 hectares), with a notable portion of 4965 sq. m. adorned with abundant green vegetation. It has been determined through calculations that the area holds approximately 307.4 tons of standing biomass, contributing 153.97 tons of biomass carbon.

It may be noted that the presence of large trees on the campus contributes to significant carbon storage, with one ton of carbon in a tree representing the removal of 3.67 tons of carbon from the atmosphere and the release of 2.67 tons of oxygen back into the atmosphere. The campus's luxuriant vegetation, particularly the large tree species, is vital in sequestering carbon. Carbon sequestration involves capturing and storing atmospheric carbon dioxide, and the analysis reveals that the campus's present vegetation carbon pool acts as a major carbon sink, contributing to substantial CO_2 reduction. Leveraging the sequestered carbon in the existing biomass and promoting the planting of new biomass can further reduce the campus's carbon footprint.

Integrating remote sensing and GIS technology has provided a novel approach for assessing biomass and carbon stocks in the above-ground layer of vegetation. Estimating biomass and carbon accumulation in the campus's vegetation cover is valuable, serving as a tool for nature-focused management and a crucial foundation for evaluating the campus's carbon status. Furthermore, these results offer practical solutions for monitoring and managing the existing carbon stocks on campus, with the ultimate goal of working towards its carbon-neutral status.

Healthy practices

Installation of Solar Photo Voltaic (SPV) System

As a best practice, the K. E campus implemented a 20 kW grid-connected solar power plant in 2019. The solar panels were installed on the rooftop of the building, following the guidelines provided by ANERT. The campus successfully generated 4,050 kW of electricity from April 2022 to March 2023, with an average monthly production of 338 kW. This solar power generation initiative has allowed the campus to decrease its dependence on conventional electricity sources and positively contribute to clean, sustainable energy usage and reduced carbon emission.

Biogas plant installation

Biogas technology plays a significant role at the K.E campus, providing a sustainable solution for waste management and renewable cooking fuel. The campus's biogas unit can process 6-7 kg of waste daily, generating enough gas to fuel a burner for approximately 4 hours. This helps in efficient waste management and reduces greenhouse gas emissions. Furthermore, the organic waste residue from the biogas

production process is utilized as valuable nutrients in the campus garden, enhancing soil fertility. Using biogas technology, K.E campus creates a closed-loop system where waste is effectively managed, energy is generated, and resources are utilized sustainably.

Organic farming course and related farming activities

The Certificate course in organic farming sanctioned to the Commerce Department and Economics Department under the National Skills Qualification Framework (NSQF), emphasizes the importance of substantial carbon sequestration in biomass and soil. The campus has designated a specific area for cultivating elephant yam using organic farming practices as a practical implementation. These methods promote sustainable agriculture and contribute to the sequestration of carbon in both the biomass of the plants and the soil, thereby supporting the campus's commitment to environmental stewardship.

Gardening and related activities

The College campus promotes planting tree saplings during special occasions, effectively increasing the vegetation carbon pool. Additionally, the extensive gardening activities, particularly in the sunbeam garden, contribute to the carbon content of the standing biomass on the campus. The sunbeam garden, known for its high plant diversity, is crucial in sequestering soil and biomass carbon. These efforts further enhance the campus's commitment to carbon sequestration and sustainability.

Green classroom programme

The College has implemented a Green Classroom program in its sustainable initiatives. This program focuses on providing outdoor spaces that link education with nature. A specific area under the shade of trees has been identified and transformed into a green classroom. Students actively participate in planning, designing, and planting various plants in this space, ensuring minimal disturbance to the natural surroundings that support carbon sequestration.

Plastic ban

The college has implemented various measures to combat plastic pollution and promote waste reduction, recognizing the significant impact on carbon emissions and the environment. Plastics are segregated and given to scrap vendors or the Haritha Karma Sena, diverting them from regular waste streams and ensuring proper disposal or recycling. The installation of pen drop boxes and displaying boards throughout the

campus promote the principles of the 3Rs (Reduce, Reuse, and Recycle), raising awareness and encouraging sustainable habits among the college community.

In addition to waste reduction efforts, the college conducts programs and awareness campaigns about the dangers of plastic pollution and the importance of reducing plastic usage. By increasing awareness, the college fosters a sense of responsibility and empowers individuals to make conscious choices that reduce their carbon footprint. Substituting traditional flex banners with cloth materials and eco-friendly decorations further reduces reliance on plastic-based materials and their associated carbon emissions. The college's holistic approach to plastic ban and waste reduction contributes significantly to carbon emission reduction. Furthermore, sustainable alternatives and eco-friendly practices are embraced, minimizing carbon emissions.

Overall, the college's initiatives align with global sustainability goals and inspire positive change within the College community and beyond. Through their efforts, the college creates a healthier environment, reduces carbon emissions, and sets an example for responsible waste management. By promoting waste reduction, recycling, and conscious consumption, the College plays a crucial role in combating climate change and creating a more sustainable future.

Recommendations

To achieve a low carbon footprint in a college setting, here are some recommendations:

- Energy Efficiency: Implement energy-efficient measures across the campus, such as using LED lighting, installing energy-efficient instruments and appliances, and ensuring proper building insulation. Encourage students and staff to turn off lights and electronic devices when unused.
- Renewable Energy Sources: Invest more in renewable energy sources like solar panels to generate clean energy for the college. Consider partnerships with local renewable energy providers or explore the possibility of on-site energy generation.
- Waste Management: Establish a comprehensive waste management system that includes recycling, composting, and properly disposing hazardous materials. Educate students and staff about reducing waste and encourage them to recycle and compost.

- Sustainable Transportation: Encourage using sustainable transportation methods by providing bike racks, promoting carpooling or public transportation, and offering incentives for students and staff to use greener transportation options. Develop pedestrian-friendly pathways within the campus.
- Green Building Design: Incorporate sustainable design principles when constructing or renovating buildings on campus. Use eco-friendly materials, optimize natural lighting, and ensure proper insulation and ventilation. Consider obtaining green building certifications such as LEED (Leadership in Energy and Environmental Design).
- Education and Awareness: Integrate sustainability education into the curriculum across various disciplines. Organize awareness campaigns, workshops, and seminars to promote environmentally conscious behavior and highlight the importance of reducing carbon footprints.
- Water Conservation: Implement water-saving measures such as low-flow faucets, toilets, and showerheads. Encourage water conservation practices among students and staff, such as reporting leaks and avoiding unnecessary water usage.
- Green Procurement: Establish a procurement policy prioritizing environmentally friendly products and services. Give preference to suppliers that have sustainable practices and reduce the consumption of single-use plastics on campus.
- Campus Green Spaces: Develop and maintain more green spaces, such as gardens and parks. These areas can serve as educational spaces and provide benefits like improved air quality, biodiversity, and recreational opportunities.
- Monitoring and Reporting: Implement a system to track and measure the College's carbon footprint regularly. Set targets and benchmarks to monitor progress over time. Publish annual sustainability reports to promote transparency and accountability.

In order to achieve a low carbon footprint requires the collective effort of the entire college community, including students, staff, and administration. Continuous engagement, education, and collaboration are essential to creating a sustainable campus environment.

IV
GREEN INITIATIVES & OUTREACH PROGRAMMES

Green initiatives in colleges are of utmost importance today, where environmental issues are becoming increasingly pressing. These initiatives are a powerful tool for colleges to demonstrate their commitment to environmental stewardship and sustainability. By implementing green practices, Colleges can take the lead in inspiring their students, faculty, and the wider community to adopt eco-friendly behaviors. One significant aspect of green initiatives in colleges is their contribution to mitigating climate change. Colleges can significantly reduce their carbon footprint by reducing energy consumption, promoting renewable energy sources, and implementing sustainable transportation solutions. This helps combat climate change and sets a positive motivation for students,

encouraging them to make environmentally conscious choices in their personal and professional lives.

Education and awareness are critical components of green initiatives in colleges. Colleges have a unique opportunity to educate and engage their students on environmental issues through sustainability courses, workshops, and awareness campaigns. By providing a platform for learning and discussion, colleges can raise awareness about the importance of sustainable practices and empower students to become environmental advocates.

Resource conservation is another crucial aspect of green initiatives in colleges. Implementation of energy-efficient measures, water-saving technologies, and waste-reduction strategies can significantly reduce resource consumption and promote a more sustainable campus. These efforts contribute to a healthier environment and result in long-term cost savings for the college.

Green initiatives in colleges also foster student engagement and empowerment. By involving students in sustainability initiatives, colleges provide them with hands-on learning experiences and opportunities for leadership development. Students can actively participate in green projects, contribute ideas, and develop critical thinking and problem-solving skills to address complex environmental challenges.

The impact of green initiatives can extend beyond the campus. Colleges can serve as catalysts for positive change in their surrounding communities. Colleges can motivate the community to adopt sustainable practices that contribute to a more eco-friendly society by organizing outreach programs, collaborating with local organizations, and engaging with government agencies.

Furthermore, colleges that prioritize green initiatives are more likely to attract and retain environmentally conscious students. With the growing awareness of environmental issues, many students actively seek colleges that align with their sustainability values. By showcasing their commitment to green practices, colleges can create a positive reputation and become an attractive choice for prospective students. Collaboration and partnerships are essential for the success of green initiatives in colleges. Colleges can leverage collective knowledge, resources, and expertise by working with local organizations, government agencies, and businesses. These collaborations enhance the

effectiveness of green initiatives and foster a sense of community and shared responsibility for sustainability.

The K.E College has implemented a green protocol based on the guidelines set by the Haritha Kerala Mission, Government of Kerala. The campus offers essential facilities like purified drinking water and uninterrupted power supply, with an energy-saving solar power plant support. The campus's cleanliness and the college garden's maintenance are taken care of by a dedicated team. Integrated water, energy, and waste management systems are in place, including rainwater harvesting, a biogas plant, a solar power plant, and a vermicomposting unit. Additionally, the campus boasts scenic attractions such as Chavara Park, Stone Park, and Sunbeam Garden.

Various cells and clubs, such as the Bhoomitrasena Club, Nature Club, Energy Club, NSS, and ENCON Club, have initiated programs to promote environmental appreciation and actively engage students in environmental conservation activities. The principal activities of the college towards fostering a green culture are highlighted below.

SUSTAINABLE ENERGY INITIATIVES

1. Energy Conservation Awareness Programme at schools in Idukki Dist

On November 23 and 24, 2022, the Department of Physics with Applied Electronics held a two-day energy-saving awareness campaign for school students in Idukki District. The Department faculty members visited 13 schools in Idukki District to create awareness among students on conserving energy and the various methods they could adopt to reduce electricity consumption. 800 Students from 13 Schools participated in the program.

Fig. 1 Energy Conservation Awareness Programme at schools in Idukki

2. A one-day workshop on ―Decoration Lights‖

On December 15, 2022, the Department of Physics with Applied Electronics, in collaboration with the IEDC, IIC, and E.D. Club, held a one-day workshop on "Decoration Lights" in Electronics Lab Room No. 304 at Kuriakose Elias College, Mannanam. The session seeks to raise student understanding of LED lights' efficiency and lower power usage as compared to traditional lighting, such as fluorescent and incandescent lights. Less energy use lessens the demand for energy from power plants while lowering greenhouse gas emissions. It also attempts to equip students with skill training.

The training course was started by Prof. Dr. Ison V. Vanchipurackal, Principal of the College, while Mr. Anish Kumar P.S., Assistant Professor of Physics with Applied Electronics, acted as the resource person. Twenty-one students from various disciplines attended the program. The program helped participants to comprehend the need to utilize energy-efficient and low-power LED lights and acquaint themselves with the bulbs' components and construction.

On December 15 and 20th, the decorated lights were sold to K.E College students and employees. These lights were also shown at the IEDC and IIC's Christmas stand on December 23, 2022. Staff and students supported the endeavor by purchasing decorative lights.


INNOVATION AND ENTREPRENEURSHIP DEVELOPMENT CENTRE
INSTITUTION'S INNOVATION COUNCIL
KURIAKOSE ELIAS COLLEGE, MANNANAM
DEPARTMENT OF PHYSICS WITH APPLIED ELECTRONICS
IN ASSOCIATION WITH
IEDC, IIC & ED CLUB
CONDUCTS
ONE DAY WORKSHOP ON DECORATION LIGHTS
15th Dec 2022, Thursday
Resource Person
Mr. Anish Kumar P. S
Assistant Professor
Dept. of Physics with Applied Electronics
Mr. Anish Kumar P. S is proficient in designing and making Electronic Circuits with more than 15 years of experience.
Prof. Dr. Issac Y. Vanchipurackal (Principal)
Fr. Dr. Xavier C.S (Vice Principal)
Fr. Biju Thomas Thekkekuttu (Bursar cum Director)
Prof. Johnny Thomas (Executive Co-ordinator(S.F))
Co-ordinators
Ms. Deepthi S. Nair (HOD, Physics with AE)
Dr. Mercy Mathews (IIC & IEDC Nodal Officer)
Ms. Divya Joseph (ED Club Co-ordinator)
Ms. Sunu Ann Thomas, Ms. Sruthy S, Mr. Manu P Rajan (Dept. IEDC Co-ordinators)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Lat 9.643632°
Long 76.51891°
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KURIAKOSE ELIAS COLLEGE, MANNANAM
DEPARTMENT OF PHYSICS WITH APPLIED ELECTRONICS
IN ASSOCIATION WITH
IEDC, IIC & ED CLUB
Decoration Lights for Sale
Single colour lights
50 LEDs, 12 m
Price: Rs 270
Blinking Multi colour lights
50 LEDs, 12 m
Price: Rs 280
LED Bulbs
9 W Bulbs
Price: Rs 70
If interested, please contact us:
Whatsapp no: 9446089653
(GPay available)


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Fig. 2 A one-day workshop on Decoration Lights and Sale

3. Solar panel and power generation

To harness renewable energy and reduce dependence on traditional power sources, the College has installed solar panels on its rooftop. With a combined capacity of 20 k.w., these solar panels efficiently capture solar energy and convert it into electricity. The generated electricity is then fed into the Kerala State Electricity Board power grid.

