MARIAN COLLEGE
KUTTIKKANAM
(AUTONOMOUS)

Integrated Audit Report on Environment, Energy and Green initiatives

a consolidated Report for three years (2019-21)

Prepared by

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Foreword

Mankind is now facing grave problems like environmental degradation, depletion of natural resources and the emerging global warming and climate change impacts, widely discussed at the global and regional levels. Life exists in our planet earth only because of nature's life support systems. Hence protection and conservation of environment is cardinal to the sustenance of life on earth. The idea of sustainable mode of development has been mooted in 1992 at the UN Conference on Environment and Development (UNCED) at Rio de Janeiro. In India, protection of environment has been prioritized in our national planning, consequently environmental studies and management have become an integral part of the curriculum of schools, colleges and universities.

Environmental auditing is the systematic process of identifying and assessing whether the practices and initiatives of the institution are sustainable and eco-friendly. Environment auditing is visualised to detect and monitor changes in the environment to improve the quality in terms of different components viz., air, water, soil, pollution levels, energy consumption, waste management, biodiversity, carbon foot print, besides human induced hazards and disasters. Maintaining the balance of nature is what is expected from every citizen.

The Government of India has declared the National Environmental Policy 2006 and made Environmental Audit mandatory to each establishment. According to the policy, it is a response to India's national commitment to clean environment mandated in the constitution in the Article 48A and 51A(g), strengthened by judicial interpretation of Article 21. It is recognised that the maintenance of the healthy environment is the responsibility of both the state and every citizen. Therefore, a spirit of partnership between state and its citizens is to be realized through the environment management and protection, aims towards environmental sustainability.

In view of the emerging cause towards environmental degradation, NAAC, an autonomous body under UGC has included the concept of Environmental Audit (Green Audit) in accreditation methodologies of colleges and universities.

Environmental auditing of educational institutions is an effort to build environmental sustainability in the campus. A thorough understanding of the need of the environmental quality has become an integral part of the educational system. Being a

premier institution of higher learning in Kerala, Marian College Kuttikkanam (Autonomous), is well aware of their responsibility towards environmental issues and wellbeing, the role in education, research, policy formation and information exchange necessary for a sustained environmental campaign and activities. The audit is the outcome of a combined effort of the college and an external expert audit group. Environmental Audit in education institutions is undoubtedly a fundamental component of good governance ensuring that processes and systems produce results that meet the needs of society while making the best use of resources at their disposal. The present Environmental Audit carried out is not only significant for the college, but also for other institutions to evaluate and adopt as a model, and therefore contributes regionally as well as nationally towards the noble cause of sustainable environment.

—— *Audit Team,*
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Executive Summary

A successful Environmental Audit plays a pivotal and integrative role in modelling a vision of environmental sustainability for the campus and hence become a mandatory procedure for educational institutions under Criterion VII of NACC.

The Marian College, Kuttikkanam (Autonomous) has adopted a spectacular environmental stewardship with its various green campus initiatives. Substantial progress has been made since the former audit, however, there remains scope for excellence where environmental commitments could be reinforced.

The Marian College Environmental Audit is based on the ISO 14000 policy standards recommended for higher education institutions towards attaining sustainability. The audit was conducted through regular site visits, interviews, facility tours, surveys and questionnaires, besides collecting existing records, reports and documents. Identified personnel who are capable of providing informed assessment in each sector were interviewed. Besides, official reports, documents and data were collected from the college. Detailed sampling studies (air and water quality) and related laboratory analysis wherever required were carried out in the School of Environmental Sciences, Mahatma Gandhi University. Application of sophisticated techniques like Remote Sensing (RS) and Geographic Information System (GIS) were also employed for quality analysis.
Meteorological Data that includes rainfall, temperature and humidity for 6 years were collected and assessed. Comprehensive field studies were conducted to elucidate the biodiversity in terms of faunal and floral diversity. As a gauge to track the institute's progress towards embracing environmental sustainability, the Environmental Audit was executed using specific performance indicators.

Energy audit

Since the previous audit, Marian College has taken momentous steps to reduce its energy consumption and improve the energy efficiency. It is observed that the management of Marian College has given due importance to address the issue of electricity wastage through proper optimization of the systems as an effective measure as per the

recommendations of earlier audit. Substantial energy saving and monetary benefits were also achieved.

The college has realised and established the potential avenues of renewable sources of energy like solar power and biogas in the campus. The Solar Photo Voltaic (SPV) System generates a substantial quantity of energy and accounts to meet approximately 40% of the total energy requirement of the campus. The potential generation of biogas from the food waste based biogas plant in the college hostel helps to trim down the energy expenditure of the Institution. Adoption of these alternative energy sources helped the campus to morph as a smart energy consumer. Specific recommendations for further improvement in energy efficiency has also been furnished.

Water audit

Imbibing the worth of water as the precious natural resource, significant and notable developments in terms of sensible water usage and conservation make the campus self-sufficient in water. The college is bestowed with surplus water resources owing to the effective conservation strategies, rain water harvesting and water management techniques. During the audit it is seen that the water sources are least polluted. The water audit indicated that the water consumption is moderate, with negligible water loss. The major water initiates of the campus identified are rain water harvest system, properly channelled water drainage and storage facility, water treatment and purification facility, sewage treatment plant etc. The best practices identified in the campus are the periodic monitoring of water quality, water harvesting, provision for ground water recharge, sewage water assisted organic farming etc. As a signature of compassion ‘Vellathotti’, an initiative of the campus stands to quench the thirst of birds and animals. Recommendations were also made to improve the efficiency of the water management system of the campus.

Waste audit

Performing the waste audit helps to manage the waste generated in the institution in a more environmentally friendly manner which ultimately contributes towards sustainability. It is noted that the waste management system in the college has been in place for the past years, as waste produced in the campus is disposed of, sorted and used for several purposes. An in-depth understanding regarding the way Marian community deals with waste is vital to recommend strategies for further carbon offset. Of the seven

categories of generated wastes, biodegradable waste forms the major proportion. Despite of the sizeable biodegradable waste being produced, through the healthy initiatives of the college considerable reduction and utilisation of waste has been achieved. The campus has well efficient and advanced mechanisms for sorting and treating both solid and liquid wastes. The institution follows a green protocol for waste management based on the previous green audit. Moreover, there is a campus wide co-ordinated waste generation programme and the implementation of Green protocol helped to reduce the plastic and paper waste.

Integrated effort has been taken from the management to minimise the paper usage and wastage through the increased dependence on digital plant forms. Campus is provided with vending machines and properly placed bins to collect disposables. Special care has been given to implement proper treatment for sewage water. Implementation of various green initiatives (fish farming, campus cleaning, gardening, organic vegetable cultivation etc.) in the college provide an interactive learning environment for students in waste management. Vermicomposting, waste derived energy generation through biogas plant, usage of food waste as animal feed (food for pig farm) etc. are the effective waste utilisation programmes of the campus. Procedures for disposal of worn-out furniture, construction waste, and other unconventional waste are well-established within the campus. Healthy practices include buy back policy with suppliers, handing over the used computers to schools and hardware training laboratories. Such attitudes seems to scale down the waste to a considerable extent. The idea of 'reducing, re-using and recycling' in the campus is revealed through the waste audit. Based on the observations, feasible recommendations were also made to maximise waste reduction in the campus, apart from outlining areas for improvement to attain environmental sustainability in terms of systematic waste management.

Biodiversity audit

Biodiversity audit comprises the observations and findings of rapid biodiversity assessment of Marian College campus and highlights the environmental history of the area, current status of flora (native, introduced, alien and invasive) and fauna (damselflies and dragonflies, butterflies, fishes, reptiles, birds and mammals), best practices observed and recommendations for better management. The campus maintains considerable composition of vegetation, despite of developmental activities. Being surrounded by

plantations and human habitations, it still serves as an abode for many native species of flora and fauna. Considering the ecological importance of the region improvement in terms of restoration with suggested native vegetation are recommended. Moreover, the healthy practice of retaining large trees and vegetation in the campus irrespective of the landscape alterations is noteworthy. Maintaining the major water bodies in the campus support teeming aquatic and associated population.

The geographical settings, and natural tranquillity of the Campus support appreciable biodiversity and moreover, the campus attitude of 'live with nature' augments campus biodiversity. Viable recommendations were also made through the audit. It is expected that the proper implementation of the suggested restoration activities and continuation of the best practices will enrich the biodiversity and ecological stability towards an ideal eco-friendly and sustainable campus.

Carbon audit

The carbon audit aims to make links between human actions that result in greenhouse gas emissions in terms of CO_2 and its impact on the surroundings. Presently, the spewing of gases into the atmosphere from various activities is increasing at an alarming rate and hence the need of awareness regarding these emissions is inevitable and undeniable. Since climate change and global warming remains as a challenge, a substitute to excessive greenhouse gas emissions must be done for a healthy environment. The successful execution of the carbon audit revealed that the per capita carbon footprint of the Marian college is approximately 0.158 TCO_2 (a substantial reduction from the earlier audit period). Besides the institutional potentiality in offsetting the emissions were also identified.

The audit identified and quantified the emission potential of major sources under three emission scopes. LPG and diesel consumption along with fugitive emission constituted the 1st scope emission categories. Consumption of purchased electricity constituted the second category and forms the major share in emission, while commuting, waste disposal and others collectively represented the scope 3 emission category. The total CO_2 emission of the campus is computed as 328.19 TCO_2 from activities under the three above mentioned categories. In comparison to the earlier reports, a significant reduction has been achieved in the total CO_2 emissions from the campus.

Disclosure of the carbon foot print of an educational institute is inevitable to identify the source and sink of emissions and the best possible mitigation measures that can be adopted towards the carbon reduction.

The Environmental Audit conducted in the Marian College, Kuttikkanam (Autonomous) revealed that the dew sparkled green campus is an ideal academic institutional model towards the path of environmental sustainability. Moreover, the present audit hopes to revitalise the Marian College and persist to act with the environment as a fundamental priority**.** Appraising the status of the environment in a massive institute like Marian College could not have come to fruition despite of the immense support and generosity which the team received. Undoubtedly, the enthusiasm, endurance and passion towards nurturing nature shown by the Marians fuelled with the unbeaten pace and proficiency of the ACESSD team remains as the major strength of this endeavour.

I

INTRODUCTION

Education is the primary step for individuals to gain knowledge, critical thinking, shaping attitudes, empowerment and skills needed to make this world a better place. As the foundation stone, education has a pivotal role in building up a strong nation with erudite citizenry. Moreover, it is a constant process by which the society consciously transmit its cultural legacy in the form of accumulated knowledge, skills and values from one generation to another through educational establishments. Throughout the country, the development and governance of educational institutions are under the directives of Indian constitution. Audit functions in educational institutions as a fundamental component of good governance ensuring that processes and systems produce results that meet the needs of society while making the best use of resources at their disposal. Higher education institutions like colleges are places where future leaders are moulded, and it must deliver an understanding of environment and sustainable development both at the level of a theoretical framework as well as showing the best practices in management. This can be achieved through a professional Environmental Audit generally known as Green Audit. Environmental Audit as an integrative tool for both sustainability training and operation management can be incorporated into the regulatory functions of an educational institute.

Background

The history of Environmental Audit implementation dates back to early 1970s in United States with Clean Air and Clean Water Act. In UK, the Environmental Audit guidelines were first introduced in 1975, and by 1992 majority of local authorities approved the audit completely or moderately. As a land mark on the history of sustainable approach to save earth, the United Nations Conference on Environment and Development (UNCED), popularly known as Earth Summit Rio - 1992 enthused the nations to appraise the effectiveness of their environmental stand as a sustainable approach. As the spirit of Earth Summit, most of the nations accepted policy and programmes to protect, upgrade and safe guard the environmental conditions. India is one among the first nations in the world to

make natural review or Environmental Audit mandatory from 1992-93. It became a requisite to each industry as mandated in the Constitution in Articles 48A and 51A(g), strengthened by judicial interpretation of Article 21 according to the Environmental Policy 2006, declared by the Government of India. As a part of endorsement process of higher education institutions, the perception of Environmental Audit has been appended by NAAC, a sovereign body under UGC.

The Environmental Audit conducted in the Marian College Kuttikkanam (Autonomous) identified the environmental status of the college being a pioneering academic institution which emphasises the importance of environmental quality. As per the detailed recommendations of the previous audit conducted, the Marian team including the management, students and staffs, incorporated the changes. From the present appraisal it is seen that the dew sparkled green campus has now turned as an ideal academic institutional model.

The integrative role of Environmental Audit

The Environmental Audit plays an integrative role in campus operation in promoting environmental sustainability, encouraging superior environmental quality and best practices. Higher education institutions are recognised as one of the prime consumers of natural resources and producers of immense quantity of wastes. As such these institutions require documented systematic and periodic verifications of environmental activities as a part of the ISO 14001 Standards. Execution of an Environmental Audit helps to reduce the environmental liability, sustainable natural resource consumption and pollution reduction of the institution. Through the assessment, the idea of sustainability as an outcome and a route of learning, as well as a catalyst for transformation in education can be achieved.

The Marian College has witnessed a reflective shift towards a holistic vision of environmental responsibility with green initiatives spearheaded by collective efforts incorporating all levels of organisation. Even though the College has made magnificent and substantial progress, there remains room for perfection where environmental commitments could be reinforced. Hence the Environmental Audit expects to assist Marian College in its effort to attain environmental sustainability. The details presented here constitute a consolidated Environmental Audit report for three years (2019-2021).

The previous audit has emphasised the need to focus sustainability in terms of energy consumption, and thus to trim down the environmental foot print of the institution. Undoubtedly, the audit has served as a potential tool in delineating arenas of upgradation through robust and detailed recommendations and suggestions about strategies and ideas. Even though much progress has been achieved as per the recommendations, the escalating pace of development and the stemming environmental implications are changing quite rapidly, and it is inevitable for an institution like the Marian College persist to act with the environment as a fundamental priority. The present Environmental Audit affectively gauges the process and progress of the college using effective performance indices.

Marian College Kuttikkanam (Autonomous), a leading academic institution established in 1995 is affiliated to the Mahatma Gandhi University. It is owned and managed by the Catholic Diocese of Kanjirappally. Located amidst the green sparkled rolling hills of Peerumedu, Idukki it sprawls over an area of 80937.1 sq. m. Marian College is predominantly a residential college with a primary concern of offering quality education to the budding generations. Marian has an inimitable and fortunate past that it gained autonomy in a span of 20 years. Presently the college offers 20 programmes, including doctoral programs in Social Work and Commerce. Marian was the youngest accredited college in India in 2003 and at present the college is re-accredited with A grade and CGPA 3.52/4 by the National Assessment and Accreditation Council (NAAC) in 2014. The college won the prestigious status of the ***College with Potential for Excellence (CPE)*** from University Grants Commission (UGC) in 2009 and 2014. The excellence of its academic programmes has garnered national and international attention. Moreover, the

residential aspect of the college encourages an informal ambience in scholastic and social situations.

The guiding vision and mission of the Marian College are as follows:

Vision

To be a transformational leader in education, facilitating and celebrating the full flowering of life in abundance.

Mission

1. **Relentless pursuit of knowledge**, realizing that the horizons of knowledge are ever expanding.
2. **Fostering spiritual and humane values**, being proud of our Indian ethos and the Christian message.
3. **Networking and collaborating for synergy**, knowing well that in today's world none of us can be as smart as all of us together.
4. **Expanding campus-community network**, because we are aware of our obligation to reach out to our less privileged brethren.
5. **Promoting sustainable living and environment friendly campus,** being sensitive to the fact that our planet Earth is the only one that we and our future generations have.
6. **Ensuring a learning environment** of creativity, adventure of ideas, constant innovation, enabling academic ambience and the state-of-the-art Information Communication Technology.

The process of NAAC accreditation has significantly influenced the continuous quality enhancement of Marian College from a systems perspective. The various systems evolved by the IQAC, together forming the Marian Quality Model (MQM), are at different phases of implementation. Through these quality assurance systems, the College is progressively improving her capability to achieve the set vision, viz., to lead transformation through higher education. The Marian family - students, teaching and administrative staff, other stakeholders and the leadership of the College - is working together to live up to the motto 'Information, Formation and Transformation'.

II

METEOROLOGICAL STATUS AND ENVIRONMENTAL QUALITY

The Marian College is situated 3,500 feet above sea level, with temperatures ranging from 10^{o}C to 30^{o}C. The extensive greenery around the campus forms an ideal environment for the college. Air quality of the campus is influenced by various natural (wind, pollen grains, dust etc.) and anthropogenic factors (vehicular movement, generators, fire, laboratory fumes, construction activities etc.).

Meteorological status

The weather data was collected from the web portal of National Aeronautics and Space Administration (NASA) (https://disc.gsfc.nasa.gov/). NASA provides the global scale observational data sets on land, ocean, ice and their interactions with the other components of Earth system to understand climate variability. Monthly average data of resolution 0.10 x 0.10° were downloaded for the period 2015-2020 and used for the analysis of weather conditions.

The Meteorological parameters such as rainfall, temperature and humidity, recorded from Marian college are given below.

The mean monthly rainfall for the years under consideration varied between 26.6 and 55.2 cm. (Table 1 & Fig.1) Maximum average rainfall was recorded during 2018 and minimum during 2016.

Table 1 Month & Year wise rainfall (cm)

Sl. No.	Months	2015	2016	2017	2018	2019	2020
1	January	1.86	1.6	1.34	1.08	0.82	0.56
2	February	3.86	0.8	2.26	1.04	0.24	0.46
3	March	11.72	10.84	9.96	9.08	8.2	7.32
4	April	13.18	11.18	11.18	14.36	10.36	10.4
5	May	31.33	33.4	35.47	37.54	39.61	36.68
6	June	72	55	80	150	132	111
7	July	77	61	63	170	162	160
8	August	80	47	82	190	172	157
9	September	48.42	49.5	50.58	51.66	52.74	46.82
10	October	28.22	22.2	16.18	20	21	12
11	November	25.66	19.3	15	14	11	13
12	December	10.54	8.3	6.06	3.82	1.58	0.66

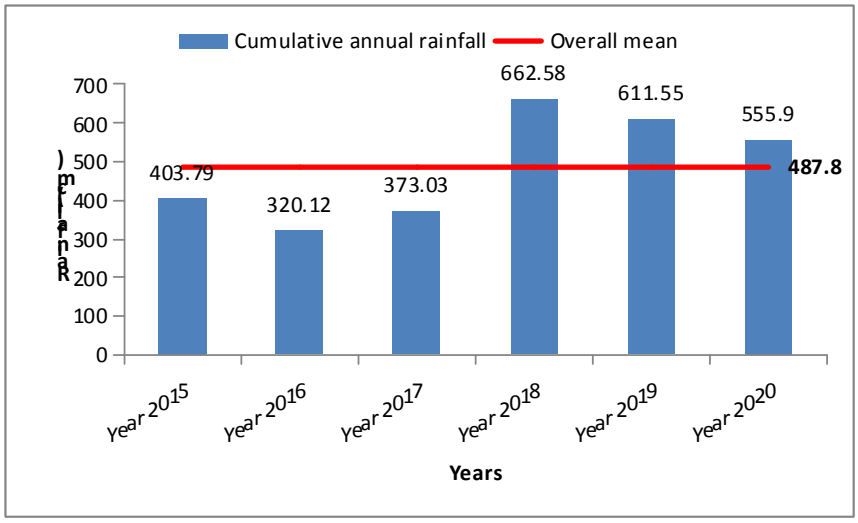


Fig. 1 Cumulative annual rainfall status (2015-2020)

The observed mean monthly temperature is depicted in Table 2. The mean monthly temperature for the years under consideration varied between 21. 2 and 22.07°C.

Table 2 Month & Year wise temperature (°C)

Sl. No.	Months	2015	2016	2017	2018	2019	2020
1	January	19.00	18.50	18.00	17.50	17.00	17.50
2	February	22.30	21.50	20.70	19.90	19.10	22.30
3	March	24.50	25.10	25.20	26.10	25.00	24.30
4	April	24.30	23.80	23.50	23.10	24.10	23.10
5	May	23.00	23.30	24.00	24.20	23.70	22.70
6	June	22.56	23.20	22.84	21.8	22.12	22.56
7	July	21.40	21.30	20.20	19.10	20.60	20.38
8	August	22.00	21.40	21.60	19.73	22.13	22.33
9	September	22.50	22.90	23.30	23.70	22.80	21.36
10	October	21.60	22.80	23.00	23.20	22.40	22.7
11	November	21.65	22.80	23.95	23.10	23.25	22.40
12	December	17.70	17.89	18.58	17.27	18.96	19.25

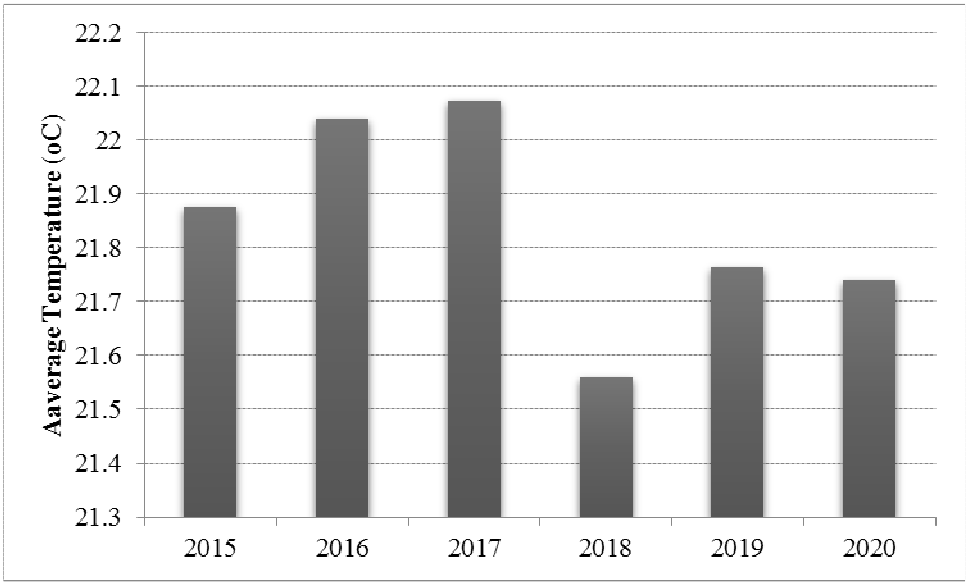


Fig. 2 Mean monthly temperature status

The average annual humidly varied between 82.2 and 83.6% in the area. The details were as follows:

Table 3 Month & Year wise humidity (%)

Sl No.	Months	2015	2016	2017	2018	2019	2020
1	January	65.3	63.1	60.9	68.7	66.5	67.3
2	February	63.5	66.5	66.5	67.5	65.5	70.9
3	March	70.7	72.7	74.7	74.7	74.7	73.3
4	April	76.9	77.9	78.9	78.9	76.9	76.2
5	May	85.1	89.1	83.1	82.1	80.1	88.8
6	June	90.2	89.2	88.2	87.2	88.2	86.8
7	July	91.4	92.3	93.2	94.1	93.21	94.468
8	August	91.6	95.6	93.6	98.6	95.6	95.5
9	September	92.8	93.7	94.6	92.5	94.4	91.2
10	October	90.1	88.3	86.5	86.7	87.9	89.1
11	November	86.9	87.9	87.9	85.9	85.9	86.7
12	December	81.3	82.5	82.7	81.9	81.1	82.6

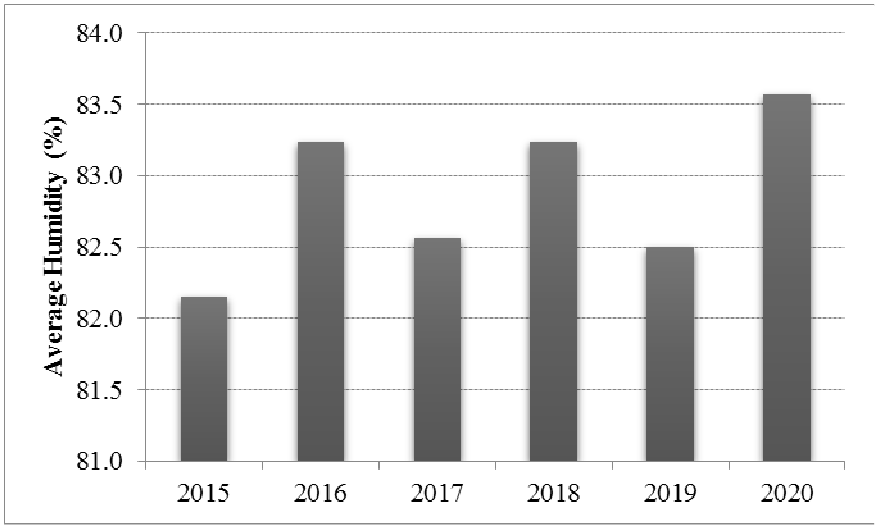


Fig. 3 Average annual humidity status

Air quality data

The air quality data was collected from the web-portal of NASA (https://disc.gsfc.nasa.gov/). The Goddard Earth Sciences Data and Information Services Center (GES DISC) archives provide atmospheric composition data from many remote sensing instruments and model assimilations dating back to 1970. These include datasets from the Orbiting Carbon Observatory 2 (OCO-2) on LEOStar-2; the Ozone Monitoring Instrument (OMI), the Microwave Limb Sounder (MLS), and the High Resolution Dynamic Limb Sounder (HIRDLS) aboard EOS Aura; the Thermal And Near-infrared Sensor for carbon Observation (TANSO)'s, Fourier Transform Spectrometer (TANSO-FTS) on the Greenhouse gases Observing SATellite (GOSAT) and the Atmospheric Infrared Sounder (AIRS) on EOS Aqua. Monthly average data (resolution 0.10 x 0.10°) were downloaded and used for the analysis.