This initiative has proven to be successful in meeting a significant portion of the campus's energy requirements. The solar power generated from the panels accounts for approximately 30% of the total energy needs of the College. By utilizing solar energy, the College reduces its carbon footprint and contributes to the campus's sustainable development.

The installation of solar panels demonstrates the College's commitment to embracing clean and renewable energy sources. It serves as a positive example for other institutions and promotes the adoption of solar power as a viable and environment-friendly alternative to traditional electricity generation.

Fig. 3 Solar panel installed

WASTE MANAGEMENT

The College has established a segregated campus waste collection and management system. Prominent billboards with slogans like "Green Campus, Clean Campus" are displayed in key areas to motivate students and staff to adopt green practices. The College takes measures to maintain organic and green surroundings using effective methods. Waste generated on the campus is segregated into different bins based on color codes. The non-biodegradable waste is collected by Haritha Karma Sena personnel on a monthly basis for recycling purposes.

Fig. 4 Wate management scenario of K.E college

1. Vermicomposting

The waste materials generated from plants and garden maintenance, such as leaves, trimmings, and other organic matter, are collected and deposited into a vermicompost unit. This unit is specifically designed to facilitate the decomposition process with the help of worms. The worms consume the organic waste, breaking it down into nutrient-rich compost through their natural digestive process. The resulting vermicompost is a valuable organic fertilizer that is utilized in the campus garden of K.E College. By utilizing the compost, the College is able to enhance the soil quality, promote plant growth, and maintain the greenery of the campus in an eco-friendly and sustainable manner

Fig 5. Vermicomposting Unit

2. Biogas production

To efficiently manage food waste generated in the college canteen, K.E College has implemented a biogas plant. The food waste is collected and processed in the biogas plant, where it undergoes anaerobic digestion. The biogas produced in the plant serves as a renewable energy source. It is utilized to reduce the consumption of L.P.G. in the college canteen. By using biogas as a cooking fuel, the College significantly reduces its dependence on fossil fuels and contributes to greenhouse gas emissions reduction. Apart from generating biogas, the by-products of the anaerobic digestion process, known as digestate or bio-slurry, are produced. This digestate is a nutrient-rich organic manure. The College utilizes this by-product as an organic fertilizer for the campus garden. By recycling the food waste in the biogas plant and utilizing the by-products as organic manure, K.E College ensures a closed-loop system where waste is effectively managed, energy is generated, and resources are utilized sustainably.

Fig. 6 Biogas Plant

3. Incinerator

To facilitate efficient trash disposal on the college campus, the college administration has installed three incinerators. These incinerators are responsible for the proper and scientific disposal of garbage collected from various premises within the campus. The incinerators are specifically designed to handle solid waste, including sanitary napkins, which can be a challenge to dispose of properly. The periodic collection of garbage ensures that waste is properly managed and not allowed to accumulate on the campus. With the installation of the incinerators, the College ensures that the waste is disposed of in a controlled and environmentally friendly manner, minimizing the potential negative impact on the surroundings.

Furthermore, the College has taken steps to address the needs of women on campus by providing a sanitary pad vending machine in the women's hall. This initiative aims to promote hygiene and convenience for female students and staff. By implementing the same the College demonstrates its commitment to maintaining a clean and hygienic campus environment while also addressing the specific waste disposal needs of its community members.

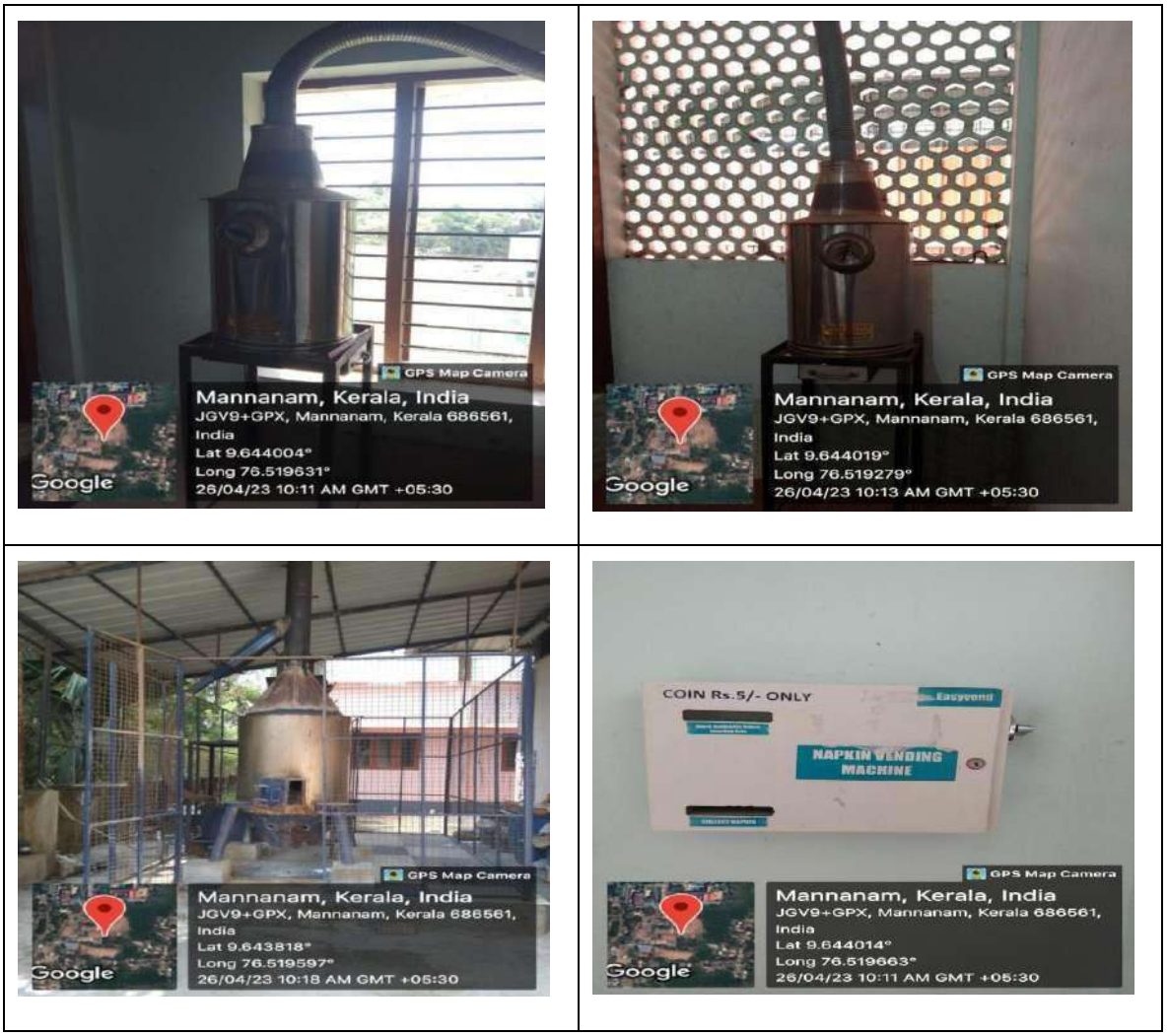


Fig. 7 Incenerators and napkin vending machine in the campus

4. Plastic waste managment

The College has implemented a systematic approach to manage plastic waste on the campus. Plastic waste is segregated and handed over to scrap vendors or Haritha Karma Sena, a group involved in waste management. Additionally, two pen drop boxes have been installed in the college building to encourage students to dispose of their used pens responsibly. The collected pens are then sent for recycling, promoting the reuse of materials.

To raise awareness and promote waste reduction practices, display boards emphasizing the principles of the 3Rs (Reduce, Reuse, and Recycle) are placed around the campus. These boards serve as reminders to the college community to actively reduce plastic waste, find ways to reuse items, and participate in recycling initiatives.

The College also conducts programs and campaigns to educate students about the environmental threats posed by plastic pollution. These initiatives aim to instill a sense of responsibility and encourage students to take action to reduce plastic usage and its impact on the natural environment.

In an effort to minimize the use of plastic-based materials, the College has made conscious choices in its daily operations. For instance, traditional flex banners have been substituted with cloth materials that are more eco-friendly. Additionally, eco-friendly materials are preferred for decorations, further reducing the reliance on single-use plastics.

By implementing these measures, the College demonstrates its commitment to plastic waste management, creating a campus environment that promotes responsible consumption, waste reduction, and a sustainable approach to plastic usage.

Main Building

Self Financing Block

Fig. 8 Pen drop boxes

Fig. 9 Awareness on waste management on the campus

5. E-waste management

The College has implemented a comprehensive approach to managing electronic goods, prioritizing sustainability and practical learning opportunities. When electronic goods experience minor issues, the staff members generally take the responsibility for repairing them. The College has partnered with Zion consultants for more significant repairs, who provide annual maintenance services and handle electronic waste disposal since June 2, 2015.

During practical sessions, the Computer Maintenance and Hardware course uses damaged computers to teach students about computer maintenance and hardware troubleshooting. This hands-on approach enables students to gain practical skills and understanding of the inner workings of computers.

Furthermore, during lab sessions, students are given electronic and electrical instruments under repair to dismantle and reassemble. This practice-oriented learning helps students develop application-oriented skills and enhances their understanding of electronic devices.

The College opts for buyback options to stay updated with technology rather than purchasing new machines. This approach allows for technology upgrades while minimizing waste and reducing the environmental impact associated with the disposal of outdated equipment. Any gadgets or electronic goods not currently used are kept in a dedicated storage room. This storage approach ensures that these items are properly stored and can potentially be utilized in the future, promoting resource efficiency and minimizing unnecessary purchases.

Overall, the College's approach to managing electronic goods showcases a commitment to sustainability, practical learning, and responsible e-waste disposal. Other organizations can learn from their comprehensive strategy to minimize waste, promote practical education, and stay current with technological advancements.

WATER CONSERVATION AND MANAGEMENT

1. Water Resources and conservation structures

a) Rainwater harvesting Unit

K.E. College has implemented a rainwater harvesting unit on its campus to collect and store rainwater effectively. This system efficiently captures rainwater from various surfaces, such as rooftops, and channels it into a dedicated tank with a substantial capacity of 100,000 liters. The primary objective of this rainwater harvesting system is to minimize the college's reliance on groundwater and other external water sources. By harnessing the power of nature, K.E. College ensures the sustainable utilization of rainwater, a valuable resource that would otherwise go to waste. The collected rainwater can be utilized for various purposes within the campus, including irrigation, cleaning, and other non-potable water requirements. This initiative helps conserve water and promotes responsible water management practices within the college community.

The rainwater harvesting unit is a significant step towards achieving water self-sufficiency and reducing the environmental impact of excessive water consumption. By implementing such measures, K.E. College sets an example for others, highlighting the importance of utilizing natural resources efficiently and embracing sustainable practices for a greener future.

Fig. 10 Rain water harvesting structures

(b) Open Well

K.E. College recognizes the value of traditional water sources and has embraced open wells on its campus. These wells have stood the test of time and continue providing reliable water sources. With two functioning wells, the College can harness this natural

resource to meet its water needs while reducing dependence on other external water sources. By utilizing open wells, the College promotes sustainable water use and embraces the rich cultural heritage associated with these traditional water sources.

(c) Bunds

The College understands the importance of water conservation and has implemented the construction of bunds in its surroundings. Bunds serve as barriers that help capture and retain water, particularly during the rainy season. By doing so, they facilitate the percolation of water into the ground, allowing it to recharge groundwater sources. This helps replenish the local groundwater levels and promotes sustainable water use in the surrounding area. Through the construction of bunds, K.E. College actively contributes to water conservation efforts and demonstrates its commitment to responsible environmental stewardship.

Fig. 11 Bunds

6. Water purification system

The College has invested in a water purification plant to ensure the availability of clean and safe drinking water on campus. This plant utilizes advanced filtration technologies to treat the water and remove impurities. It consists of a multigrade sand filter, which helps remove larger particles and sediment. An iron removal filter is incorporated to eliminate any iron content in the water. Finally, an activated carbon filter is used to remove organic compounds and improve the taste and odor of the water. By operating this water purification plant, the College prioritizes its students' and staff's health and well-being by providing them with access to high-quality drinking water.

Fig. 12 Water purification system

(e) Water Purifiers

In order to ensure clean drinking water, water purifiers are installed throughout the campus.