Satellite image used

SI No:	Year	Image Acquisition Date	Satellite/ Sensor	Resolution (m)	Bands
1	2020	28-Feb	Landsat 8/ OLI	30	3,4,5

Analysis performed

The weather and atmospheric data files downloaded (.netcdf format) from the data portal were converted to raster file using Arc GIS Software and the spatial position of the Marian College, Kuttikkanam was overlaid on it. The pixel values of the corresponding location were estimated using extract value function in the software.

Nitrogen dioxide (NO_2)

Nitrogen dioxide (NO_2) is one among the group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NOx). NO_2 is used as the indicator for the larger group of nitrogen oxides. NO_2 primarily gets in the air from the burning of fuel and other forms of fire. NO_2 also accumulates from emissions of all kinds of vehicles (two- wheelers, cars, trucks, buses etc.), power plants, and off-road equipment. From the results, it is observed that NO_2 concentration of the region didn't show much variation in the monthly wise data collected from the campus. The average NO_2 concentration in the region is calculated as 13.1 µg/m³ (Fig. 4). Compared with CPCB standards NO_2 concentration reported in the campus was within the permissible limit (40 µg/m³) (Table 4).

Table 4 Monthly status of NO_2 level

Sl. No.	Months	NO_2 (µg/m³)*
1	January	14.9
2	February	12.5
3	March	14.2
4	April	13.6
5	May	13.8
6	June	11.2
7	July	10.6
8	August	11.3
9	September	12.7
10	October	13.1
11	November	14.1
12	December	14.7
	Average	13.1

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

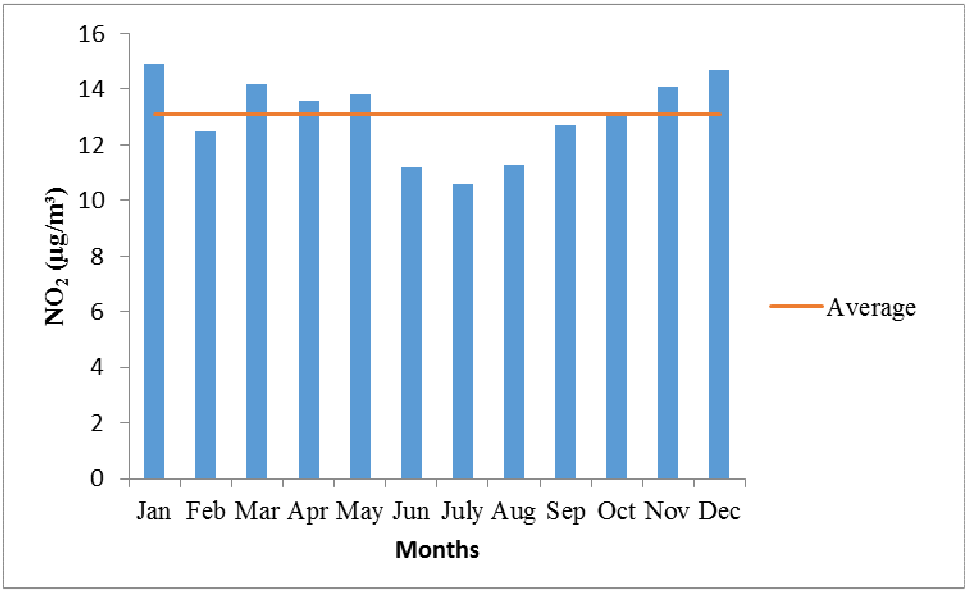


Fig. 4 Monthly NO_2 variation

Sulphur dioxide (SO_2)

Sulphur dioxide (SO_2) is one of the major air pollutants which is used as indicator for the larger group of gaseous sulphur oxides (SOx). Largest source of SO_2 in the atmosphere is from burning of fossil fuels by power plants and other industrial facilities. The lesser

sources of SO_2 emissions include industrial processes, heavy equipments etc. The results showed that monthly wise SO_2 concentration value falls within the range of 1.9-2.2 µg/m³ with maximum value recorded in the month of February and minimum in May. Any significant variation in the monthly data of SO_2 pollutant recorded from the campus. The average SO_2 concentration observed in the institutional area was found much lower (2.05 µg/m³) than the limit of CPCB standards (50 µg/m³)(Fig. 5).

Table 5 Monthly status of SO_2 level

Sl No.	Months	SO_2 (µg/m³)*
1	January	2.1
2	February	2.2
3	March	2.1
4	April	2
5	May	1.9
6	June	2
7	July	2
8	August	2.1
9	September	2
10	October	2.1
11	November	2.1
12	December	2
	Average	2.05

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

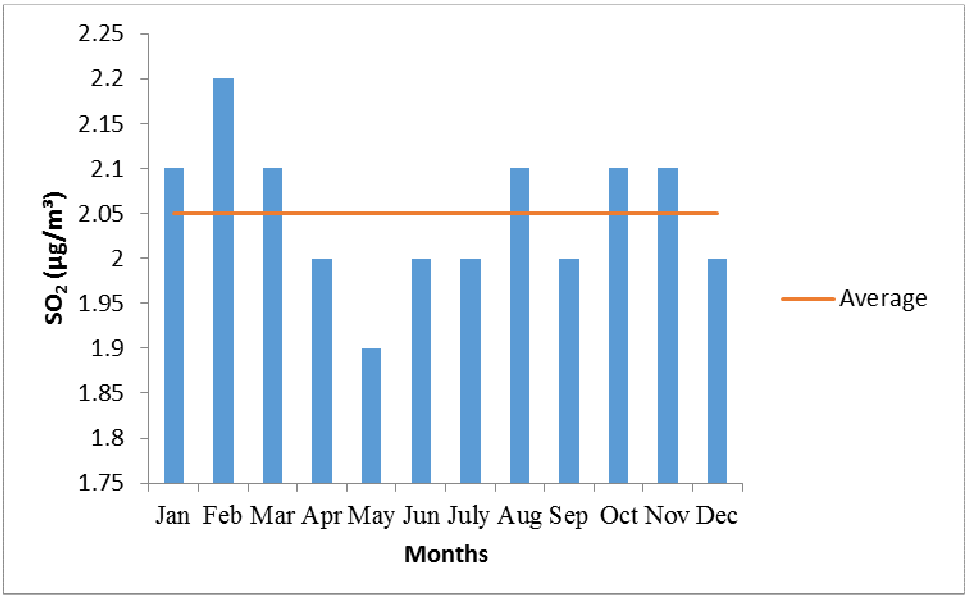


Fig. 5 Monthly SO_2 variation

Ozone (O_3)

Ozone (O_3) is a highly reactive gas composed of three oxygen atoms. It is both a natural and a man-made product that occurs both in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere). Depending on where ozone resides, it can protect or harm life on Earth. Stratospheric ozone is formed naturally through the interaction of solar ultraviolet (UV) The "ozone layer," situated approximately 6 to 30 miles above us reduces the amount of harmful UV radiation reaching the earth surface. The study revealed that monthly wise O_3 concentration varies from 22.6 µg/m³ (July) to 27.1 µg/m³ (December) in the region with average value calculated as 25.6 µg/m³ (Fig. 6). The permissible limit of CPCB standards is 100 µg/m³ (Table 6).

Table 6 Monthly status of Ozone level

Sl No.	Months	O_3 (µg/m³) *
1	January	26.9
2	February	26.7
3	March	26.5
4	April	26.2
5	May	26.5
6	June	24.1
7	July	22.6
8	August	22.8
9	September	25.3
10	October	26.1
11	November	26.3
12	December	27.1
	Average	25.6

*CPCB Standard of ozone level is (100 µg/m³)

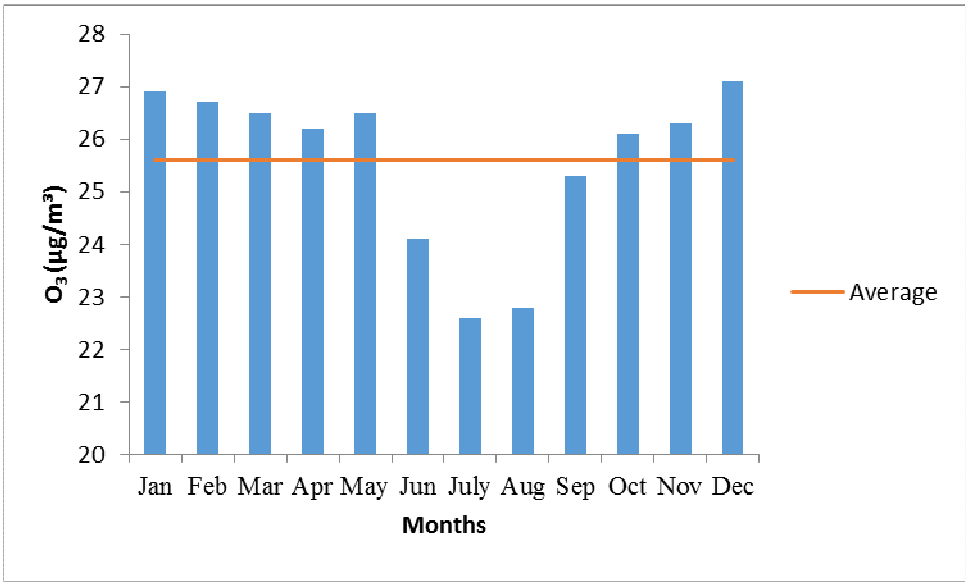


Fig. 6 Monthly O_3 variation

Particulate Matter (PM_{10})

Particulate matter (PM), also called particle pollutants, is a mixture of solid particles and liquid droplets found in the air. Among these, certain particles such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Whereas others are so small and can only be detected using an electron microscope. PM_{10} are inhalable particles, with diameters that are generally 10 micrometers or smaller.

The result indicates that month January had the highest PM_{10} concentrations while July marked the lowest. As expected, the monsoon months (June, July and August) recorded lower concentration compared to other months studied. The average PM_{10} concentration considering all the months in the region is estimated to be 32.4 $\mu g/m^3$ (Fig.7). As per the CPCB standards, permissible level of PM_{10} is 60 $\mu g/m^3$ (Table 7).

Table 7 Monthly status of particulate matter (PM_{10})

Sl No.	Months	PM $_{10}$ (µg/m³)*
1	January	35.1
2	February	34.6
3	March	33.8
4	April	34.2
5	May	33.5
6	June	30.1
7	July	27.4
8	August	29.6
9	September	31.2
10	October	32.9
11	November	31.8
12	December	34.9
	Average	32.4

* CPCB Standard of PM $_{10}$ level is (60µg/m³)

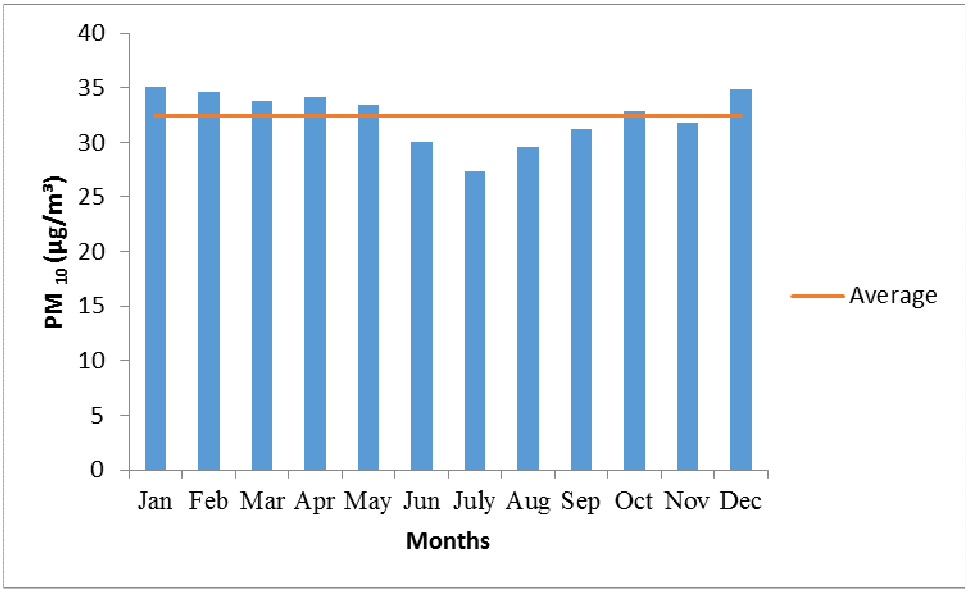


Fig.7 Monthly PM_{10} variation

Particulate Matter (PM $_{2.5}$)

Fine particulate matter ($PM_{2.5}$) is an air pollutant that may cause serious health issues when their levels are high in the atmosphere. Fine particulate matter ($PM_{2.5}$) is tiny particles in the air that reduce visibility due to haziness. Outdoor $PM_{2.5}$ levels are most likely to be elevated on days with little or no wind.

Here also January recorded maximum value while monsoon month August noted minimum in the concentration of Fine particulate matter ($PM_{2.5}$). Considering different months and taking its average, the quantity of $PM_{2.5}$ is calculated as 12.4 µg/m³ (Fig.8). Both month-wise and its average value of $PM_{2.5}$ data of Marian college was found within the limit (40 µg/m³) of CPCB standards (Table 8).

Table 8 Monthly status of fine particulate matter ($PM_{2.5}$)

Sl No.	Months	PM $_{2.5}$ (µg/m³)*
1	January	15.2
2	February	14.3
3	March	14.5
4	April	14.1
5	May	13.5
6	June	11.2
7	July	10.6
8	August	9.5
9	September	10.2
10	October	10.3
11	November	11.3
12	December	14.2
	Average	12.4

* CPCB Standard of PM $_{2.5}$ level is (40 µg/m³)

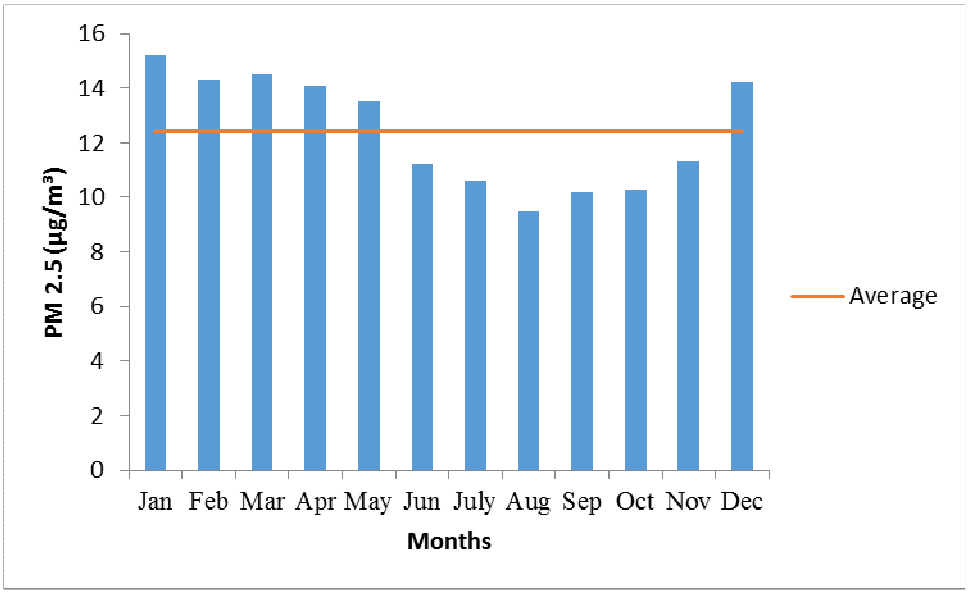


Fig. 8 Monthly $PM_{2.5}$ variation

Carbon monoxide (CO)

Carbon monoxide (CO) is a colourless and odourless gas that can be harmful when inhaled in large quantity. The major source of CO in the outdoor air is vehicles and industrial machinery that burn fossil fuels. Moreover various household items such as leaking chimneys, furnace and gas stoves also release CO and can affect indoor air quality. Month February recorded maximum value CO (1.35 mg/m³) and minimum in the month of August (0.89 mg/m³). Average value of CO observed from campus is estimated as 1.13 mg/m³. An observed value of carbon monoxide in the area is given in Table 9. The obtained results revealed that all the CO values are within the permissible limit of CPCB standards. The permissible limit of CPCB is 2 mg/m³.

Table 9 Monthly status of CO ($PM_{2.5}$)

Sl. no.	Month	CO (mg/m³)*
1	January	1.236
2	February	1.356
3	March	1.265
4	April	1.29
5	May	1.13
6	June	1.025
7	July	0.956
8	August	0.896
9	September	0.989
10	October	1.069
11	November	1.189
12	December	1.225
	Average	1.13

***** CPCB Standard of CO level is (2 mg/m³)

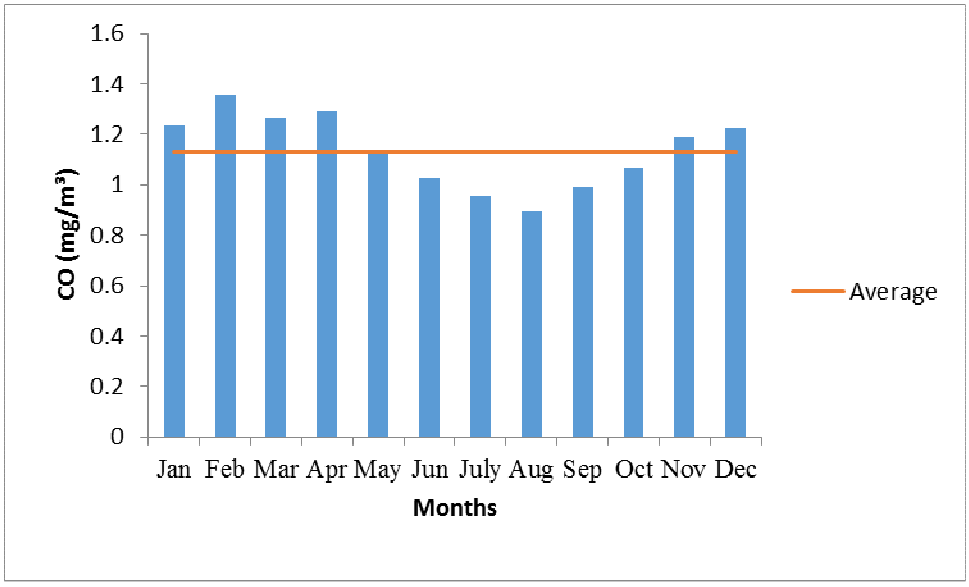


Fig. 9 Monthly CO variation

Marian college situated on the western edge of Western Ghats, which makes it ideal for getting upto 5000 mm rainfall. More than 75% of annual rainfall occurs during Southwest

monsoon period that is June to September. Maximum temperature rarely crosses 30^{o}C and minimum temperature rarely goes below 10^{o}C. Annual mean temperature of 22.5^{o}C without much seasonal variation attracts tourists. Misty climate throughout the year is mainly due to high humidity, a favourable tourism attracting factor of this region.

It is revealed that all the air quality parameters are within the permissible limit of Central Pollution Control Board (CPCB) standards. Moreover, the peculiar geographical disposition like high latitude and the distinct meteorological features including high wind speed (40 km per hour) helps to dissipate pollution load in the area. Most of the air pollutants will be removed from atmosphere as wet deposition.

III

Component Audits
(Healthy practices and recommendations):

1. ENERGY AUDIT

Energy is a vital and balancing factor in the indices for sustainable development since the 1992 Earth Summit. As higher education institutions are robust places to nurture management and action, such institutions are taking the lead to promote energy sustainability through proper energy management. Through proper energy management it is possible to address the escalating energy related economic and environmental liability. As such, the importance of energy audit as a gauge to monitor the energy efficiency of an institution receives immense importance from a developmental perspective.

According to the Energy Conservation Act 2001, Energy Audit is the verification, monitoring and analysis towards the sustainable use of energy for improving energy efficiency with an action plan to reduce energy consumption. It enables an organised method to the energy management in a system, in order to balance the energy input and usage. It is an effective and concrete method to achieve rapid improvement in energy efficiency in buildings and industrial processes. The primary objective of the energy audit is to determine ways to reduce energy consumption to lower operating costs.

Objectives

- Identification of major energy resources of the campus
- Generation of energy consumption profile of the campus
- Identification of sustainable energy avenues existing in the campus

Methodology

A team from ACESSD visited Marian Campus to assess the energy resources and its consumption pattern. The students and faculty members of Marian College assisted the team for data collection. Information regarding energy sources, quantity of consumption, its pattern of use, wastage etc. were entered in standard datasheets. Besides, rigorous field visits, interviews and discussions were conducted with the concerned authorities.

Energy sources and consumption profile

The Marian College utilizes electricity as the main energy source. The electrical energy is being supplied by the Kerala State Electricity Board (KSEB). Besides, LPG and diesel forms the additional energy sources. The campus is utilising the potential of solar power as a renewable energy option. The proposed 150 kWp Grid Tie Solar Photo Voltaic (SPV) System on roof tops of the institute is being productively executed under different phases. During 2019, the solar energy system of the campus was connected to the distribution system of KSEB and attained substantial reduction of electricity consumption. The campus also generates biogas from food waste that considerably substitutes current LPG usage.

1. Electrical Energy

Monthly electrical energy consumption

The mean annual electrical energy consumption of the campus was computed as 181184 kWh (Table 10) with a monthly average consumption of 16618 kWh. The variation of monthly power consumption is given in the graph (Fig. 10).

Table 10 Energy and cost distribution

Energy inputs	Unit	Annual consumption	Energy equivalent		Average cost/unit (Rs)	Total coast	
			kWh	%		Rupees	%
Electrical	kWh	181184	181184	42.76	10.68	1935137	57.78
Diesel	Litre	6000	76744	18.11	87.45	524700	15.67
LPG	kg	11880	165767	39.12	1235	889200	26.55
Total			423695	100	-	3349037	100

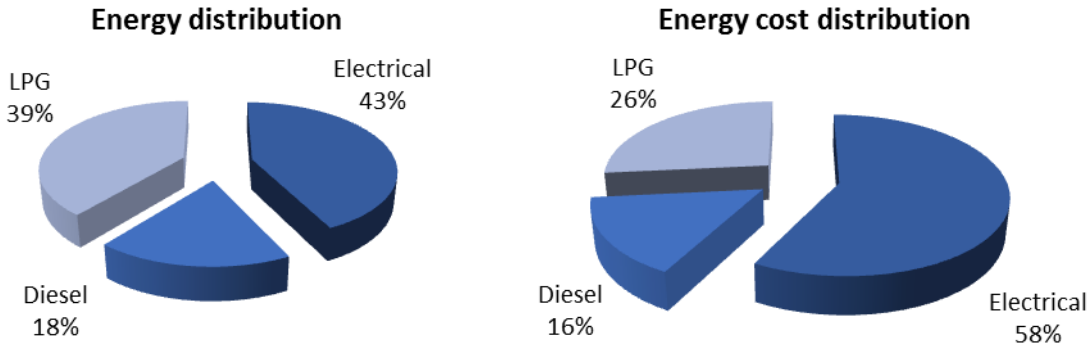


Fig. 10 Energy distribution and Energy cost distribution of the campus

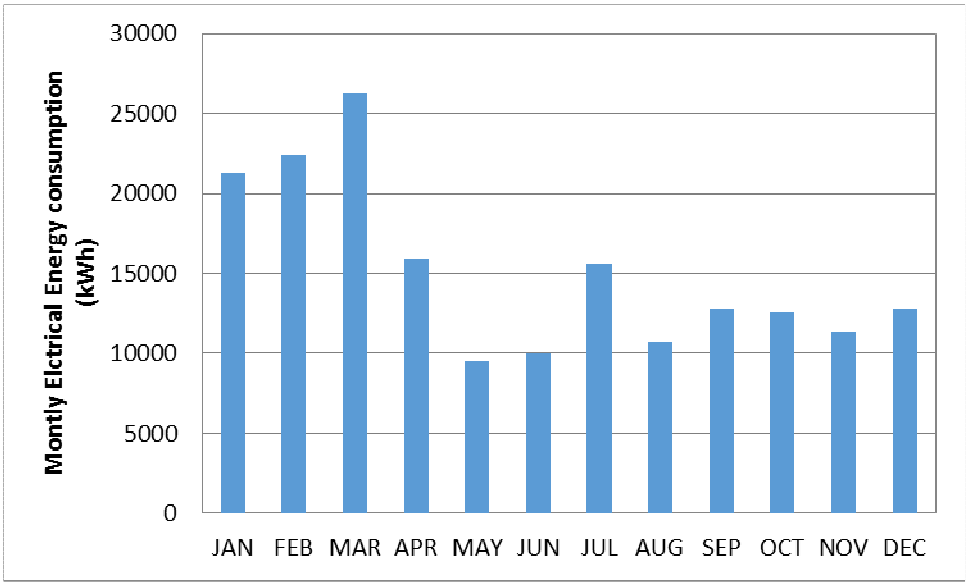


Fig. 11 Mean electrical energy consumption

Maximum energy utilisation was noted during the month of March whereas May recorded the minimum. The College is well equipped with adequate electrical installations and facilities. Considering the proportion of energy consumption among various devices present in the campus, maximum utilization is recorded for indoor lighting systems (34%) followed by the water heaters (19%). In the previous energy audit report conducted in the campus, the UPS and computer systems were found to consume maximum electricity. The energy saving interventions through the introduction of modular UPS systems and efficient computers helped to trim down the electric consumption significantly.