Main building second floor

Main Building First Floor | **Principal's Office**

	
Visitors loung	**Ground Floor**
	
Boys Hostel	**Self Financing Block**
	
Canteen	

Fig. 13 Water purifiers installed in various location of the cmapus

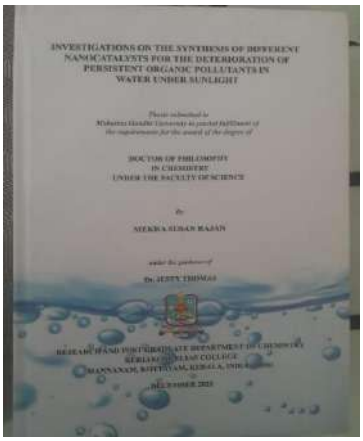
(f) Monitoring of Water Quality

The College is equipped with a water analysis facility that regularly monitors water quality on campus and in nearby areas. This facility utilizes a water analyzer, allowing for comprehensive water parameter testing. The analysis includes assessments of factors such as pH levels, dissolved solids, microbial content, and chemical contaminants. By conducting these routine tests, the College ensures that the water consumed on campus meets the prescribed quality standards set by Indian regulations.

(g) Academic initiatives for water quality management

The College's Research and Postgraduate Department of Chemistry focuses on various research areas, including water quality management. A noteworthy research study titled "Investigations on the Synthesis of Different Nanocatalysts for the Deterioration of Persistent Organic Pollutants in Water under Sunlight" was completed and submitted in December 2022. This research project delved into synthesizing and characterizing innovative nano semiconductor photocatalysts and their application in treating wastewater. The significant findings of the research work have been recognized through publication in a reputable peer-reviewed journal with a high impact factor, highlighting the quality of the research conducted.

Furthermore, the department also offers a certificate program in water analysis, demonstrating its commitment to providing students with specialized knowledge and skills in analyzing and assessing water quality. By emphasizing research and educational initiatives in water quality management, the department contributes to advancing scientific understanding and practical solutions in addressing water pollution and ensuring the availability of clean and safe water resources



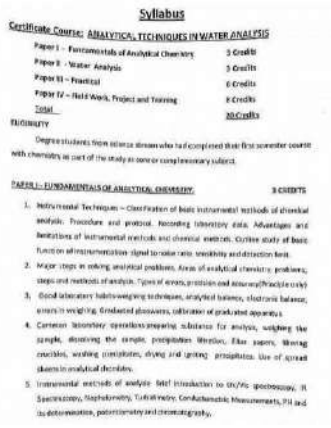


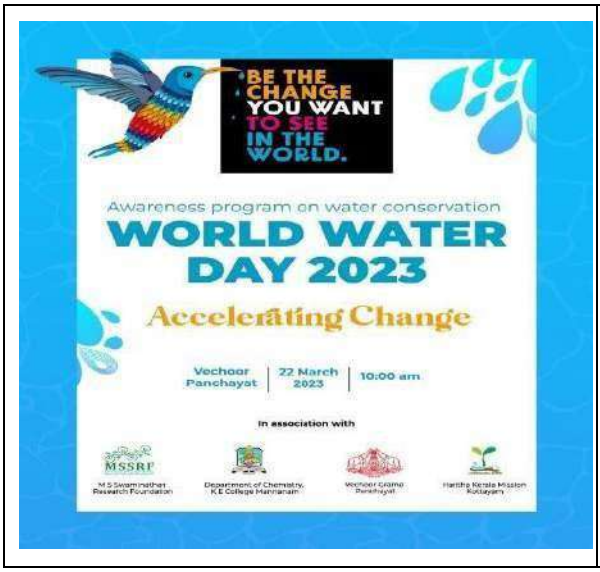
Fig. 14 Academic initiatives

(h) Water Conservation Awareness Programmes

The College has actively taken steps to promote awareness about water conservation and the significance of sustainable water usage. In line with this commitment, the Department of Chemistry organized an awareness program on water conservation for the residents of Vechoor Gramapanchayat on March 22, 2023, in collaboration with the M.S. Swaminathan Research Foundation and Harithakeralam Mission, as part of the International World Water Day celebration.

During this program, various activities were conducted to educate the community about the importance of water conservation. The event aimed to raise awareness about sustainable water management practices and encourage individuals to take responsible actions in their daily lives to conserve water resources. Competitions, workshops, and interactive sessions were organized to engage the participants and provide them with valuable information on water conservation techniques and strategies.

By collaborating with renowned organizations and actively involving the local community, the College demonstrated its dedication to promoting water conservation towards a sustainable future. Such initiatives play a crucial role in instilling a sense of responsibility and encouraging individuals to contribute to preserving water resources for present and future generations.



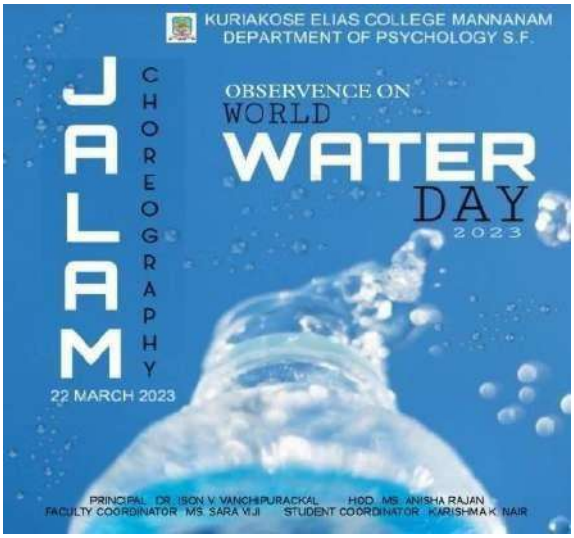


Fig. 15 Various water conservation awareness programmes of the campus

OTHER ACTIVITIES

NATURE CAMP AND AWARENESS PROGRAMMES

The students of K.E College have embarked on a journey to explore the wonders of nature through their participation in nature camps. These camps offer them a unique opportunity to delve into the environment, biodiversity, and sustainable development. By engaging in these camps, the students acquire knowledge and cultivate a deep appreciation and attachment to the natural world. Throughout the academic year 2022-2023, the students had the privilege to participate in nature camps organized by the Kerala Forest and Wildlife Department, enriching their understanding of the natural environment. The details are as follows:

1. Nature Awareness programme- Chemistry Department

About 19 students and two teaching staff from the Chemistry department visited Chinnar Wildlife Sanctuary on December 15, 2022. The program included extensive exploration of the Sanctuary through inventory walks, trekking, interaction with forest officials and guards, and informative demonstration classes. Through this program, the students experienced nature and its components, different ecosystems, their functions, various life forms of plants and animals, remnant art forms, and Dolmens (muniyaras). The students got the opportunity to visit the conservation area for Indian Star Tortoise in the Sanctuary, which is a rehabilitation center for the Indian Star Tortoise. Thus, the program reveals the rich biosystem of Chinnar wildlife Sanctuary with different species of flora and fauna to the students.

Fig. 16 Nature Awareness programe- Chemistry Department

2. Nature Awareness programme- Zoology Department

The Department of Zoology organized a three-day nature camp for 1DC and 2DC BSc Zoology students at Thattekkadu Bird Sanctuary, Ernakulam, from October 17-19. The camp's objective was to provide the students with an opportunity to observe and learn about the diverse flora and fauna of the region. The group went trekking at Bhoothathankettu and had a firsthand experience of the region's natural beauty. The group visited the Thattekkadu Bird Sanctuary and participated in trekking, bird watching, quiz competitions etc. The nature camp at Thattekkadu Bird Sanctuary was a remarkable experience for the students and faculty members. The camp successfully achieved its objectives and provided a platform for the students to learn, observe and appreciate the beauty of nature.



Fig. 17 Nature Awareness programme- Zoology Department



Fig. 18 ***Nature Camp Programme- Psychology Department***

3. Nature Camp Programe- Psychology Department

The Department of Psychology organized the nature camp. The Government of Kerala and the Kerala Forest Department sponsored the program on February 7, 2023. A total of 42 students and three faculty members participated in the camp. Nature camp allowed students and faculty members to explore the Tholpetty forest range and understand the significance of conserving Mother Nature. The nature camp taught the students and faculty members about preserving nature and the need for collective action to combat the

ecological crisis. The nature camp was an enriching and educational experience for all the participants. The participants also fostered a sense of appreciation and gratitude for the natural world; some expressed their desire to volunteer for forest conservation activities in the future.

4. Nature Camp- Psychology S.F department

A two-day nature camp was organized at Peechi-Vazhani Wildlife Division in Thrissur, Kerala, on 7th and 8th of February 2023—the program aimed to create awareness about the importance of biodiversity and the need to conserve natural resources. The camp was led by the Beat Forest Officer of Peechi Wildlife Division, Mr. Salish and the participants included students and faculty members. The program aimed to create awareness on the forest and wildlife in Kerala and the need for their protection. The two-day nature camp at Peechi-Vazhani Wildlife Division was an enriching experience for all the participants. The program succeeded in creating awareness of the importance of biodiversity and the need to conserve natural resources.

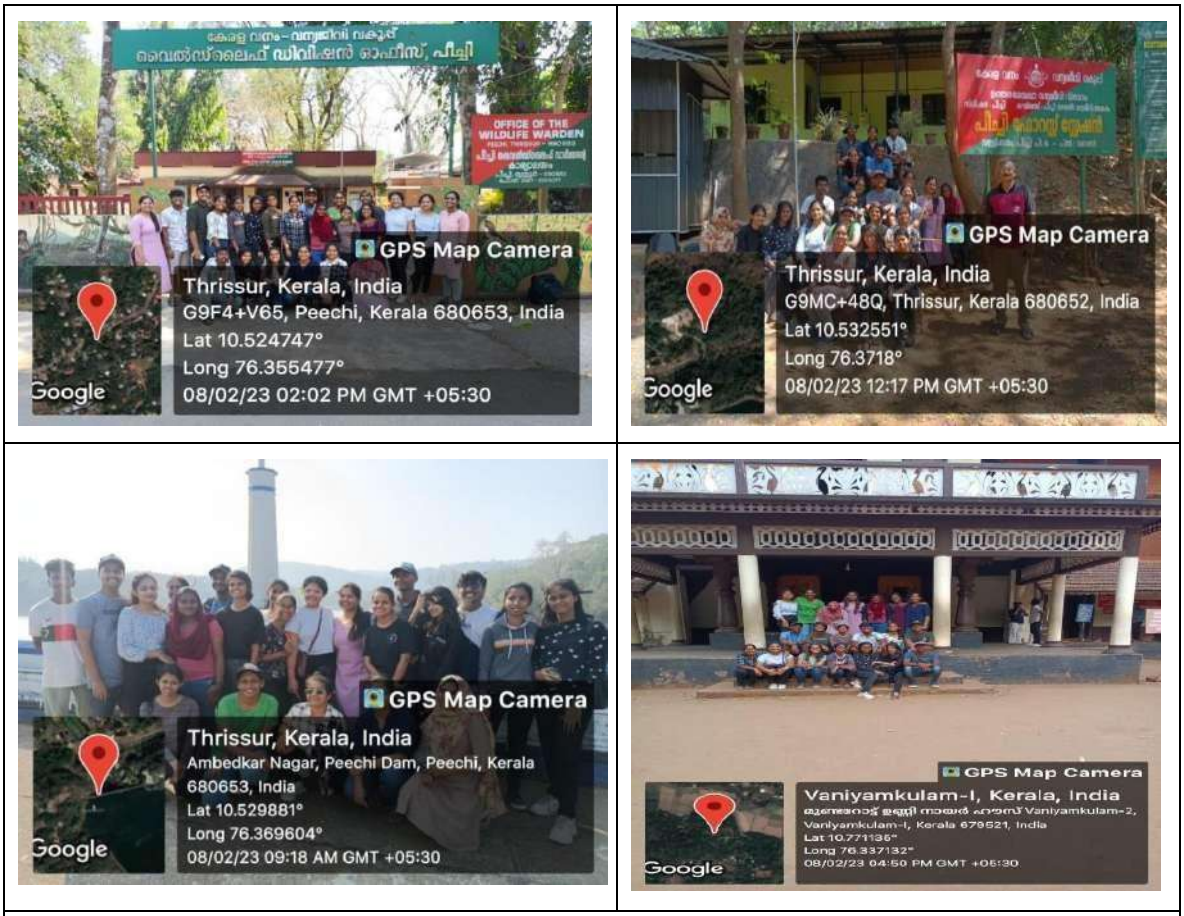


Fig. 19 ***Nature Camp- psychology S.F department***

5. Nature Awareness Programme -Economics Department

The Research and Post Graduate Department of Economics organized a three-day Nature Awareness Programme at Eravikulam National Park in Munnar, located in the Western Ghats Mountain range, from March 3 to 5 2023. 28 students and two faculty members attended the camp. The Nature Awareness Programme was a successful event that allowed the students and faculty members to learn about the diverse flora and fauna of the region. The program successfully achieved its objectives, and the participants expressed their eagerness to attend similar programs in the future.