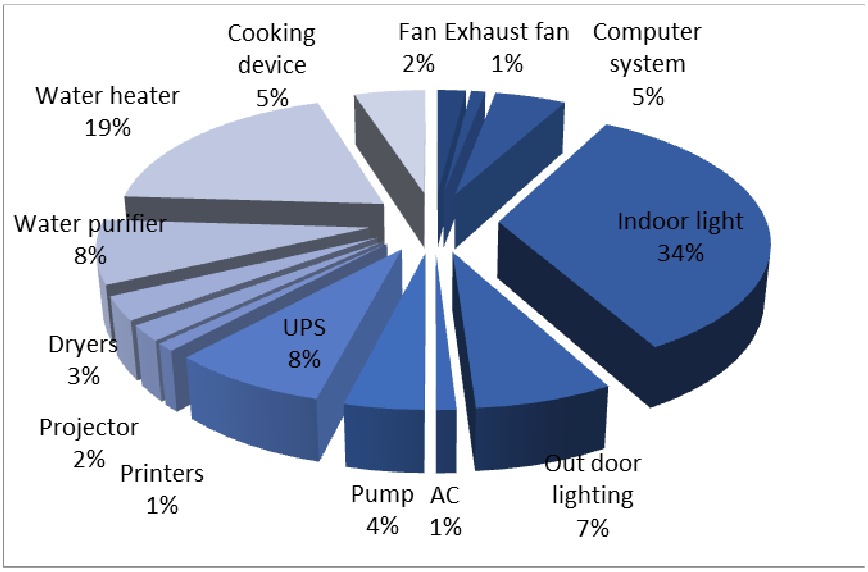


Fig. 12 Percentage energy consumption status by electric devices

For the campus, the connected load recorded is 269.73 kW and against this load, the electrical energy consumption rates falls under 3 different time zones of the day namely, normal (6 AM to 6 PM), peak (6 PM to 10 PM) and off-peak (10 PM to 6 AM). The energy use is charged as per the consumption rate during these three tariff regimes. The recorded charges for these zones were 6.20, 9.30 and 4.65 per unit respectively (KSEB). From the fig. 13 it is assumed that maximum electricity consumption is under the normal tariff period (41%).

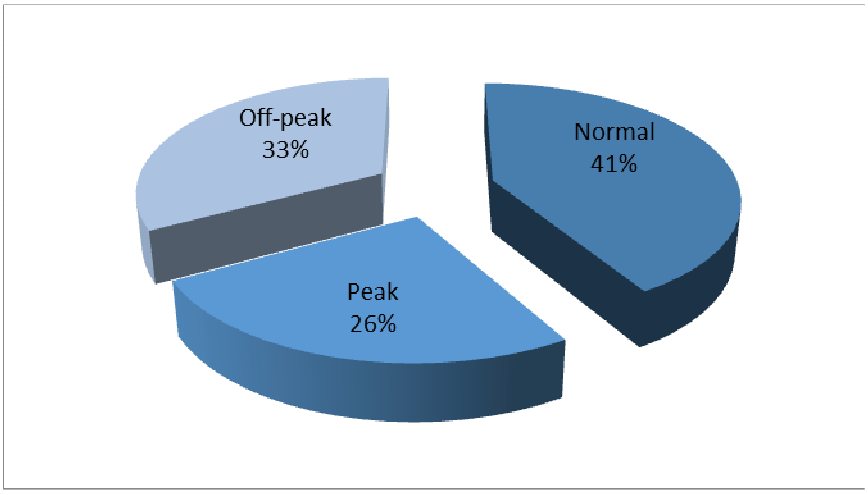


Fig. 13 Annual electricity consumption as per tariff regimes

Specific electrical energy consumption

The specific electrical energy consumption is the electrical energy consumed per unit. In the case of Marian college, the specific electrical energy consumption was calculated as the electrical energy consumption per person and electrical energy consumption per square meter of built-up-area (kWh/m^2).

In order to calculate the specific energy consumption, the total number of the persons present in the campus (including students, staffs and non-teaching staffs) and the total built up are considered.

Monthly variation in the specific energy consumption (Fig. 14 and Fig. 15) reveals the changing activities of the campus. The consolidated yearly specific energy consumption computed is 9.17 kWh/m^2/year and 95.05 kWh/person/year respectively.

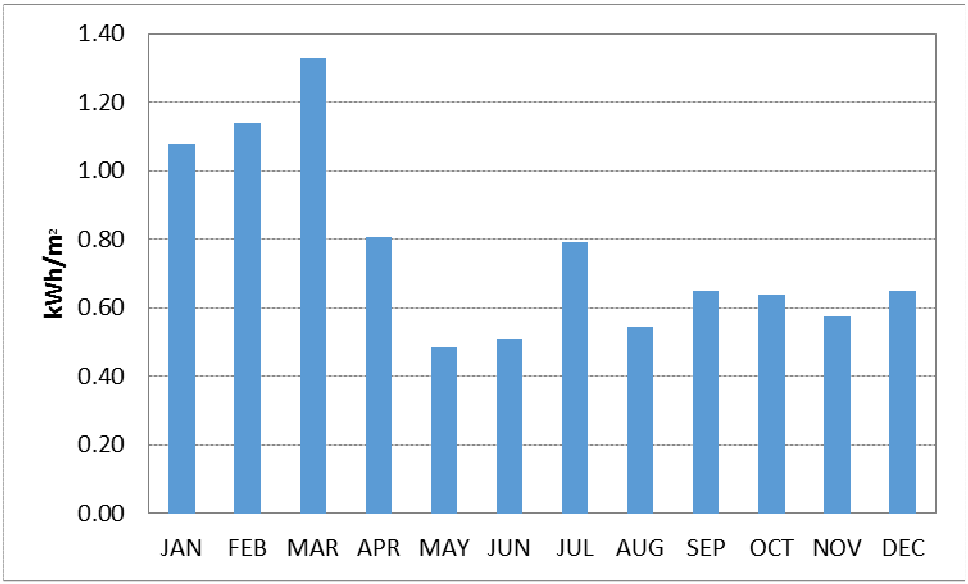


Fig. 14 Mean monthly specific energy consumption per sq. meter

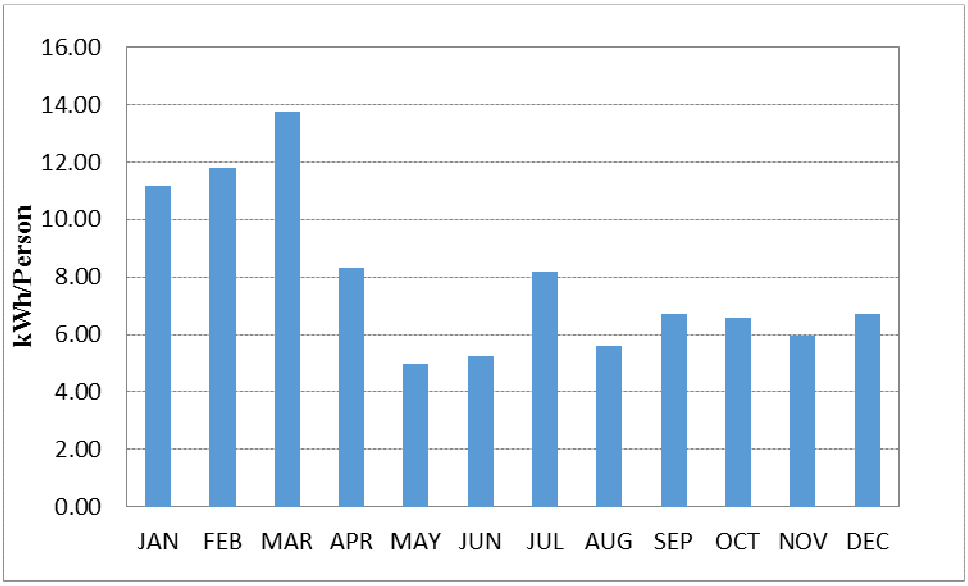


Fig. 15 Mean monthly specific energy consumption per person

In the previous audit, electricity wastage or leakage as 'Phantom load' (any kind of electricity that is used by devices that are turned off but are still plugged into an electrical outlet) in the institution has been identified and it is observed that the management has given due importance to address this issue through effective measures. It was estimated that 63% of the phantom load was contributed by the UPS system in the institute. Therefore, proper optimization of the system was done as per the audit recommendation and the phantom load was trimmed down considerably. Moreover, strict adherence to follow the management instructions regarding turning off and unplugging the electronic devices especially computers in the college helped to reduce the wastage of electricity considerably. Substantial energy saving and associated monetary benefits were obtained.

2. Diesel consumption

In the campus, diesel is used as an energy source mainly for power generation and transportation. For an uninterrupted power supply of the campus, a standby diesel generator (DG) is currently in use. In addition, the institution owns diesel operated vehicles (6 four-wheelers) for transportation.

The annual diesel consumption of the campus was estimated approximately as 6000 L which accounts for about 18.1% (76,744 kWh) of the total energy equivalent. Annually, about 3600 and 2400 L of diesel was consumed in vehicles and generator respectively. The diesel consumption accounts for a total annual expenditure of about 5,24,700 Rupees.

3. LPG

LPG consumption contributes nearly 39.12% (165767 kWh) to the total annual energy utilisation of the campus and hence considered as a major energy source. LPG is used in the hostels and canteen for cooking purposes. Additionally, in laundry, LPG derived energy is used in dryers. It is noted that 30 cylinders of each 14 and 19 kg capacity (total cylinders - 60) are being used in the campus for these purposes. Per year the total LPG requirement of the campus is computed as 11880 kg, accounting nearly a total expenditure of Rs. 8,89,200.

Table 11 Energy inputs, annual consumption and cost

Energy inputs	Unit	Annual consumption	Energy equivalent		Average cost/unit (Rs)	Total coast	
			kWh	%		Rupees	%
Electrical	kWh	181184	181184	42.76	10.68	1935137	57.78189
Diesel	Litre	6000	76744	18.11	87.45	524700	15.66719
LPG	kg	11880	165767	39.12	1235	889200	26.55092
Total			423695	100	-	3349037	100

Renewable energy avenues of the campus

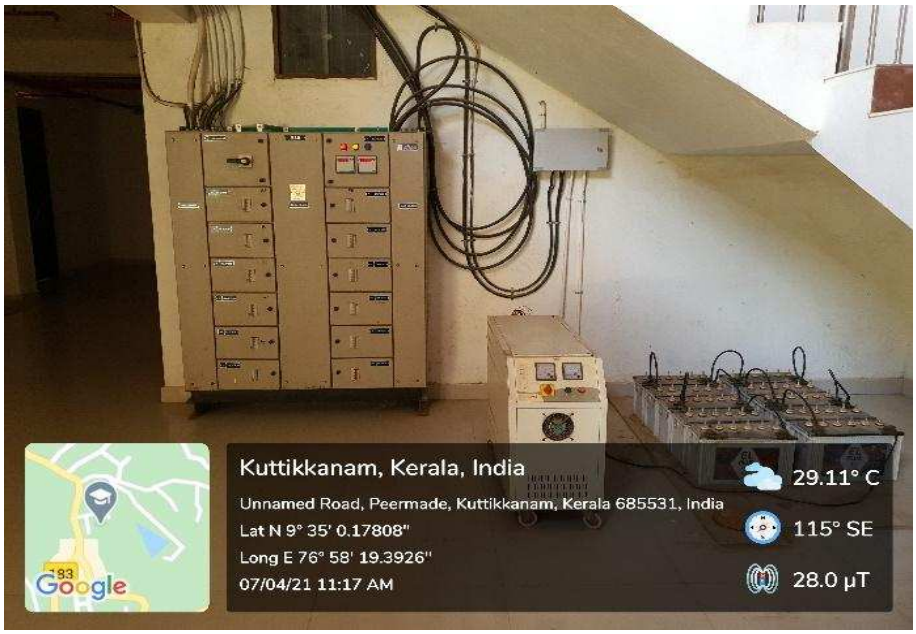
Marian College has realised the avenues of renewable sources of energy and its environmental output. Accordingly they searched the appropriate technologies and possible subsidies. Based on Environmental Audit Marian college took the following avenues and morphed as a smart energy consumer.