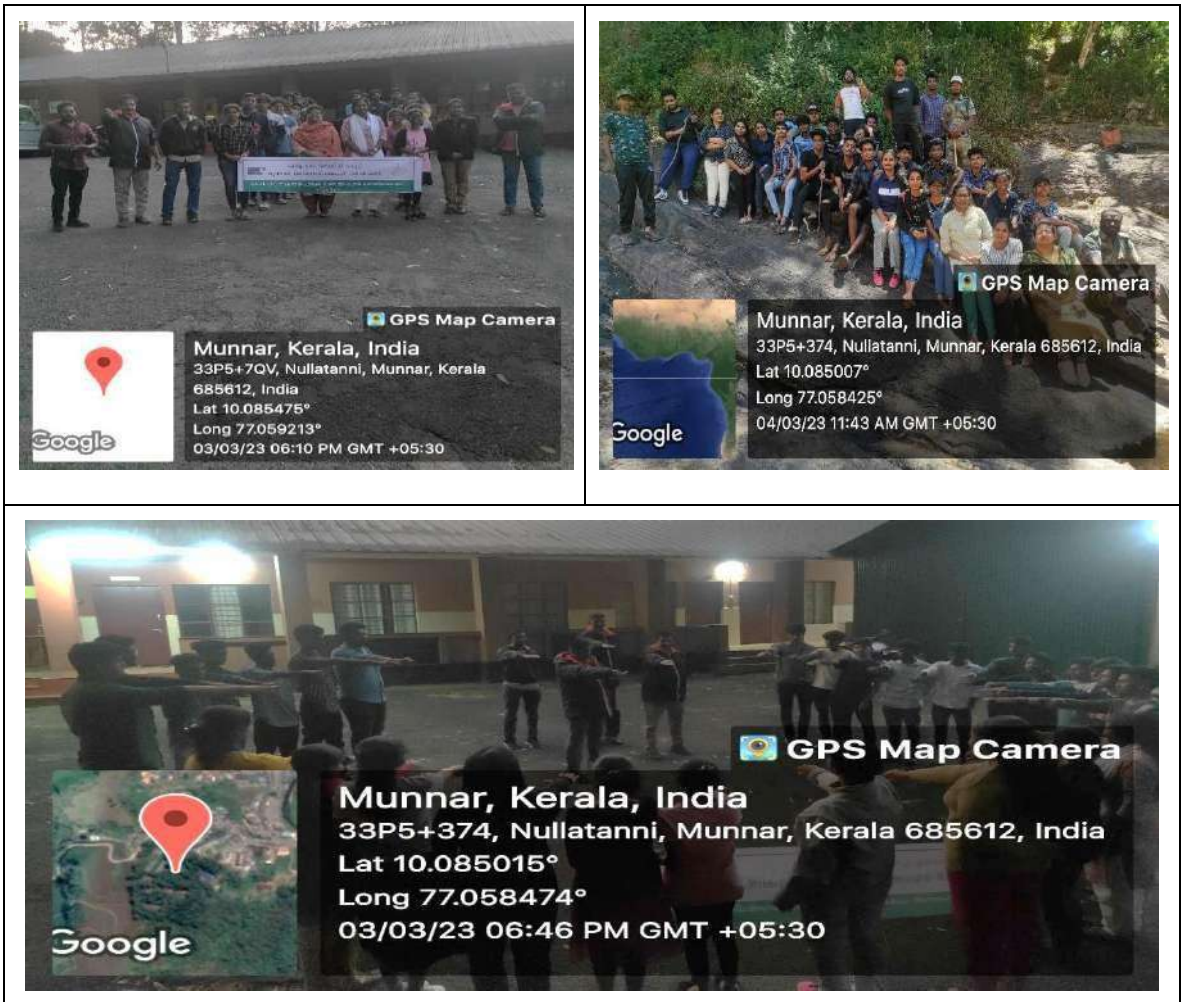


Fig. 20 Nature Awareness Programme -Economics Department

In conclusion, the nature camps were successful initiatives that provided a unique opportunity for students and faculty members to connect with nature and understand the need for collective action to preserve it. The program served as a reminder of the

interdependence of humans and nature and the importance of sustainable development for welfare.

ADD-ON GREEN COURSES (Skill Development Programme under UGC-NSQF)

1. Diploma course in beekeeping

This course aims to impart knowledge and skills in modern beekeeping practices and promote apiculture development. It targets traditional beekeepers and individuals interested in entering the beekeeping sector. The course seeks to empower participants to establish organized and successful honey production units by providing comprehensive training, leading to economic support and environmental conservation. By the end of the course, participants will be enriched to help transform the unorganized beekeeping sector into an organized one, leading to improved economic and nutritional security for farmers, farm women, and rural youth. Beekeeping offers a uniquely feasible, sustainable, and environmentally beneficial way to help the rural population create livelihoods. The NSS volunteers' commendable efforts in maintaining the bee hives serve as an excellent example of collaboration and service within the campus, deserving high appreciation.

Fig. 21 Diploma course in beekeeping

2. Diploma course in herbal chemistry and technology

During the academic year 2020-21, K.E College Mannanam introduced a new NSQF Diploma course in Herbal Chemistry and Technology, with UGC sanction. This course received approval from the Agricultural Sector Skill Council of India (ASSC), and the possible job position offered by the council upon completion of the course as "Medicinal Plant Grower". The course included both skill components and general components.

Diploma in Herbal Chemistry and Technology programme aims to train students in the methods used to analyse and characterise medicinal natural products, to examine the safety and efficacy of currently used herbal medicines, analytical and bioassay methods, and the ethno pharmaceutical uses of plants from traditional systems of medicine. The curriculum in each of the semester of the programme will be a suitable mix of general education and skill development components. The General Education Component shall have 40% of the total credits and balance 60% credits shall be of Skill Component.

The course officially commenced on 16-2-2021, and 37 students enrolled for the program. It consisted of two semesters involving theory, practical, and training sessions. By November 2021, the course reached its concluding stage. The final assessment was conducted by the SSC on 8-12-2021, with 34 students appearing for the examination.

Fig. 22 Diploma course in herbal chemistry and technology

3. Certificate course in ornamental fish breeding

Department of Zoology introduced a _Certificate course in Ornamental fish breeding‘ in 2020-2021. About 31 students enrolled in the course and completed it successfully. The syllabus covered both practical and theoretical aspects of ornamental fish breeding.

The course aims to provide hands-on training in feeding practices, aquaria setup and maintenance, culture and breeding techniques, and mass production of ornamental fishes. The course aims to generate employment opportunities in the ornamental fish industry, particularly for rural and urban households facilitating in export-oriented production. Participants will gain practical expertise in feeding requirements, feed formulation, and techniques for optimal fish health and growth. They will also learn creating and maintaining aquaria skills, including water quality management and tank decoration. The course targets fisheries, aquaculture, and biological sciences graduates, promoting employment and entrepreneurship by equipping them with practical skills and knowledge. Overall, the course aims to enhance the participants' capabilities in ornamental fish breeding and production, contributing to the industry's growth meeting the domestic and international market demands.

Fig. 23 Certificate course in ornamental fish breeding

4. Certificate course in vermicomposting

Department of Zoology at Kuriakose College Mannanam aims to cultivate a love for nature and promote conservation principles and eco-friendly living among students. As part of this initiative, the department offers a certificate course in Vermicomposting to inspire youth to adopt green practices for effective waste management. The course is designed to equip students with the necessary knowledge and skills in Vermicomposting, enabling them to meet the growing demand for professionals in this field. Students will receive training in developing, implementing, and monitoring vermicomposting projects specifically in the agricultural sector. Completing this course, students will be prepared to contribute to the field of vermicomposting, addressing the need for professionals with

appropriate qualifications and practical exposure in this area. They will gain expertise in managing and utilizing organic waste through vermicomposting methods, thereby promoting sustainable agricultural practices and environmental conservation.

Fig. 24 Certificate course in vermicomposting

5. Certificate course in organic farming

This certificate course was sanctioned to the Commerce Department and Botany department under the NSQF during the academic year 2020-21. About 39 students enrolled for the course.

The course focuses on organic farming and covers various aspects related to it. It includes an introduction to organic farming, principles, and types of organic farming. It

discusses the differences between conventional farming and organic farming, as well as the benefits and requirements of organic farming. The course also explores organic plant nutrient management, including biofertilizers, compost preparation, and the role of organic manure. It covers organic horticulture, including soil composition, methods to increase soil productivity, seed bed preparation and irrigation techniques. Additionally, the course includes a module on cultivation processes, explicitly focusing on mushroom cultivation, involving culture preparation, substrate selection, and harvesting techniques.

The college also owns a specified area for elephant yam cultivation, following organic farming practices to grow the yams used in the college canteen.

Fig. 25 Certificate course in Organic Farming

SPECIAL DAYS AND OBSERVATIONS

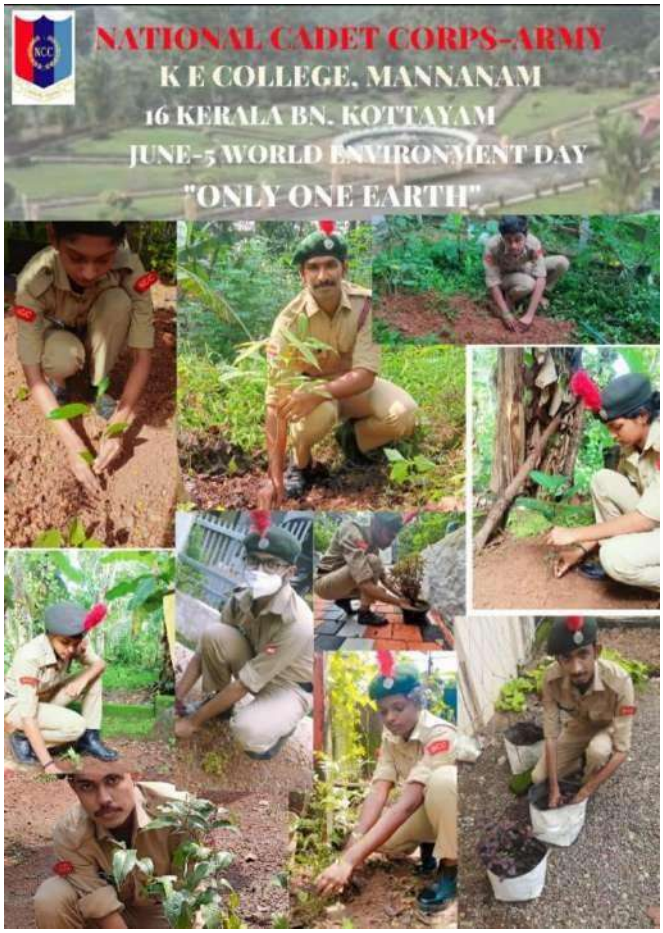
1. World Environment Day – 5 th June 2022

As part of the Environment Day celebrations on June 5th, 2022, it was decided to create a green classroom for the students. A survey and ground study was conducted using

Google Earth to identify a suitable space for the green classroom. The college campus was mapped, and an inventory of the plants was made. Additionally, it was also explored the ways the college campus could be utilized for outdoor learning. These activities aimed to create a conducive environment for incorporating nature-based education and outdoor learning experiences into the student's curriculum.

After the survey, a suitable outdoor space measuring 688 sq.m was identified to be converted into a green classroom. The students actively participated in creating the classroom, including site planning, design, and planting beautiful plants in the area. The transformation of the space into a green classroom involved the collaborative efforts of the students and aimed to create a serene and inspiring learning environment in harmony with nature. The volunteers were reminded of the need to protect these trees for the coming generations. 15 volunteers and programme officers attended the programme.

Again to mark the observance of World Environment Day on June 5th, 2022, the NCC Army wing cadets of Kuriakose Elias College, undertook a tree planting initiative in their respective homes and localities. The event was titled "Only One Earth" and aimed to demonstrate the cadets' dedication to the well-being of future generations.



2. Women's Entrepreneurship Day

On the commemoration of Women's Entrepreneurship Day, the Innovation and Entrepreneurship Development Centre, the Institution's Innovation Council, and the SESRE Cell organized the Handicrafts and Sweets Fiesta on November 16, 2022, at Kuraikose Elias College. The event aimed to promote vocational education, enhance students' skills, and encourage eco-friendly rural business.

The initiative began by forming student self-help groups, and after a week, the most promising business ventures were selected. A total of 92 faculty members and 750 students actively participated in the program. The students enthusiastically showcased and sold their environment friendly goods from stalls set up on the ground floor.

The fiesta provided a platform for students to display their artistic talents and highlighted the significance of handicrafts and food products in terms of eco-friendly production. Overall, the event fostered an entrepreneurial spirit among the students and emphasized the importance of women's entrepreneurship in rural areas.

3. World Forestry Day Observation-"PUTHUNAMPU''-2023

"Puthunampu" is an extension program organized by Bhoomitrasena Club in collaboration with the Department of Botany at K.E College, Mannanam. The event took place on March 27th, 2023, as part of the observation of "World Forestry Day." The main highlight of the program was the distribution of vegetable saplings and the sale of

organic vegetables cultivated by student volunteers from Bhoomitrasena and the Botany department.