Solar Photo Voltaic (SPV) System

As per the recommendation of the previous audit, the management has set up the first phase of roof top solar system (30 kW) and connected the out puts to the distribution system of KSEB during 2019. The installation provides a reasonable harvest of 4 kWh energy per day. The per day total power requirement of the college is computed as 199 kW of which the SPV system provide nearly 80 kW energy and accounts to meet approximately 40% of the total energy requirement. Mainly the energy is utilised for the

working of water filters and purification, heaters and lighting purposes especially LED bulbs. The commissioning of the extended system is anticipated to contribute towards increased energy harvest of the campus.

The potential Solar Photo Voltaic (SPV) System of Marian College



Electric grid connections of Solar Photo Voltaic (SPV) installation

Substantial reduction in energy consumption and associated monetary reimbursement, environmental benefits like reduced carbon foot print are anticipated in long term from the SPV installation initiative.

Biogas production

For the Marian College, it seems nothing goes to waste. The Biogas Plant constituted in the hostel utilises the generated food waste and other biodegradable materials. The biogas produced is used to substitute the LGP cylinders in hostel for cooking purposes.

Presently there are four hostels operating in the campus, accommodating appreciable inmate strength. It is noted that biogas plant is now operating only in one hostel with 300 inmates. Approximately 10 LPG cylinders of 14 kg capacity per month are required for the cooking purpose in the hostels. The potential generation of biogas from the present food waste based biogas plant of 2 lakh litre feed capacity (fixed dome model) in the hostel helps to substitute nearly 4 LPG cylinders (56 kg LPG) per month. This has considerably reduced the energy expenditure of the Institution. However, the campus provides three more hostel facilities for the students but is devoid of this biogas generating facility. Intense dependence on firewood and purchased LPG cylinders for cooking purposes in these hostels were noted.

Considering the inmate strength and possibility of biogas production potential, there is an immense scope of constructing biogas plants in other hostels.

Another noteworthy green initiative of the management is the constructed storage tank set up for the extraction of leachate from the biogas plant and its further utilisation as a bio-fertilizer in the polyhouse farming.

Thus as an education institution Marian College tend to be a starting point for change. It seems that they are passionate about the big picture regarding sustainability and are ambitious for new technologies.

Biogas unit in the campus

Carbon Dioxide equivalent emission

Carbon foot print is the amount of the carbon dioxide released into the atmosphere as a result of the related activities of a particular individual, organisation or the community under concern. In case of electricity consumption Carbon Footprint (CF) represents the indirect CO_2 emission at the point of generation and not at the point of consumption.

In order to compute the generated CO_2, emission factors are used. It is the ratio of CO_2 generated from a given quantity of the fuel consumed. Based on the type of the fuel, the emission factor varies. As part of the audit conducted in the Marian Campus, an analysis has been carried out to estimate the approximate carbon foot print in terms of associated carbon dioxide emissions based on the energy utilisation.

The campus mainly relay up on Electrical energy, Diesel and LPG as energy sources. The CO_2 emission potential of these sources per unit is given in the table 12.

Table 12 Emission factors for energy categories

Energy category	Unit	CO_2 emission factor (kg CO_2)
Electricity	kWh	0.9
Diesel	Liter	2.68
LPG	Kg	3.0

Table 13 CO_2 emission corresponding to the annual consumption of energy

Energy category	Unit	Annual consumption	CO2 emission (kg)
Electricity	kWh	181184	163065.6
Diesel	Liter	6000	16080
LPG	Kg	11880	35640
Total Emission			**214785.6**

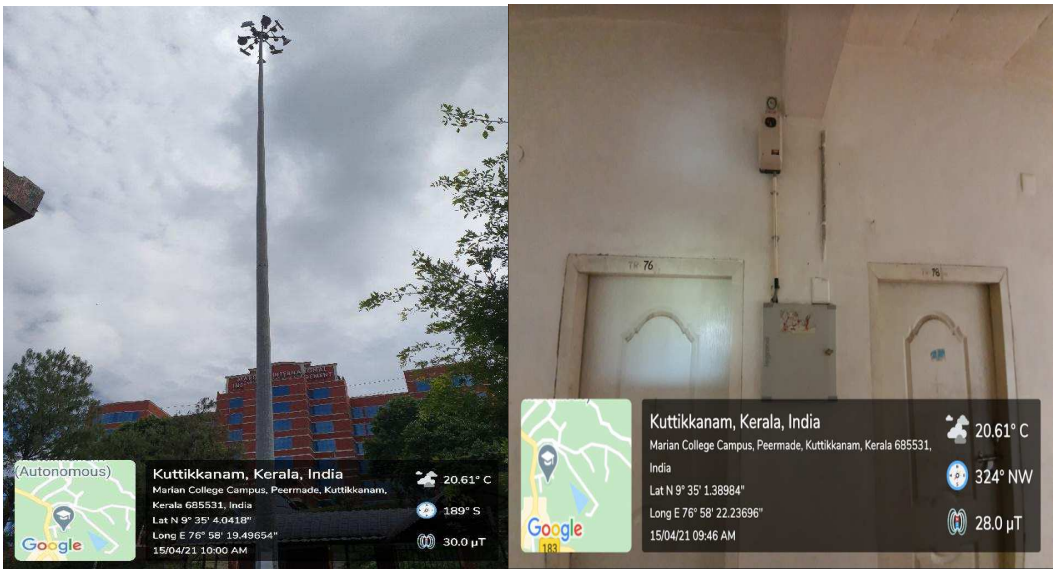
The current CO_2 emission from the campus is about 214.79 tonnes per annum and about 30% substantial emission reduction has been achieved per year when compared to the CO_2 emission estimations (306.8 tonnes of CO_2) of previous report. It is noted that the proper

implementation of the proposed energy conservation activities in the campus helped to reduce the carbon foot print to a considerable level paving a green track to sustainability.

Healthy practices

The college encourages sustainable energy in every aspects / activities particularly of its energy requirements as follows;

1. **Reducing day time utility**: Considerable day time electric energy has been saved mainly because the hostel buildings of the college were setup with solar panels. This energy is used for functioning the water filter and purification mechanisms. Moreover, the emphasis in utilising solar power through augmenting the capacity of the existing system is under consideration. This is a green and healthy initiative towards energy sustainability in the campus.
2. **Food waste derived Biogas plant:** A biogas unit is established to assimilate waste and to generate reserve fuel for cooking in hostel canteen. Presently only one biogas plant is under the process of energy generation and it helps to substitute nearly 4 LPG cylinders (14 kg capacity) per month in the canteen.
3. **Social enhancement**: Working computers with outdated configuration are donated to the School children of the surrounding community for their learning purpose.
4. **Installation of Timer facility**: A high-mast light is used in the campus, which is working with the support of an automated timer machine.
5. **Shift to energy efficient devices**: Marian campus has completely shifted to the use of LED bulbs as part of energy efficiency. More particularly, on yearly basis inefficient devices with respect to electricity consumption are systematically sold to vendors, which includes monitors, CPU, printers and other peripherals
6. **Updation of electrical equipment**: The outdated electrical equipment of the institute were replaced and updated. The UPS system was replaced with efficient dynamic modular UPS systems to reduce the energy loss.
7. **Installation of Sensor appliances**: Sensory based electrical appliances are used to conserve energy consumption and to benefit the environment. Heaters in the hostels are well connected with automated timer machines, which save considerable electricity consumption



High-mast light with timer **Heater with timer**

LED bulb assembling training

Marian College has signed MoU with KEL Electricals Mundakkayam for regular supply of LED bulbs and to buy-back the damaged LED bulbs. Besides, training has been given for the students on LED making.

LED bulb assembling training

Recommendations

- Display of signboards regarding optimal use of electrical appliances in the concerned rooms and offices.
- Replacement of CFL with LED bulbs.
- Replacement of inefficient machines with new ones.
- Make a regular check on the gadgets to improve its efficiency.
- Non usable CFLs can be exchanged with LED bulb through KSEB energy saving programme.
- Make sure to turn off and unplug the appliances and other gadgets after their use.
- "Phantom loads," or the electricity used by electronic devices when they are turned off or in standby mode, are a major source of energy waste. Hence use smart power strips.
- Promote the procurement and purchase of energy efficient appliances
- Incorporate energy efficient technologies in new and future buildings. It is also recommended to renovate the old rooms and constructions with energy efficient equipment and connections.
- It is recommended to monitor government energy projects and initiatives to ensure participation of the institution towards alternative energy initiatives, CDM programmes etc.
- Establishment of a mini hydropower plant for the Marian College.

Marian institution has developed a unique green trail to environmental sustainability in terms of energy efficiency. The institution has a clear vision and policy for the protection, preservation and sustainability. The motto of the policy is, **'live for Nature and live with Nature'.**

Possibility of introducing Energy Management System (EMS) in the campus

Energy Management System is the cautious and effectual use of energy to minimise costs and enhance operational efficiency and management as per ISO-50001 standard. This is

identified as an effective system towards improving the energy competence of an institution through continuous monitoring, measuring and analysis.

Introduction of EMS acquire data from different location within the campus by using communication capable energy meters linked by software applications. The data collected can be archived and processed for further interpretations and future needs. The introduction of EMS as a potential initiative can serve as a better podium for future energy efficiency improvement of the institution. Moreover it can promote centralisation of energy consumption data which can be further used for carbon foot print analysis. Hence the present audit recommends the introduction of an efficient EMS in the campus.

2. WATER AUDIT

Water is a precious natural resource facing shortage of availability all over the world. Kerala that receives about 3000 mm annual rainfall is reported to be drought prone in almost all districts. Kuttikkanam in Idukki district is gifted with an annual rainfall upto 5000 mm. The water audit of Marian College Autonomous Kuttikkanam is focused on the availability, usage, purification, and recycling of the water resources in the campus. Healthy practices taken up are also looked into.

It may be noted that the National Mission on Water Conservation with the campaign '*Jal Shakti Abhiyan*' initiated by the Government of India, appeals all citizens to collectively address the problem of water shortage, by conserving every drop of water and suggested for conducting water audit for all sectors of water use.

General guidelines for Water Audit & Water Conservation, 2005 envisages that water audit is a full analysis of water processed by a utility. It is an effective management tool for minimizing losses, optimizing various uses and thus enabling considerable conservation of water. Water audit improves the knowledge and documentation of the distribution system, problem and risk areas and a better understanding of what are happening to the water after it leaves the source point.

The water audit is a well-established method for identifying both productive and wasteful usage of water. A water-saving plan can be designed if one understands where water is consumed and lost. Detecting and fixing leaks saves a significant amount of water while also eliminating the need to find additional water sources to satisfy rising demand. As a consequence, a water audit may produce desired outcomes by detecting and resolving water issues, as well as making water utility financially sustainable. The ultimate objective of a water audit should be to identify and execute water-saving programmes.

Objectives

- To list out the water resources of the Campus
- To find out the pattern and quantity of water usage in the Campus
- To trace the quantity of water wastage in the Campus
- To assess the quality of available water
- To suggest remedial measures and water conservation practices

Methodology

A team from ACESSD visited Marian Campus periodically and assessed the status of water resources. The students and faculty members of Marian College assisted the team for data collection. Information regarding sources, pattern and quantity of water usage, wastage etc. were entered in the standard datasheets. Besides, rigorous field visits, interviews and discussions were conducted with the concerned authorities. The water samples collected were brought to ACESSD in Mahatma Gandhi University for physico-chemical analysis. Important parameters like pH, EC, TDS, salinity, hardness, chloride and nitrate of the water samples were analysed and assessed.

Sources of water

The campus is found self-sufficient in water. There are two checkdams (constructed surface water reservoirs) that collect water and form the major water sources of the campus. The water collected by the rainwater harvesting network is channelled to the check dams. Besides, there is a bore-well for groundwater. Since the campus is enriched with sufficient water throughout the year it does not depend on public water system.

Surface reservoirs

Water quality

Water quality refers to the condition of a water sample, including its chemical, physical, and biological qualities, as well as its suitability for a certain purpose. It is measured by analyzing different factors like pH, Total Dissolved Solids (TDS), salinity, hardness, chloride, nitrate, etc. Periodic analysis helps in understanding the quality of water and can enhance it if necessary.

Physico-chemical parameters of water

The present study looked into the details of different physico-chemical parameters like pH, Electrical Conductivity (EC), TDS, salinity, hardness, chloride and nitrate of the water samples from the campus. The list of mentioned water quality parameters and their analytical methods are shown in table 15. The water samples were collected from the four stations of campus. The name of different sampling stations and their codes are given in table 14.