During the event, pamphlets containing instructions on sowing and nurturing the vegetables were distributed along with the saplings. The student members of Bhoomitrasena Club also raised awareness about the significance of organic farming. Overall, the program aimed to promote sustainable agriculture practices and educate individuals about the benefits of organic farming methods

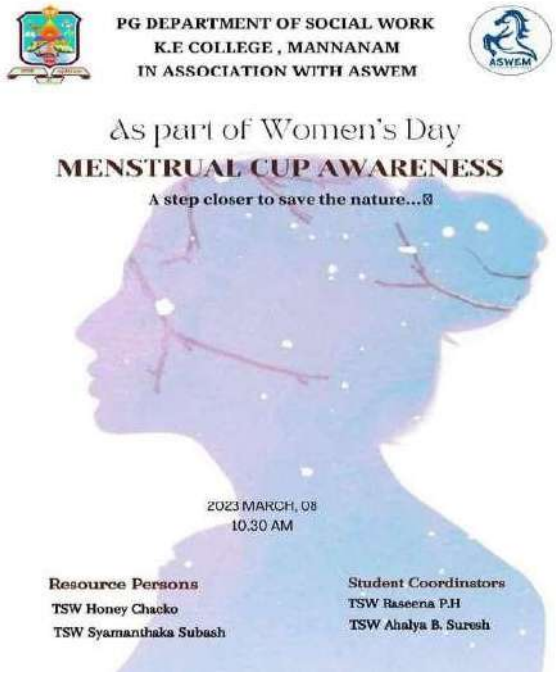
4. Gandhi Jayanthi

In observance of Gandhi Jayanthi, the Department of Statistics at Kuriakose Elias College, Mannanam, conducted cleanliness drive. The initiative involved the participation of five faculty members and 30 students. The cleaning activity commenced from the car parking area and extended to the surrounding lawns, garden, and roads. The participants diligently worked towards removing all types of waste, including plastic

bags and food waste, from the designated area. The event was organized under the guidance of Captain Jobin Varghese from the Department of Computer Applications and Dr. Smitha S, the Head of the Department of Statistics

5. International Women's Day

The celebration of International Women's Day, an awareness session on menstrual hygiene and the use of menstrual cups was conducted for Social Work postgraduate students. The session was highly informative and encouraged active participation from the attendees. The student coordinators, TSW. Raseena and TSW. Ahalya B Suresh, along with resource persons TSW. Honey and TSW Symanthaka, were acknowledged and appreciated for their valuable contributions during the live session.



In collaboration with the .rala State Women Development Corporation and Education for Good Foundation, the K.E Women's Forum organized a session on Sustainable Menstruation at Kuriakose Elias College, Mannanam. The session was conducted at Christopher Hall at 11 am on 09/03/2023, focusing on "Sustainable Menstruation: A Need of The Hour." The program's objective was to raise awareness about menstrual health care and hygiene management. The advantages of using menstrual cups and reusable eco-friendly napkins were emphasized during the session. The participants were encouraged to use the reusable menstrual products to promote environmentally sustainable menstruation. 90 girl students and ten teachers attended the program and actively participated in the interactive session. The session provided valuable information to break menstrual taboos and fostered a greater understanding of the sustainable menstrual practice

Skill Development Programmes

1. Skill development workshop on preparation of hand sanitizer and soap

The Postgraduate and Research Department of Chemistry, in collaboration with the IIC (Institution's Innovation Council) and IEDC (Innovation and Entrepreneurship Development Cell) of K.E. College Mannanam, organized a skill development workshop. The workshop focused on preparing environmentally friendly hand sanitizers and soaps at a low cost, considering the importance of using alcohol-based sanitizers and soap to combat the rapidly evolving COVID-19 pandemic. Mr. Tony Francis, an Assistant Professor in Chemistry at St Mary's College Manarcadu, conducted the training session. On August 31st, 2022, a one-day hands-on workshop titled "HAND SANITIZER AND SOAP PREPARATION" was conducted, with 20 students and 5 teachers. The participants found the training to be a valuable experience.

2. Hands-on training in oyster mushroom cultivation, phase-2

The initiative focused on fostering agri-based microenterprises among students, equipping them with valuable skills to enhance their livelihoods. As part of a one-year certificate course in "Mushroom Cultivation," the second training session was conducted specifically for final year BSc Botany students. The objective of the program was to educate students on mushroom farming and culture techniques. It aimed to provide them with knowledge about wild mushrooms, enabling them to differentiate between edible and poisonous varieties. Furthermore, the training included practical experience and business development aspects of oyster mushroom cultivation. 22 students from the 3rd year BSc Botany program benefited from this training. The program commenced on March 1st, 2023, starting with a demonstration of substrate sterilization and the preparation of mushroom beds. In the subsequent days, students received training on watering the mushroom beds, conducting screenings for potential contamination, and assessing the mycelial growth in the bed. The mushroom produce was harvested from 21th day onwards and was put for sale in the college community under the name" white blooms".

3. Social Entrepreneurship, Swachhta & Rural Engagement Cell

Kuriakose Elias College, was officially recognized as a Social Entrepreneurship, Swachhta & Rural Engagement Cell (SES REC) Institution by the Mahatma Gandhi National Council of Rural Education, under the Department of Higher Education and Ministry of Education, Government of India. As an SES REC Institution, the College has successfully developed and implemented an action plan to address various areas of improvement in both the campus and the surrounding community, including sanitation and hygiene, waste management, water management, energy conservation, and green initiatives in the post-COVID-19 era.

The College has established ten working groups to promote a culture of social responsibility, mentoring, and care for the environment and resources. These groups were entrusted for implementing initiatives and projects that enhance facilities and practices in the campus and the adopted villages. Additionally, the College actively participated in three significant events related to entrepreneurship, community engagement, and environmental awareness

The SES REC Institution aims to instill a sense of responsibility towards social entrepreneurship, cleanliness, and rural development in faculty, students, and the community. By focusing on mentoring, social responsibility, swachhta (cleanliness), and environmental conservation, the College strives to positively impact society and cultivate a sustainable and eco-friendly environment.

Certificate

This is to certify that Kuriakose Elias College, Kottayam, Kerala is now a Recognized Social Entrepreneurship, Swachhta & Rural Engagement Cell (SES REC) Institution. The Institution has successfully framed the SES REC Action Plan and constituted ten working groups for improving facilities in the Campus and the Community/Adopted Villages in the areas of Sanitation & Hygiene, Waste Management, Water Management, Energy Conservation and Greenery post COVID-19, along with the observation of three environment, entrepreneurship and community engagement related days to inculcate in faculty, students and community, the practices of Mentoring, Social Responsibility, Swachhta and Care for Environment and Resources.

Date of Issue: 29/08/2020

Dr. W G Prasanna Kumar
Chairman

Mahatma Gandhi National Council of Rural Education
Department of Higher Education, Ministry of Education
Government of India

Certificate

This is to appreciate that the Institutional Success Story of KURIAKOSE ELIAS COLLEGE, Kottayam, Kerala has been showcased in our monthly Swachhta Action Plan Implementation Program of February 2022 with the support of Fr.Dr.Xavier. C.S, Head of the Institution. The Swachhta team of the institution has completed the activity based program "Showcase! The Success of Sustainability". The Swachhta Action Plan of the Higher Education Institution is elevated in the sustainability components: Greenery, Water, Energy, Waste Management and Land use Management. The program is organized by Mahatma Gandhi National Council of Rural Education, Hyderabad.

Date of Issue: 10/3/2022

Mahatma Gandhi National Council of Rural Education
Department of Higher Education, Ministry of Education
Government of India

Cleaning programmes

1. Youth Day — cleaning campaign

The Psychology (SF) department of K.E College Mannanam organized a cleaning campaign on 22nd August 2022 to celebrate the significance of youth day and recognize the potential of youth as partners in today's global society. The campaign was conducted from 3 p.m. to 5 p.m. with the active participation of Psychology department students, their teacher, and Head of Department (H.O.D). The objective was to clean the surroundings and raise awareness about maintaining cleanliness.

The cleaning campaign was carried out systematically, with everyone working diligently to clean the designated areas. After the cleaning session, refreshments were provided to all participants as a token of appreciation. The event concluded with a group photo, symbolizing the unity and collective effort of the participants. The programme was deemed a great success as it resulted in a cleaner environment and raised awareness among the participants and others about the significance of youth day. The students showcased their commitment to environmental cleanliness and demonstrated their active involvement as responsible young individuals.

2. Cleaning of Mudiyoorkkara Chaathunnippara Road

In commemoration of the 75th Independence Day, the N.S.S unit of the College conducted a cleaning program on 13th August 2022. A group of 50 dedicated volunteers participated in the Shramadhan, focusing on cleaning the sides of the Mudiyoorkkara - Chaathunnippaara link road, which spans approximately 3 km in Ward 8 of Aarppookkara Panchayath. The volunteers worked earnestly to remove litter and debris, ensuring a cleaner and more pleasant environment for the local community.

3. Scrap Challenge (Reduce, Recycle and Reuse)

On 23rd August, the N.S.S unit coordinated a waste collection program within the college campus called the Scrap Challenge. This initiative aimed to collect various recyclable materials such as used papers, plastics, and old newspapers. The collected waste was then sold, and the funds generated from the Scrap Challenge were utilized for two noble causes. Firstly, a portion of the funds was used to distribute grocery kits to the Below Poverty Line (BPL) families in our adopted village. Secondly, another portion of the funds was allocated for the distribution of "Onakkodi," a traditional gift given during the Onam festival, to Abhaya Bhavan's inmates, located in Kudamaaloor. This gesture aimed to bring joy and happiness to the residents of the shelter home.

Through the Scrap Challenge, the N.S.S unit promoted waste management and recycling and demonstrated their commitment to social welfare and community service.

4. Pacha thuruth Inauguration

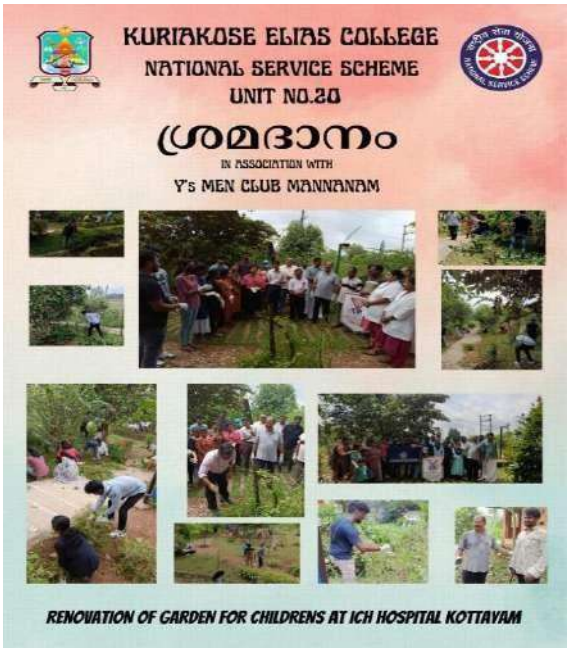
During the N.S.S day celebrations on September 24th the initial stage of Pacha Thuruth, a project initiated by the Haritha Keralam Mission, was inaugurated as an innovative project that involves the plantation of a designated area of not less than 5 cents with a diverse range of plants, including fruit plants and shrubs. This style of plantation follows the principles of Miyawaki, which focuses on creating dense and sustainable forests in small spaces.

The inauguration of the initial stage of Pacha Thuruth marks the beginning of this ambitious project at the College. By planting various plants, we aim to enhance the green cover, promote biodiversity, and contribute to our campus's overall beautification and sustainability.

The event held on N.S.S day was a significant milestone in the College's journey toward creating a greener and more environmentally conscious campus. It signifies the commitment to environmental conservation and aligns with the mission of Haritha Keralam to create a sustainable and eco-friendly Kerala. Through the Pacha Thuruth project, the College hopes to create a vibrant and thriving green space that benefits the college community and serves as a model for others to emulate.

5. Children's Park , ICH cleaning

On October 5th, as part of the Gandhijayanthi Day celebrations, our N.S.S unit organized a shramadhaan activity. This initiative was carried out in collaboration with the Y's men Club Mannanam and aimed at supporting ICH Hospital in Gandhinagar, renowned as a leading children's hospital in Kerala. The hospital has a small park that provides a space of respite for the children and their parents amidst the challenges of seeking medical treatment. With its rides and recreational facilities, this park brings smiles to the faces of the young patients and offers them a moment of joy during their difficult times. Recognizing the importance of maintaining this park, our N.S.S unit, along with the Y's men Club Mannanam, agreed with the hospital authorities to undertake its upkeep. As part of this agreement, the unit took responsibility for the maintenance and cleaning of the park. During these cleaning drives, volunteers worked diligently to ensure the park remained clean and well-maintained for the children and their families to enjoy. By engaging in this shramadhaan initiative,the N.S.S unit demonstrated its commitment to social service and contributed to the well-being of the children visiting ICH Hospital. The collaboration with the Y's men Club Mannanam strengthened KE's efforts and enabled them to impact the young patients' lives positively.



6. Chavara Kadavu Maintenance

The Mannanam Boat Jetty, known as Chavara Kadavu, holds great historical significance as it was the place where Saint Chavara landed in Mannanam and served as a crucial route for transporting goods to the Athirampuzha Market during the 1800s and early 1900s. However, with the advent of road transport and the growth of weeds in the river, the relevance of the Mannanam Jetty has diminished over time. In response to this, the unit took on the responsibility of renovating the boat jetty as part of our sustainable tourism project, started in 2018. The aim was to restore and revitalize the jetty, making it relevant and functional. The jetty has significantly improved through our efforts, making it an important part of the pilgrim tourism circuit through river linkage, as recognized by the DTDC (District Tourism Development Council).

This year, the unit continued its commitment to maintaining and preserving Chavara Kadavu by organizing two cleaning programs. By undertaking the renovation and maintenance of the Mannanam Boat Jetty, the unit has played a vital role in preserving an important historical site and contributing to sustainable tourism development in the region. Through our efforts, we have helped to bring attention back to this significant location and provide visitors with a glimpse into the rich history and cultural heritage of Mannanam.

7. Vedagiri Hill Cleaning

Vedagiri Hill, also known as Dhaksina Kaasi, holds significant historical importance and is renowned for its Vedha Vyasa temple, which attracts numerous tourists. This area is located within the reserve forest region managed by the Kerala Forest Department. Recognizing its potential, the Athirampuzha Panchayath has initiated the development of the forest area into a Miyawaki-style forest. The NSS unit has actively participated in the sustainable tourism project by collaborating with the panchayath and Kudumbashree and to contribute to the development of the Miyawaki forest in this area. In the project's first phase, a three-day cleaning program was organized from December 29th to December 31st. With the dedicated efforts of 130 volunteers, the NSS unit worked towards creating a clean and pristine environment for the future development of the Miyawaki forest. The project enhanced the ecological value of Vedagiri Hill and promoted sustainable tourism practices. Through rejuvenating the forest area and implementing the Miyawaki technique, the team aspires to create a biodiverse and thriving ecosystem that will attract tourists and contribute to the overall conservation of the region.

Publications

1. **Title: Customer Perception and Satisfaction towards Mobile Wallets – An Empirical Study in Kerala**

Traditional checkout payment methods, such as cash and plastic credit cards, emit an average of 3.78 g of CO_2 per transaction. Considering this situation, a technology that can provide a cardless, traceable, and green payment service is vital for sustainability. Hence, mobile wallets can be promoted as a sustainable method of payment.

Journal of Financial Services Marketing
https://doi.org/10.1057/s41264-022-00174-9

ORIGINAL ARTICLE

Why do people continue using mobile wallets? An empirical analysis amid COVID-19 pandemic

Ajimon George[1] · Prajod Sunny[2]

Received: 27 April 2022 / Revised: 22 June 2022 / Accepted: 20 July 2022

Abstract
This paper aims to formulate and test a comprehensive model by integrating the strengths of the TAM and IS success model and the addition of two constructs, namely promotional offers and situational influence, to explain the continued usage intention of mobile wallets. Using an online survey, data were gathered from 588 mobile wallet users who had prior experience using mobile wallets for more than six months. The data were examined using the partial least square-structural equation modelling to investigate relationships between variables and test the hypothesised model. The proposed model disclosed 62.6% of the variance in continued usage intention. The situational influence of COVID-19 emerged as the strongest predictor, followed by satisfaction. This study offers valuable insights to service providers and policymakers involved in executing and deploying mobile wallet services. For academicians, this research presents a comprehensive framework that investigates the continued usage of mobile wallets.

Keywords Mobile wallets · Continuance intention · COVID-19 · Technology acceptance model (TAM) · Information systems success model

Article

Developing a Research Model for Mobile Wallet Adoption and Usage

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Abstract
The scope of the mobile wallet in a 'Cashless India', whose utility has been spurred by the exponentially growing smartphone technology, is a contemporary topic of deliberation. The reach of mobile wallets gets broader each day with the entry of new stakeholders into the scenario, making mobile wallets indispensible for meeting daily needs. Given the COVID-19 pandemic situation, increased reliance on mobile wallets, and its acceptability among the public and other associated e-services, researchers and service providers are eager to explore its adoption as well as its continued usage. This paper theoretically examines factors influencing behavioural intention and actual usage of mobile wallets through various technology adoption models and behavioural studies. Based on an extensive review of the literature, this paper attempts to draw a comprehensive conceptualization of mobile wallet adoption and actual use by exploring the influence of various key factors. This proposed model could successfully present the case of mobile wallet adoption and usage, as well as offer the possibility of deriving important managerial implications concerning effective marketing techniques.

Keywords
Compatibility, perceived reputation, trust, promotional offers, perceived critical mass, behavioural intention, COVID-19

Introduction

Going digital is a phenomenon no sector can afford to ignore. Irrespective of the industry one is operating in—whether large or small scale, traditional or e-commerce, consumer interfacing or industrial—every sector is bound

Digital financial services have brought financial services from bank branches into our homes and pockets. During this transformation, financial transactions have become more convenient and have reached a broader group of users (Reiss, 2018). Technological innovations in mobile devices and financial applications drive the adoption of

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DETERMINANTS OF BEHAVIORAL INTENTION TO USE MOBILE WALLETS – A CONCEPTUAL MODEL

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ABSTRACT

The widespread use of smartphones and various technological advancements are transforming the way we make payments. Smartphones are used as communication devices, entertainment tool, internet access tool, and now even as a payment tool. People have started making payment for purchase of goods and service through mobile wallet. Despite its number of advantages, the acceptance of mobile wallets as a payment method is not so impressive. Consumer looks for convenience, usefulness and benefits over the existing leather wallet in order to decide whether they would adopt or reject the mobile wallet as a payment method. The purpose of this paper is to develop a conceptual model that examines the consumer's behavioral intention to use mobile wallet services based on Technology Acceptance Model (TAM) and Unified

Campus greening Programmes

1. Management of Campus Nursery and Plant protection

The management of the campus nursery and plant protection at College is given significant attention, recognizing vegetation's crucial role in beautifying the campus and creating a vibrant environment. The campus nursery primarily cultivates ornamental plants, adding aesthetic value to the surroundings. To ensure the well-being of the plants, two dedicated staff members are appointed to take care of the nursery. Their responsibilities include watering the plants daily, providing the necessary nutrients, pruning when required, and attending to any other specific needs for maintaining a healthy and beautiful nursery. Their diligent efforts contribute to the overall health and appearance of the plants in the nursery.

In addition to the campus nursery, College also maintains a collection of medicinal plants. These plants serve a dual purpose, contributing to the campus's aesthetic appeal while providing educational and medicinal benefits. The students and staff actively nurture and care for these medicinal plants, further fostering a sense of connection and responsibility towards nature.

2. Un-Constructed Barren Areas and others

The College significantly emphasizes transforming any barren and unconstructed areas into green spaces. These areas, which lack vegetation or structures, are given special attention to introduce green cover and make them functional and beneficial for the college community.

Efforts are made to convert these unconstructed spaces into constructive areas that students and staff can utilize. The focus is on creating functional and appealing spaces that serve a purpose and contribute to the campus environment. This may involve landscaping, planting trees and shrubs, and creating seating or recreational areas. By filling these previously barren areas with green cover and transforming them into constructive spaces, the College enhances the campus's overall aesthetics while providing practical and enjoyable areas for the college community to utilize.

3. Green Outdoor Classroom

After conducting a survey, a picturesque outdoor area measuring 688 square meters was identified on the college campus. This area, already blessed with a natural tree cover, was chosen to be transformed into a green classroom. The students took charge of the entire process, starting from the site planning and design to selecting and planting aesthetically pleasing plants. Given the existing shade provided by the trees, there was no need to create additional cover for the students. The focus was on maintaining the natural ambiance while enhancing the space for educational purposes. The premises were thoroughly cleaned to create a welcoming and pleasant environment. To provide seating for the students, benches were strategically placed in the green classroom. Care was

taken to ensure that the placement of the benches did not disrupt or harm the surrounding natural elements. The intention was to create a harmonious blend of functionality and preservation, allowing students to enjoy the outdoor classroom while appreciating the beauty of the natural surroundings. Overall, the students successfully transformed the identified area into a green classroom, showcasing their dedication to environmental conservation and creating a serene space for learning and engagement with nature.

Chavara Park

4. Pedestrian-friendly pathways

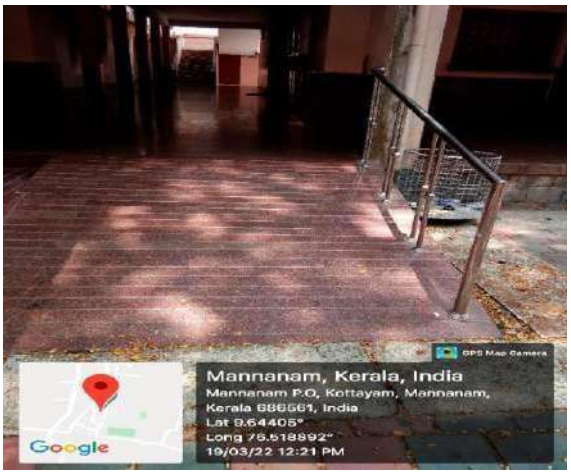
The College prioritizes the maintenance of well-designed pathways that are convenient and safe for pedestrians. These pathways are carefully planned and regularly maintained to provide a comfortable walking experience for students, faculty, and staff.

In line with the commitment to inclusivity, the College has installed disable-friendly ramps at specific points throughout the campus. These ramps ensure easy movement and accessibility for individuals with disabilities, allowing them to navigate the campus independently and without barriers.

To further prioritize pedestrian safety, the entry of vehicles on campus is restricted. This restriction creates a pedestrian-friendly environment, minimizing the risk of accidents and enhancing the overall safety of those walking within the campus premises.

By providing well-maintained pathways, installing disable-friendly ramps, and limiting vehicle access, the College demonstrates its commitment to ensuring the safety, convenience, and inclusivity of all individuals moving through the campus. These

measures contribute to a positive and harmonious campus environment that fosters a sense of security and ease for pedestrians.



Healthy practices:

In conclusion, K.E College has taken commendable green initiatives to create a sustainable and environmentally conscious campus. These initiatives encompass various aspects, including waste management, organic gardening, biogas production, plastic waste management, electronic waste management, and water conservation.

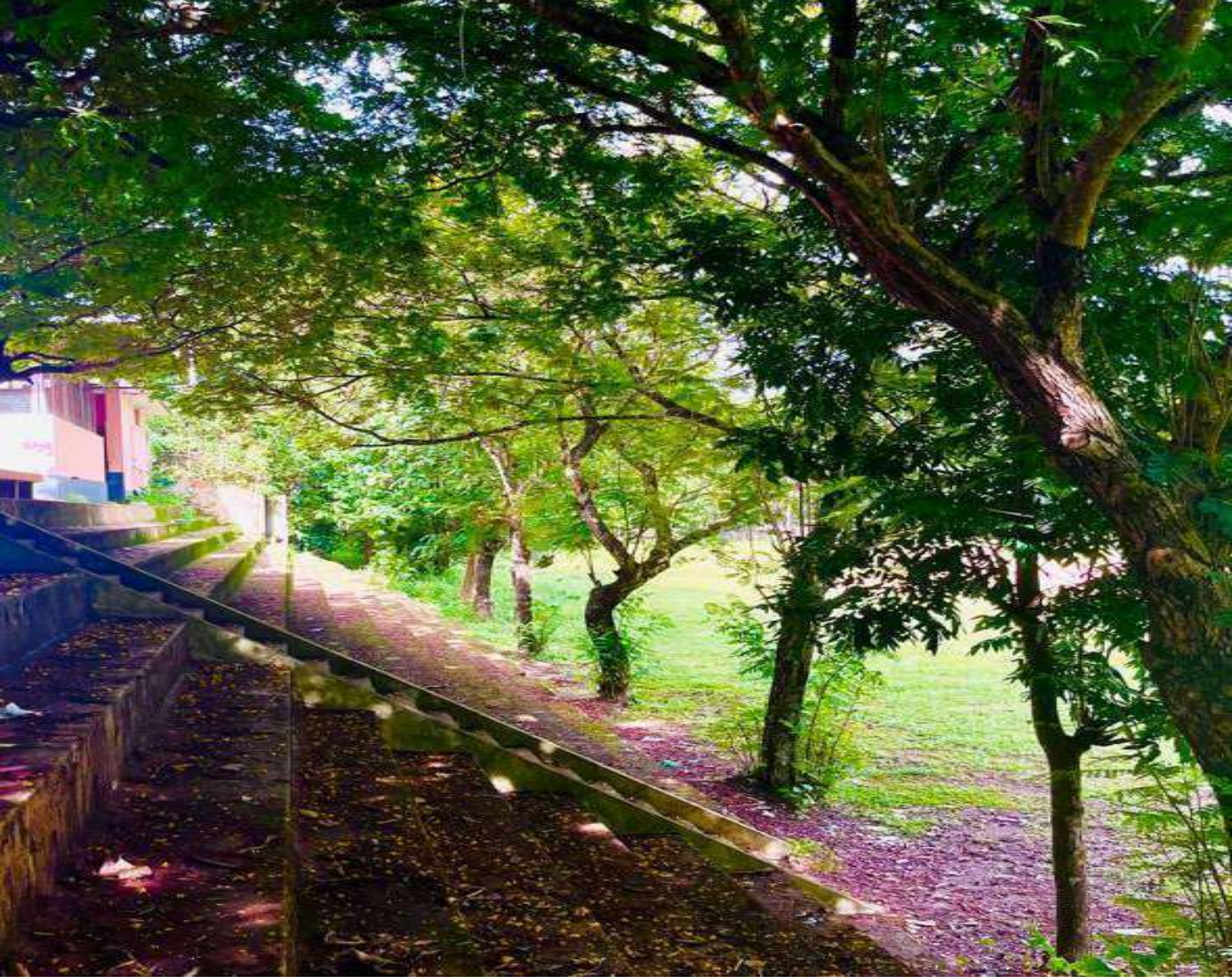
1. The College has implemented segregated waste collection and recycling systems, promoting proper waste disposal practices among students and staff.
2. The utilization of vermicompost units and biogas plants for organic waste management reduces waste and contributes to resource conservation and energy efficiency.
3. Efforts to manage plastic waste, promote the 3Rs (Reduce, Reuse, Recycle), and raise awareness about the dangers of plastic pollution showcase the College's commitment to tackling environmental challenges.
4. The College's focus on electronic waste management, repair, and technology upgradation demonstrates a responsible approach towards electronic consumption and disposal, fostering a culture of sustainability and resource optimization.
5. Water conservation measures, such as rainwater harvesting, open well utilization, and water quality monitoring, contribute to sustainable water management on campus.
6. Additionally, the College's research and academic programs related to water analysis and purification further emphasize the importance of water conservation and quality management.
7. The installation of solar panels for renewable energy generation showcases the College's commitment to reducing carbon emissions and dependence on non-renewable energy sources.