Table 14 Sampling stations

Code	Water sampling stations
S1	Lower checkdam
S2	Bore well
S3	Filtration point
S4	Upper checkdam

Table 15 Physico-chemical parameters and methods

Sl.No.	Parameters	Unit	Method/Instruments
Physico-chemical parameters			
1	TDS	ppm	pH meter
2	EC	µs/cm	,,
3	pH	-	,,
4	Salinity	ppm	,,
5	Chloride	mg/L	Argentometry
6	Hardness	mg/L	EDTA titrimetry
7	Nitrate	mg/L	Brucine method

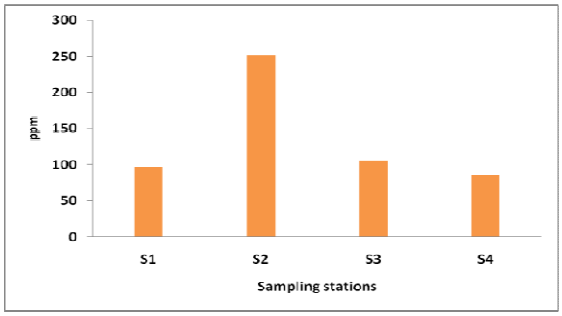
Appraisal of physico-chemical parameters of water samples

The results of the physico-chemical parameters like pH, EC, TDS, salinity, hardness, chloride and nitrate of the water samples from the campus are depicted in table 16. Among the different sampling stations, site S2 (Borewell) recorded the highest values of TDS (251 ppm), EC (354 µs/cm), pH (7.84) and Salinity (170 ppm) whereas S4 (Upper checkdam) recorded the lowest values (Table 16). In the case of chloride, hardness and nitrate, site S4 recorded highest values. During the study it is found that the values of the physico-chemical parameters are within the permissible limit of WHO.

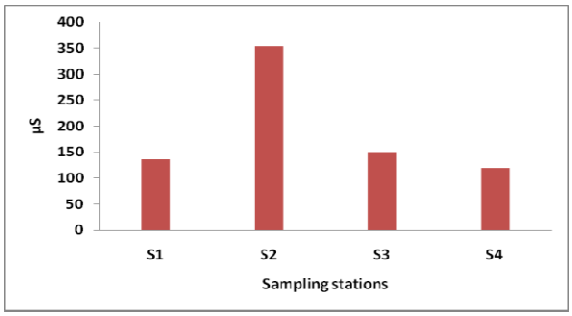
Table 16 Status of physico-chemical parameters tested from the water samples of the campus

Physico-chemical parameters	WHO Standards	S1	S2	S3	S4
TDS (ppm)	500	96.3	251	106	85.5
EC (µs/cm)	--	135.8	354	149.7	119.4
pH	6.5-8.5	7.71	7.84	7.68	7.33
Salinity (ppm)	500	67.6	170	73.9	60.7
Chloride (mg/L)	250	14.9	12.9	10.4	16.7
Hardness (mg/L)	300	12	6.6	2	18
Nitrate (mg/L)	45	4.2	4.5	0.1	8.2

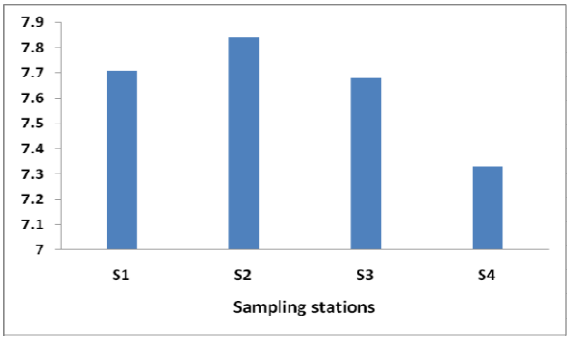
WHO – World Health Organization



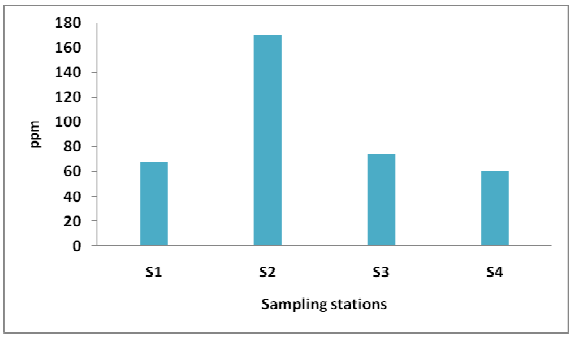
TDS



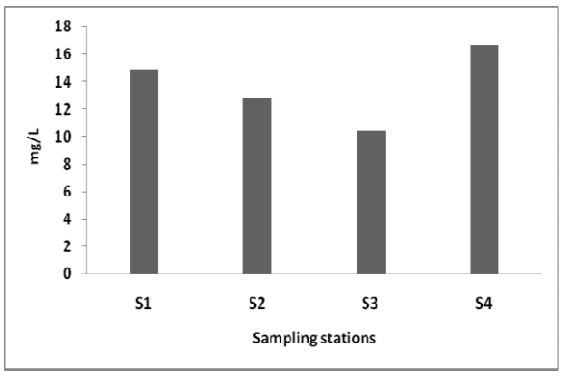
Conductivity



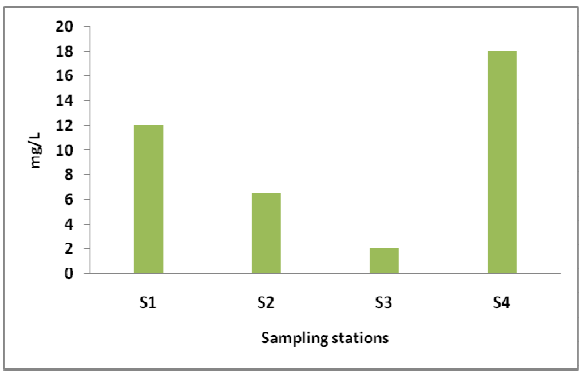
pH



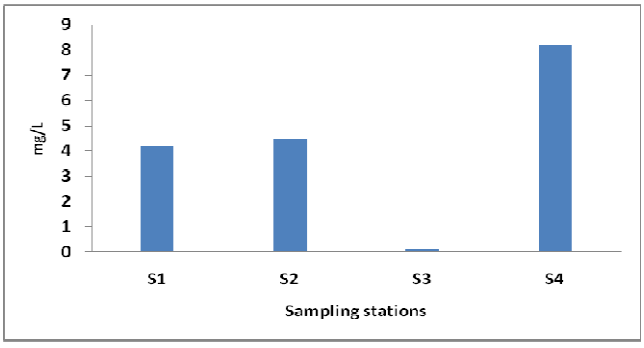
Salinity



Chloride



Hardness



Nitrate

Fig. 16 Variation in physico-chemical parameters

Bacteriological Parameter

MPN test of water samples

The table 17 listed the Most Probable Number (MPN) index of the water from different sampling stations.

Table 17 MPN result

Sample code	MPN load (MPN/100ml)
S1	210
S2	64
S3	0
S4	1100

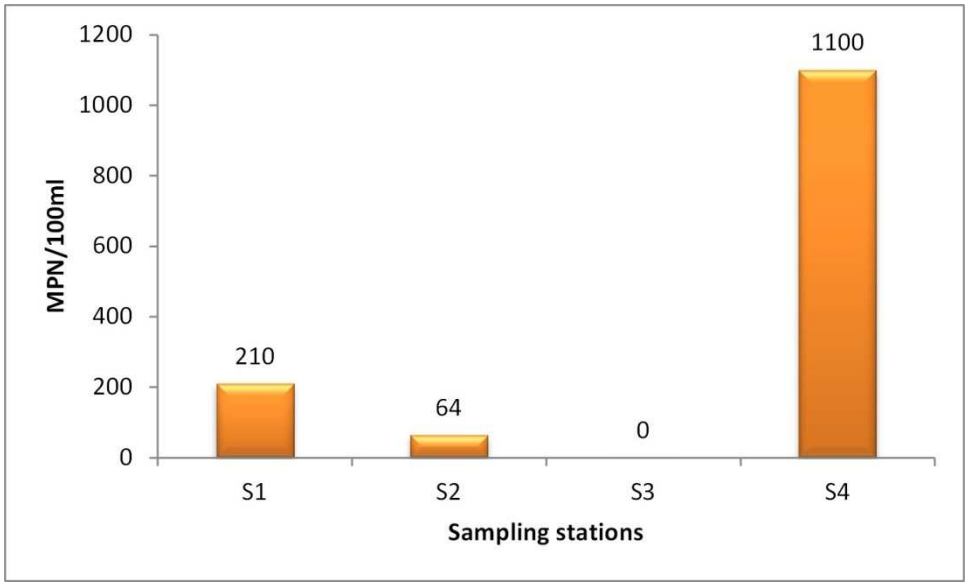


Fig. 17 MPN index of *E. coli*

Escherichia coli (*E. coli*) is a single-celled bacteria that are commonly found in the gastrointestinal tract and faeces of warm-blooded animals. It is noted that, the MPN index value (1100/100ml) obtained for the upper checkdam (S4) is higher and the water samples from the filtration unit (S3) is devoid of *E. coli* contamination (Table 17). The majority of *E. coli* strains are either non-pathogenic or cause only mild diarrhoea. However, a few strains can cause severe stomach cramps, bloody diarrhoea, and vomiting.

Quality of the available water in the campus is regularly monitored to ensure purity and proper pH value. Students associations like NSS and NCC units and college employees, along with nearby residents volunteer to maintain the water quality of the campus.

Water usage in the Campus

The water usage can be referred to as water used from different water sources for various activities like usage in the canteen, hostels, academic blocks, gardens, grounds etc. Being a residential institution with large campus, its water usage is relatively high. The campus uses water for both drinking purpose and non-drinking purposes. The non-drinking purposes include, toilet and bath, shower, watering plants, construction works etc.

Table 18 Total water usage

Sl No.	Fixtures	Total daily use (L)	Total yearly use (L)	Per capita use (L)	%
1	Kitchen taps	2800	677600	258.63	8.88
2	Utility taps	11000	2662000	1016.03	34.88
3	Bathroom faucet	1104	267168	101.97	3.50
4	Shower	800	193600	73.89	2.54
5	Outside taps	2880	696960	266.02	9.13
6	Lab taps	1080	261360	99.76	3.42
7	Hose	35	8470	3.23	0.11
8	Large kitchen taps	4800	1161600	443.36	15.22
9	Water purifier	39	9438	3.60	0.12
10	Flush tank	7000	1694000	646.56	22.20
Total		**31,538**	**76,32,196**	**2,913**	**100**

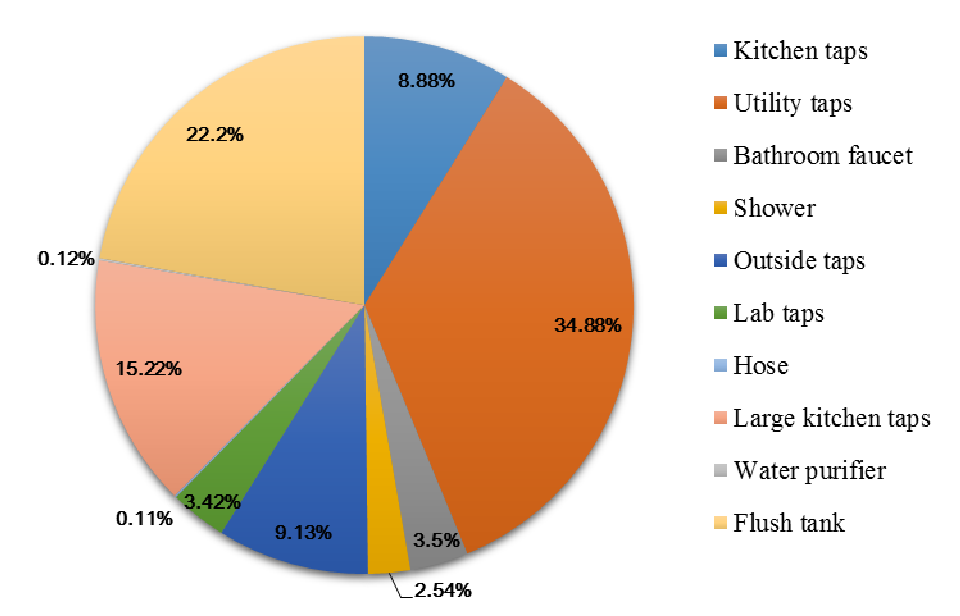


Fig. 18 Proportion of water usage in the Campus

A total of 31,538 and 76, 32,196 litre water is used daily and yearly respectively in the campus. It is seen that about 9,438 litre water is consumed for drinking purpose only. From the data gathered, it is evident that the major portion of water is consumed through utility taps (26, 62,000 litre/year) which are the common taps associated with wash basins. A total of 144 and 451 utility taps are in the college and hostels respectively.

About 16, 94,000 litre of water is utilized by the flush tanks per year. This can be reduced to an extent by replacing existing flush tanks with dual flush systems. Nearly 2, 67,168 litre water is found to be used by bathroom faucets, followed by 1, 93,600 litre for showers whereas laboratory taps consume 2, 61,360 litre per year. For gardening and related activities, about 8,470 litre water is utilized annually.