Overall, K.E College's green initiatives reflect a holistic approach towards environmental stewardship, demonstrating the institution's dedication to creating a greener and more sustainable campus. These initiatives serve as a model for other educational institutions and communities, inspiring and encouraging sustainable practices for a better future.

Recommendations

Based on the observations of the green initiatives at K.E College, here are some future recommendations for a more green and sustainable campus:

1. Expand renewable energy: Increase the capacity of the solar panels and explore other renewable energy sources such as wind or geothermal energy. Aim to generate more of the campus's energy needs from renewable sources.
2. Enhance water conservation: Implement additional water conservation measures such as rainwater harvesting systems, water-efficient fixtures, and landscaping practices that minimize water usage. Conduct regular water audits to identify areas for improvement.
3. Strengthen waste management: Implement a comprehensive waste management plan that includes proper segregation, recycling, and composting facilities. Educate students and staff about the importance of waste reduction and encourage sustainable waste practices throughout the campus.
4. Green transportation: Encourage using eco-friendly transportation options such as bicycles, electric vehicles, or carpooling. Provide designated parking spaces for these vehicles and establish charging stations for electric vehicles.
5. Expand environmental education: Integrate sustainability and environmental education across various disciplines and encourage research and projects related to sustainability. Organize workshops, seminars, and awareness campaigns to educate the campus community about sustainable practices.
6. Outreach activities: Collaborate with local organizations, communities, and government bodies to promote sustainability initiatives beyond the campus. Establish partnerships for joint projects, community clean-up drives, and awareness campaigns to create a broader impact.
7. Continual assessment and improvement: Regularly assess and monitor the effectiveness of green initiatives on campus. Collect feedback from students, staff, and the community to identify areas for improvement and implement innovative solutions.
8. By implementing these recommendations, K.E College can create a more sustainable and environmentally friendly campus that serves as a model and contributes to a greener future.



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SWOC ANALYSIS

SWOC analysis is a strategic planning tool used to assess the strengths, weaknesses, opportunities, and challenges of an organization. It helps identify the internal and external factors that can impact the organization's performance and guides decision-making and action planning.

In the context of environmental auditing of colleges, SWOC analysis plays a crucial role in assessing the college's environmental management practices, identifying areas of improvement, and formulating effective strategies to achieve sustainability goals. The significance of SWOC analysis in environmental auditing:

Strengths: By identifying the strengths, such as existing green initiatives, well-defined policies, and committed staff, colleges can leverage these factors to enhance their environmental performance and build upon their strengths.

Weaknesses: Recognizing weaknesses, such as limited infrastructure, lack of awareness, or insufficient resources, enables colleges to address these shortcomings and develop strategies to overcome them, thereby improving their environmental management practices.

Opportunities: Identifying opportunities, such as new technologies, funding opportunities, or partnerships, allows colleges to capitalize on these prospects to enhance their environmental auditing and management efforts.

Challenges: Recognizing challenges, such as regulatory compliance, changing environmental regulations, or resistance to change, help colleges develop strategies to address these hurdles and ensure effective environmental auditing and management.

Strategic planning: SWOC analysis provides colleges with a comprehensive understanding of their internal and external environmental factors, enabling them to develop a strategic plan tailored to their needs, goals, and circumstances.

Continuous improvement: SWOC analysis is an iterative process, allowing colleges to regularly reassess their environmental auditing efforts and adapt their strategies to changing circumstances, ensuring continuous improvement in environmental management practices.

By conducting a SWOC analysis, colleges can gain valuable insights into their environmental auditing practices and make informed decisions to enhance their sustainability efforts, promote responsible environmental management, and contribute to a more sustainable future.

Scope of SWOC analysis in the environmental auditing of K.E College

For several reasons, incorporating SWOC analysis in the green audit of K.E College is paramount. Firstly, it allows for a comprehensive assessment of the college's environmental management practices by examining the internal strengths and weaknesses and external opportunities and challenges. This holistic evaluation provides a clear understanding of the current state of environmental performance and serves as a foundation for developing effective strategies. By identifying strengths, such as existing

green initiatives and committed staff, the college can leverage these assets to further enhance its environmental sustainability efforts. It can build upon successful practices and expand their implementation throughout the campus, fostering a culture of environmental responsibility.

Simultaneously, recognizing weaknesses is crucial as it highlights areas that require improvement. It may involve addressing issues like limited infrastructure, lack of awareness, or insufficient resources. By identifying these weaknesses, the college can develop targeted strategies to overcome challenges, allocate resources effectively, and enhance its environmental auditing practices. Moreover, SWOC analysis brings attention to the opportunities available for the College to improve its environmental performance. These opportunities include adopting new technologies, exploring funding options for sustainable projects, or establishing collaborations and partnerships with external stakeholders. By seizing these opportunities, the college can drive innovation, implement sustainable solutions, and stay at the forefront of environmental best practices. Lastly, SWOC analysis helps the College identify and address challenges and obstacles hindering its green audit process. These challenges can range from compliance with environmental regulations to resistance to change within the institution. By proactively recognizing and strategizing around these challenges, the college can develop measures to overcome them, ensuring a smooth and successful green audit.

Incorporating SWOC analysis into the green audit of K.E College facilitates a comprehensive understanding of the College's environmental management practices, enabling the development of a tailored and practical action plan. It promotes continuous improvement, helps set realistic goals, and ensures that environmental sustainability remains a key priority for the institution. Ultimately, it empowers K.E College to become a model for sustainable practices and contribute significantly to environmental conservation.

Domain	Strength	Weakness	Opportunity	Challenge
Water	• Availability of natural water sources such as wells and ponds on campus. • Commitment to environmental protection and sustainability. • Implementation of water management initiatives and policies. • Awareness and support from the college community for water conservation efforts. • Potential for rainwater harvesting and groundwater recharge.	• Underutilization of roof-top rainwater harvesting potential • Absence of wastewater treatment facilities in major labs • Lack of advanced water management infrastructure and technologies. • Challenges in implementing strict water conservation practices across all departments.	• Wastewater recycling facilities • Scope for increased rain water harvesting • Install water efficient systems in laboratories • Collaboration with water management experts and organizations for guidance and support. • Implementation of innovative water-saving technologies and practices. • Integration of water management into the curriculum and research programs. • Awareness campaigns to educate and involve the College community in water conservation.	• Balancing water requirements for various campus activities while minimizing wastage. • Adapting to changing water availability due to seasonal variations or climate change. • Ensuring continuous maintenance and upkeep of water management infrastructure • Amount of wastewater produced and its subsequent treatment • Increasing per person water consumption on campus • Water demand for construction activities exceeding available supply
Waste	• Implementation of a waste minimization policy focused on reuse, reduction, and recycling. • Enforcement of a plastic	• Lack of adequate waste management infrastructure and technological capabilities. • Inadequate monitoring	• Collaboration with waste management experts and organizations for guidance and support. • Implementation of	• Coping with the rise in waste production resulting from increased campus activities. • Ensuring adherence to waste management

	ban on campus. • Proper handling and disposal of e-waste and hazardous waste. • Food waste composting and manure production • Existing back policy • Plastic ban in the campus • Proper E-waste and hazardous waste handling • Existence of green protocol to minimize waste • Awareness and commitment to environmental protection and sustainability. • Active participation and cooperation from the college community in waste management practices.	and data collection on waste generation and disposal practices. • Potential for improper handling and disposal of laboratory waste. • Underutilization of the potential for expanding biogas facilities • Need for improved laboratory waste handling practices. • Limited availability of experts or specialized personnel in waste management. • Requirement for the installation of Effluent Treatment Plants (ETPs) in science departments.	innovative waste reduction and recycling techniques like: - Food waste derived biogas generation facility - Biodegradable waste derived energy production potential - Waste derived bio-fertiliser production • Integration of waste management into the curriculum and research programs. • Awareness campaigns to educate and involve the college community in waste reduction and recycling. • Strengthening of institutional green policy • Formulation and implementation of waste management policy • potential for grants and funding opportunities to support waste management initiatives	regulations and standards. • Formulating efficient strategies to reduce waste generation in specific areas. • Implementing Information, Education, and Communication (IEC) programs to enhance communication and awareness. • Managing the escalating per capita resource consumption. • Recording greenhouse gas emissions and calculating the carbon footprint. • Dealing with miscellaneous waste generation and disposal. • Focusing on infrastructure development to support waste management initiatives.

Carbon	• Provision for renewable energy usage • Natural carbon sinks like vegetation through conservation area and gardens • Strong commitment to environmental protection and sustainability. • Availability of green initiatives and policies. • Presence of a responsible environmental management culture on campus. • Potential for implementing carbon reduction strategies and technologies. • Access to educational resources and expertise in the field of carbon management.	• Limited awareness and understanding of carbon management practices. • Lack of comprehensive data on carbon emissions and footprint. • Challenges in implementing carbon reduction measures across various departments and activities. • Potential for resistance or lack of participation from certain stakeholders. • Insufficient funding and resources dedicated to carbon management initiatives.	• Potential for vegetation-based carbon sequestration. • Implementation of green initiatives to minimize emissions. • Availability of skilled human resources and technical expertise • Scope for carbon neutral campus • Collaboration with carbon management experts and organizations for guidance and support. • Integration of carbon management into the curriculum and research programs. • Adoption of renewable energy sources and energy efficiency measures to reduce carbon emissions. • Engagement with the college community through awareness campaigns and incentives for carbon reduction.	• Addressing the diverse sources of carbon emissions within the college. • Ensuring compliance with carbon management regulations and standards. • Developing effective strategies for carbon offsetting and sequestration. • Overcoming resistance to change and fostering a culture of sustainability throughout the college • Ensuring consistent and accurate data collection and analysis. • Addressing infrastructure development needs and requirements. • Managing landscaping activities effectively. • Dealing with the transportation requirements and waste generation associated

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				with the floating population.
Biodiversity	• Rich biodiversity with a diverse range of plant species • Sense of belonging and concern towards nature • Existing environmental stewardship and conservational mentality • Innate nature of the region in terms of indigenousness and rare biodiversity • Special efforts in growing honey bees for pollination and increased yield. • Proximity to the Vembanad wetland system, enhancing the ecological value of the campus.	• Majority of plant species are exotic garden plants, potentially affecting the native biodiversity. • Limited area of the campus may restrict the expansion of natural habitats. • Lack of comprehensive assessments and observations across different seasons, possibly missing out on undiscovered species. • Limited resources and expertise dedicated specifically to biodiversity management. • Infrastructural development and landscaping activites	• Potential for establishing conservational patches • Green initiatives to foster rare and endemic plants and animals • Initiatives to implement medicinal and rare plant gardens • Organic farming initiatives • Programmes to promote native species of plants and trees • Conduct regular assessments and observations to document and monitor the biodiversity. • Collaborate with experts and research institutions to enhance biodiversity conservation efforts. • Explore possibilities of introducing more native plant species to enhance biodiversity value. • Implement sustainable landscaping practices to support and promote local wildlife.	• Infrastructural development and other requirements • Balancing the maintenance of exotic garden plants with the conservation of native biodiversity. • Managing and mitigating potential threats to the existing biodiversity, such as invasive species. • Allocating sufficient resources for biodiversity management in a limited space.

VI. ENVIRONMENTAL AUDIT STATEMENT

The Environmental Audit of K.E. College, Mannanam, is an earnest endeavor by the Advanced Centre for Environmental Studies and Sustainable Development (ACESSD), Mahatma Gandhi University to appraise the ways in which the College interacts with the environment. The present audit was conducted for the chief domains like energy, water, waste, biodiversity, and carbon footprint and analyzed the baseline status from an environmental sustainability perspective. The audit helps to depict the extent to which the College impacts the nature and the social outreach of the activities towards embracing eco-sustainability. The domains under consideration revealed appreciable performance and were found to emphasize unique green initiatives. The College has adopted significant steps to reduce energy consumption and to increase energy efficiency. The College is currently following outstanding water harvesting and conservation methods. The green initiatives of the campus ensure water conservation practices as well as optimal and conscious water usage. The biodiversity of the campus is highly appealing despite space constraints. The various green initiatives and activities of College reflect the attitude of preserving and conserving nature. The campus has a competent and advanced mechanism for managing solid and liquid wastes. The strong adherence to the institutional green protocol for waste management is highly appreciable. The initiatives to generate food waste-derived biogas energy as a fuel substitute is a way forward to energy sufficiency and appropriate waste management. From a climate change conscious and mitigation perspective, the College stands with a difference. The present environmental audit reveals the magnitude of the meticulous green efforts of the K.E. College to maintain an eco-friendly, healthy campus.

VII. ENVIRONMENTAL AUDIT CERTIFICATE

The Environmental Audit conducted at K.E. College, Mannanam, followed standard procedures and guidelines for assessing environmental performance and governance. The College demonstrated its potential to become a leading academic institution aligned with its vision and mission. The audit conclusions were derived from the information provided by the College, which was thoroughly assessed and cross-referenced with relevant documentation.

The College extended wholehearted support for physical inspections and interviews, allowing for periodic interactions with key personnel like, the manager, principal, selected faculty, administrative staff, and students. This collaborative approach ensured a comprehensive assessment of the College's environmental practices. The focus of the College on nature conservation through green initiatives and the cultivation of healthy habits aligns with the national vision of promoting sustainable practices and environmental stewardship.

The institution's approach to resource utilization, including energy, water and waste management, biodiversity conservation, and adherence to green practices, is commendable. The College has also achieved notable environmental quality indicators, which are within national standards, indicating a high level of environmental quality on campus.

The healthy practices and steps taken by K.E. College place it as a model for environmental sustainability. The College's efforts can inspire others to follow, maintaining its green status and spreading the noble message of environmental sustainability.

14/03/2023

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VIII. ANNEXURES

A. Environmental Policy

1. Preamble

Kuriakose Elias College, Mannanam, a leading higher education institution in Kerala, recognizes its responsibility towards environmental issues and the well-being of society. The College acknowledges the crucial role of education, research, policy formation, and information exchange in sustaining environmental campaigns and activities. The current Environmental policy reflects the College's dedication and stewardship toward environmental protection and sustainability.

The College is committed to adopting a sustainable approach to achieve environmental stability and reduce its ecological footprint. A responsible environmental management culture has been established on campus, with a strong focus on resource and waste management supported by robust green initiatives. These efforts align with the government's existing environmental laws and regulations to promote a pollution-free environment.

The policy establishes significant objectives, specific targets, and action plans to achieve environmental sustainability. It draws upon various regulations, including the Municipal Solid Wastes (Management and Handling) Rules, 1999, the Water Act, Environmental Protection Act, and National Environmental Policy of 2006. This environmental policy highlights the College's commitment to water management, waste management, biodiversity conservation, energy efficiency, carbon management, and its dedication to green initiatives.

2. Policy Statement

The College acknowledges the vital role of a strong environmental framework as an integral part of academic excellence and the overall well-being of the institution. To achieve this excellence, developing, implementing, and maintaining a policy statement that serves as the foundation for an Environmental Management System aimed at achieving sustainability is essential.

Energy Policy:

1. Establish an Energy Management Cell with representation from all departments to effectively implement an energy management program and ensure adherence to procedures for baseline assessment, goal setting, monitoring, and the adoption of conservation methods towards achieving a zero-carbon campus.
2. promote energy efficiency by tracking and analyzing energy usage, utilizing energy-efficient infrastructure, adopting a sustainable approach to equipment replacement, encouraging the use of energy-efficient appliances and lighting, and implementing energy-saving measures such as BLDC ceiling fans and TFT computer monitors.
3. implementation of energy waste elimination methods by occupancy sensors, optimal temperature settings, timely repair or replacement of old instruments, maximizing the use of natural daylight and ventilation, timer switches for streetlights and classrooms, promotion of good housekeeping practices, and regular maintenance and replacement of lights with LEDs to save energy.
4. substitute conventional energy sources with sustainable alternatives by maximizing natural light utilization, implementing solar water heaters, increasing the use of grid interactive solar PV systems, installing additional biogas plants, promoting the use of electric vehicles, and encouraging bicycle usage within the campus.
5. optimizing energy costs through effective management of reactive power, taking advantage of time-of-day (TOD) tariff benefits by operating flexible loads during off-peak periods, and implementing dual trigger RTPFC panels to optimize DG fuel consumption.
6. promoting energy management and sustainability through awareness programs, workshops on solar PV systems, energy training, student projects, 'No Vehicle Day' events, energy conservation programs, and encouraging faculty Energy Audit certification

Water Policy:

1. Implementing regular desilting and maintenance of natural water sources such as wells and ponds on campus to increase water storage capacity and promote groundwater recharge, and utilizing roof rainwater from nearby buildings to replenish the groundwater through recharging of wells wherever possible.
2. Extreme care has to be taken to reduce the wastage of water in the campus for instance, avoid prolonged over-flowing while pumping water to the overhead tanks; repair and proper maintenance of leaking faucets and plumbing.
3. Implementing roof rainwater harvesting structures of appropriate capacities in science department that can be connected to the laboratories, specifically the water distillation units, to conserve and utilize the significant quantity of coolant water discharged from these units, thereby minimizing wastage daily. It can also be diverted to rainwater collection tanks or near by ponds to save water.
4. Periodic maintenance and cleaning of the water channels, pipes, faucets and water tanks is very essential.
5. Instillation of an effluent treatment plant for waste water purification and reuse.

Waste policy

1. Implementing a comprehensive waste segregation system throughout the campus, promoting the separation and segregation of recyclable materials such as paper, plastic, glass, and metal. Establish recycling points and educate the college community on proper segregation practices.
2. Placement of colour coded waste collection bins in each department and division of the administrative section for source segregation of solid waste
3. Encouraging the utilization of appropriate techniques to process the waste for material recovery, energy generation, or manure production.
    i. Biogas plants, composting, and vermicomposting yards are established in suitable locations on campus.
    ii. The bio-manure derived from these yards will be exclusively utilized within the college premises for horticultural purposes.

4. Minimising single-use items such as plastic bottles, disposable cutlery, and packaging materials.
    i. Encourage reusable alternatives and provide adequate facilities for refilling water bottles and food containers.
    ii. Phasing out the use of plastics on campus, starting with a ban on the use of flex banners
    iii. Consider installing purified water kiosks at multiple locations to reduce plastic bottle usage and promote tap water consumption.
5. Developing a systematic approach for safely handling, storing, and disposing of hazardous waste (e-waste and biomedical waste) generated within the college premises, in compliance with relevant regulations. Implement training programs to educate staff and students on proper handling practices.
    i. *E-Waste management :* Properly collected, stored, and periodically given to concerned scrap dealers. Technology upgradation is prioritized through the buyback option instead of purchasing new machines
    ii. *Laboratory waste / Hazardous waste management*: Liquid chemical wastes and reagents will be collected with minimal segregation into separate containers, and these will be responsibly handed over to recyclers or authorized agencies specialized in disposing such wastes.
6. Conduction of awareness campaigns, workshops, and training sessions to educate the college community about waste management best practices, emphasizing the importance of waste reduction, recycling, and responsible disposal.
7. Fostering collaborations with local authorities, waste management agencies, and relevant stakeholders to enhance waste management initiatives, including community participation clean up drives and waste reduction programs.

Biodiversity policy

1. Conserving the natural vegetation and improving the tree cover on campus to preserve floral and faunal diversity. Efforts will be made to protect and enhance the ecological balance by promoting the conservation of native plants and the habitats they provide.

2. Recognizing the valuable role of nature clubs in documenting and monitoring the campus biodiversity, active encouragement and involvement are emphasized to foster a sense of responsibility toward conserving local fauna.
3. Ensuring the active involvement of the nature club in documenting and monitoring the biodiversity on campus, instilling a sense of responsibility and cultivating a collective effort to preserve the campus's natural ecosystem.
4. Ensuring the periodic monitoring of the conserved biodiversity patches(Gardens, organic farm yards, and associated areas) of the College by concerned groups or personnel.
5. Promotion of flower garden, medicinal plant garden, haorticultire farm and canopy cover

Carbon Management:

1. Setting clear targets for reducing carbon emissions and implementing a robust monitoring and reporting system to track and communicate the progress towards achieving these targets.
2. Formation of a dedicated task force responsible for assessing the emission scenarios of the campus using a standardized methodology. This task force will be responsible for conducting comprehensive evaluations to determine the current and future emissions levels, enabling informed decision-making and effective implementation of emission reduction strategies.
3. Encourage public transportation, carpooling, and cycling among the college community to reduce carbon emissions from transportation.
4. Parking of two-wheelers and four wheelers preferably outside the campus.
5. Reducing the carbon footprint by prioritizing renewable energy sources and minimizing reliance on non-renewable energy.
6. Envouraging measures to reduce the carbon foot print towards attaining a carbon neutral campus.

General Administration setup envisaged

An effective administrative structure is essential to ensure the successful implementation of the policy. The responsibilities and institutional provisions outlined in the policy are

allocated to individuals at different administrative levels within the college, establishing clear lines of authority and accountability for its execution.

To implement an environmental policy in a college, the following administrative structure can be considered:

1. **Senior Management/Administration:**
    - Principal/President: Provides overall guidance and support for the policy implementation.
    - Vice Principal/Vice President: Assists in policy development and oversees its implementation.
    - Environmental Committee: Comprises key personnel responsible for policy formulation, implementation, and monitoring.
2. **Environmental Coordinator/Manager:**

    Appointed staff member responsible for coordinating and overseeing environmental initiatives. Works closely with different departments and stakeholders to ensure policy compliance and progress.
3. **Departmental Representatives:**
    - Faculty Representatives: Act as liaisons between faculty members and the Environmental Coordinator/Manager, promoting environmental awareness and compliance within their respective departments.
    - Student Representatives: Engage with student organizations and clubs to foster environmental initiatives and raise awareness.
4. **Operations and Facilities Management:**
    - Facilities Manager: Ensures efficient implementation of environmental practices in campus operations, including waste management, energy efficiency, and sustainable infrastructure development.
    - Maintenance Staff: Implements day-to-day environmental initiatives, such as waste segregation, recycling, and energy conservation.

5. **Education and Outreach:**
    - Sustainability Office/Department: Develops educational programs, awareness campaigns, and training sessions on environmental issues for students centered outreach activities for the public.
    - Environmental Clubs and Organizations: Actively involve students in environmental activities, promote sustainable practices, and contribute to policy implementation and extension.
6. **Monitoring and Reporting:**
    - Environmental Compliance Officer: Monitors policy compliance, conducts regular audits, and ensures reporting of progress towards environmental goals.
    - Data Management Team: Collects, analyzes, and reports environmental data to track the effectiveness of the policy implementation for improvement.
7. **Stakeholder Engagement:**
    - Community Relations Officer: Coordinates with external stakeholders, such as local communities, government agencies, and environmental organizations, to foster collaborations and partnerships to support the policy.

This administrative structure provides a framework to ensure effective coordination, implementation, monitoring, and reporting of the environmental policy within the College, involving various individuals at different levels of responsibility.

By adhering to this environmental policy, KE College demonstrates its commitment to sustainability, environmental stewardship, and the promotion of green initiatives. The institution believes that integrating these principles into its operations can create a more environmentally conscious campus and contribute to a greener future and a model to others.

GREEN PROTOCOL

The College has implemented green initiatives that align with the standards set forth by the Haritha Kerala Mission. These initiatives cover various aspects related to sustainability.

1. Promote and advocate for the adoption of the 'respect, rethink, reduce, reuse, and recycle (5Rs)' principle within the campus community.
2. Cultivate a culture of responsibility among the campus community to prevent the wastage of resources.
3. Encourage a mindset that discourages the use-and-throw culture and excessive consumerism.
4. Support the use of reusable utensils for dining and beverages on campus, particularly during events and functions.
5. Facilitate the proper separation and management of waste into categories such as biodegradable, non-biodegradable, and hazardous materials.
6. Promote the responsible disposal of used sanitary napkins and other sanitary waste through scientific methods like incineration.
7. Advocate for the composting of biodegradable waste to create organic manure, following a "waste to wealth" approach.
8. Promote the conversion of organic waste into valuable resources like vermicompost manure or biogas.
9. Encourage recycling by segregating non-degradable materials, such as plastics, and sending them for recycling through "Haritha Karma Sena."
10. Discourage the use of non-degradable decoration items like plastic-covered bouquets, flex banners, and pharmocol during functions.
11. Advocate against the use of plastic or rexine-coated binding materials for projects and proposals.
12. Recommend alternatives like cloth banners, metal boards, and electronic displays instead of flex and other non-eco-friendly hoardings.
13. Promote the use of reusable items like ink pens and bags made from jute, cloth, or paper during workshops and seminars.
14. Advise on the proper storage, handling, and disposal of electronic waste in compliance with e-waste management regulations.

15. Instill a sense of personal responsibility regarding resource utilization, waste generation, and reducing one's carbon footprint.
16. Foster a sense of belonging, encourage minimalism, and promote eco-sustainability throughout the campus.
17. Encourage students to observe "clean-up drives" concerning environmentally relevant days.
18. Provide training programmes to the students on L.E.D. bulb making, paper bag making, etc. to make them self-reliant in an eco-friendly lifestyle.
19. Incorporate and regularly conduct environmental audits.
20. Enhance and expand existing green initiatives and best practices to achieve environmental sustainability.
21. Ensure the engagement of campus green teams to monitor and maintain environmental health.
22. Introduce programs and initiatives that cultivate environmental stewardship and awareness.
23. Promote community responsibility and engagement by fostering increased cooperation among students, staff, and the local community on environmental initiatives and extension programs.
24. Setting up functional rainwater harvesting systems to mitigate the water scarcity issue in summer and water recharge pits to ensure groundwater supply year-round.
25. Encourage students and staff to reduce the use of automobiles and follow energy-conserving modes of transport like cycling, walking, vehicle pooling, and more reliance on public transport systems.
26. Provide tree-lined pathways and landscaping on the college campus to ensure stress-relieving, relaxing strolls for the students and staff.
27. Conduct nature conservation programmes in the neighborhood communities through the extension activities of cells or clubs
28. Inspire students to develop environmental responsibility through nature camps and field trips.
29. Support the green initiatives of the Government of Kerala and the Union Government.