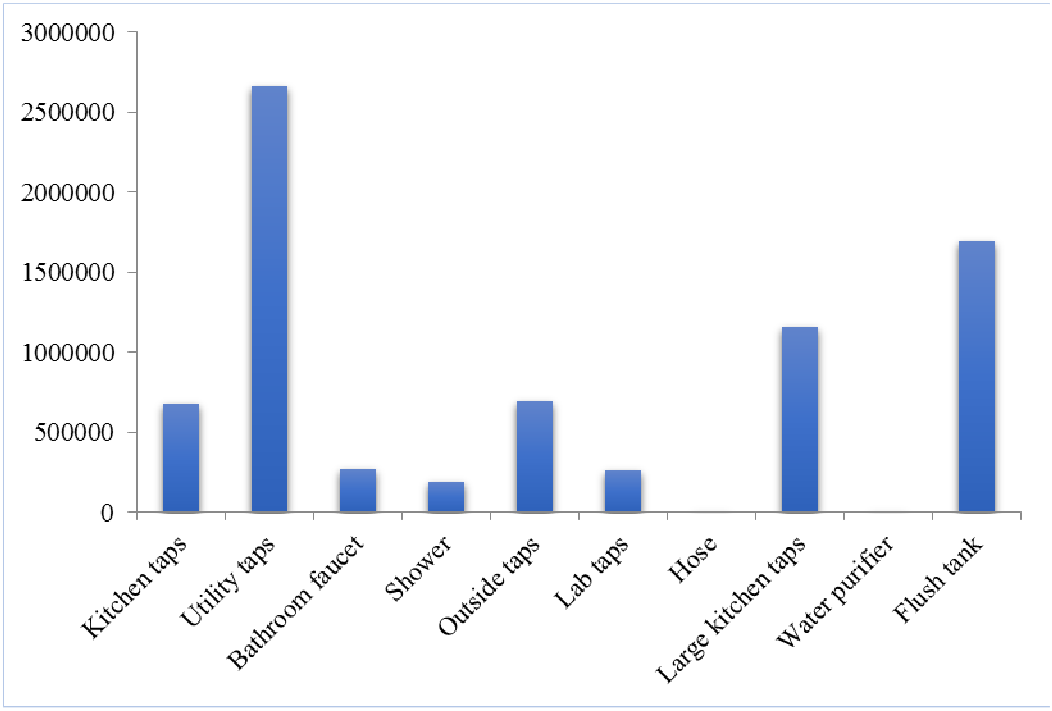


Fig. 19 Annual water consumption

Total loss of water per day due to leaking taps

Leaking taps is the most common source of water loss in the campus. It is observed that only three taps are found leaking, which accounts for about 129.6 litre of water loss per day. If unattended, the projected water loss would be approximately 46,209 litre/year. In order to overcome this situation, periodic inspections are required.

Number of leaking taps	3
Quantity of water loss through leaking taps	**129.6 litre/day**

Storage capacity and frequency of filling water

The campus has four pumps, two of which have a capacity of 5 HP and the other two have a capacity of 7.5 HP. About 1, 64,000 litre water is pumped out per day by electric pumps from the reservoir and the sewage treatment plant.

Table 19 Storage capacity and frequency of filling water

Sl. No.	Type of building with water tank	Capacity	Frequency of filling per day	Average amount of water usage (litre/day)
1	Old Academic Block	10000	1	4157
2	New Academic Block	33000	1	4612
3	Administrative Block + Guest House	15000	1	1255
4	MIIM	34000	1	4100
5	PG Boy's Hostel	29000	2	7225
6	UG Boy's Hostel	16000	1	6090
7	Ladies Hostel	15000	2	7225
8	STP (Ladies Hostel)	5000	1	2675
9	STP (MIIM)	5000	1	2880
10	STP (PG Hostel)	2000	1	2675
Total		**1,64000**		**44,215**

Water management practices in the Campus

Rainwater Harvesting

In Peermedu, Idukki district, the average annual rainfall recorded is upto 5000 mm. It is reported that the campus attained self-sufficiency in terms of water by 2001; prior to which the water requirement of the campus was met from outside sources. This is a remarkable achievement acquired by the Marian College owing to their wise water planning strategy. Water sufficiency achieved by the campus is a sustainable water resource model which can be recommendable to other such institution. The Campus has

efficient rainwater harvesting systems with two constructed surface water reservoirs. Along with rainwater harvesting, they undertake fish farming in the two reservoirs. The capacity of the reservoirs was about 71 lakh and 2 crore litre of water respectively. The reservoirs also function as storage tanks for harvested rainwater. It may be noted that this large storage system aids in recharging groundwater.

Reservoirs

Inclined terrain

Drainage system

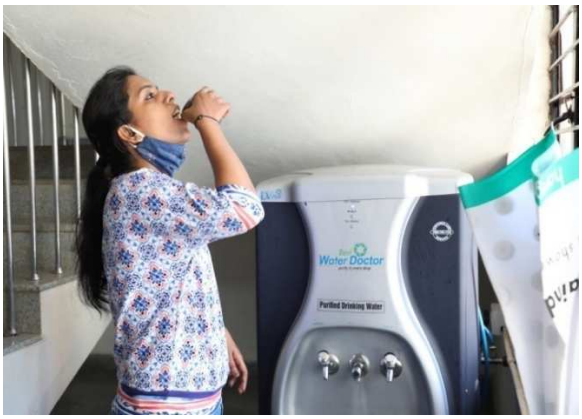
The campus has well-engineered channel system that transports and collects water from the ground and other areas to reservoirs. Such a criterion saves considerable volume of surface water. All the runoff water from the campus and the rooftops are collected via pipes and channels built on the surface. It is assured that the pipes and tanks are of the highest quality, and that the circulatory system is built scientifically to avoid unintended contamination. The storage of rainwater in the two reservoirs has aided in the enhancement of the area's ground water level, resulting in a significant reduction in the shortage of water for the local population during drought conditions.

Channel System

Water treatment system

There is an efficient treatment facility for purifying the water stored in the reservoirs. This water is used for drinking and cooking after UV filtration. More than 30 filter taps are made available for drinking purposes in the campus.

Water treatment system



UV filtered drinking water

Orientation and public participation

Orientation classes are conducted in the campus for creating awareness on the significance of water conservation by the School of Social Work, Extension Department, NSS and NCC unit of the college for the students and neighbouring communities. Public participation is encouraged for planting trees, vegetables, and medicinal herbs along the reservoir banks. Besides, the institution has a well-maintained organic farm irrigated by recycled water.

Orientation classes

Public participation in organic farming

Sewage treatment plant

The campus owns an advanced sewage treatment plant with a considerable treating capacity of 50,000 litre of waste water per day. The treated water is used in toilet flushing, farming and gardening (sprinkler irrigation system).It is noted that this recycled water usage reduces nearly 65% of the primary fresh water utilization in the campus.

Sewage treatment plant

Student Participations

A strong students participation in activities like cleaning of tanks, reservoirs, and filters help to raise awareness on water management. Participatory fish farming is also done in the two reservoirs, and a considerable catch is available each year.

Student Participation in reservoir cleaning

Fishes from the reservoirs

Healthy practices

1. Periodic monitoring of water quality
2. Rainwater harvesting
3. Groundwater recharging
4. Water treatment plants
5. Rearing fishes in reservoirs
6. Organic farming with public participation
7. Vellathotti – a water initiative for animals and birds

Groundwater recharging

ജലദിനത്തിൽ പക്ഷിമൃഗാദികൾക്ക് ശുദ്ധജലം ലഭ്യമാക്കുന്നതിനു വേണ്ടി കുട്ടിക്കാനം മരിയൻ കോളജ് ക്യാംപസിൽ സ്ഥാപിച്ച വെള്ളത്തൊട്ടി. 150 ലിറ്റർ വെള്ളം സംഭരിക്കാവുന്ന തൊട്ടിയാണ് നിർമിച്ചിരിക്കുന്നത്.

Vellathotti

8. Certificate of appreciation for environmentally sustainable endeavors

As a reverence to the sustainable green initiatives of the Marian College, the Kanchiyar Grama Panchayath of Idukki district, has honoured the college with a ***Certificate of Appreciation*** specifically for the rainwater harvesting and sustainable energy project implementation. The water conservation and storage aided through intensive rainwater harvesting programme helped in the retaining and percolation of water in the region and this has facilitated to improve the water recharging efficiency of the nearby areas also.

Certificate of Appreciation

Conclusion

The water audit is an excellent tool for assessing the available water resources and consumption pattern of the campus. Furthermore, it offers scientific ways to promote water conservation by minimizing water loss and indiscriminate consumption practices.

The water audit executed in the Marian College found that the water consumption is moderate, with negligible water loss. It is found that the highest water use in the campus is through utility taps. Hence, it is recommended to implement adequate water conservation measures. A significant amount of water is lost through the leakage of pipes. The periodic inspection and timely maintenance of leakage can reduce the loss.

While water quality analysis reveals that all physico-chemical parameters are within acceptable limits of WHO, but *E. coli* contamination is observed in the check-dams. The presence of *E. coli* in water is a reliable indicator of sewage or animal waste contamination.

The present awareness programmes for the management of sustainable water use is found highly efficient in this college.

Recommendations

- Install sensor taps for saving water loss
- Plant *Vetiveria zizanioides* along the banks of check-dams
- Wick or drip irrigation should be practiced in gardens
- Install dual flush systems in toilets
- Install spray tap systems on common taps
- Conduct regular monitoring (e.g. bi-monthly) of water usage
- Install automatic switching system in pump sets for overhead tank filling
- Timely reporting and proper maintenance of water carrying installations
- Re-strengthening the existing water awareness

3. WASTE AUDIT

Most human activities generate waste and its disposal remains a major concern. Generally the waste can be categorized as solid, liquid or gaseous waste. Domestic waste is waste, which is either solid or liquid generated in residential, commercial settings and institutions. It is nevertheless an inevitable and inherent product of social, economic and cultural life. Safe disposal or management of solid and liquid waste is an integral component of "Sustainable Sanitation". The world generates 2.01 billion tons of municipal solid waste annually, of which 33% is not managed in an environmentally safe manner. In India, approximately 1,43,449 million tons of Municipal Solid Waste (MSW) is being generated daily.

Today, the people are not much aware of waste management related issues, and the general apathy creates challenges. Hence there is a demand for accurate and complete accounting of waste generation rates. In order to reduce waste in an organizational level it is inevitable to gather data. For an effective waste management in an organization, data is required for a smart plan of attack. A waste audit is such a plan that would help in estimating waste production and its treatment in order to quantify impacts, plan initiatives and set policy. Waste management audit involves assessing the waste generated by the institution/ organization to determine the types, sources and amounts of waste that is being generated and disposed of within given time frame. It provides baseline data to determine priorities and ways to improve efficiency of current waste management systems. Once an institution understands how it is wasting resources, it can begin conserving, recycling, or reusing. Therefore, there should be systematic procedure to review operations and subsequently the waste generation. Performing the waste audit helps in managing the waste generated in the institution in a more environmentally friendly manner which ultimately contributes towards sustainability.

Objectives

1. To document the status of solid and liquid waste generated in the campus.
2. To examine the status of biodegradable and non-biodegradable waste
3. To appraise the prevailing waste disposal methods and suggest measures to improve the existing waste management strategies.

Methodology

Data collection was performed through frequent field visits, direct observations and assessments, communication with responsible persons etc. Besides details were also collected using well devised datasheets and also from institutional reports.

Status of waste generation

From the survey, it is revealed that the major solid wastes generated in the campus falls under seven categories (Table 20, Fig. 20). The waste mainly comprises paper, plastic, glass, damaged furniture, biodegradable (food, sweeping, crop waste etc.), e-waste and others (sandals, clothes, napkins etc.).

Considering the different waste categories from various blocks (old academic block, new academic block, administrative block and guest house, MIIM, PG Boys hostel, UG Boys hostel, Ladies hostel) of Marian College, the approximate total waste generated in the campus was estimated at 9174 kg/year (Table 20). It is observed that, among the various categories, biodegradable waste (food, sweeping, crop waste etc.) constituted nearly 72% (6643 kg/year) of the total waste generated (Fig. 20). The plastic waste forms the next highest category and accounts for about 14% (1277.5 kg/year) of the total share, which is followed by paper waste - 9% (839.5 kg/year), damaged furniture - 2% (204 kg/year), other waste (sandals, clothes, napkins etc.) - 2% (144 kg/year), glass waste - 1% (54 kg/year), and e-waste - 0.04% (12 kg/year). Despite the large amount of biodegradable waste being produced, the campus is able to tackle these wastes in a more excellent manner (recycling) for other uses including manure (vermicomposting), energy generation (biogas) and animal feed (food for pig farm). Green protocol initiated might have played a major role in reducing the quantity of plastic and papers generated in the institution.

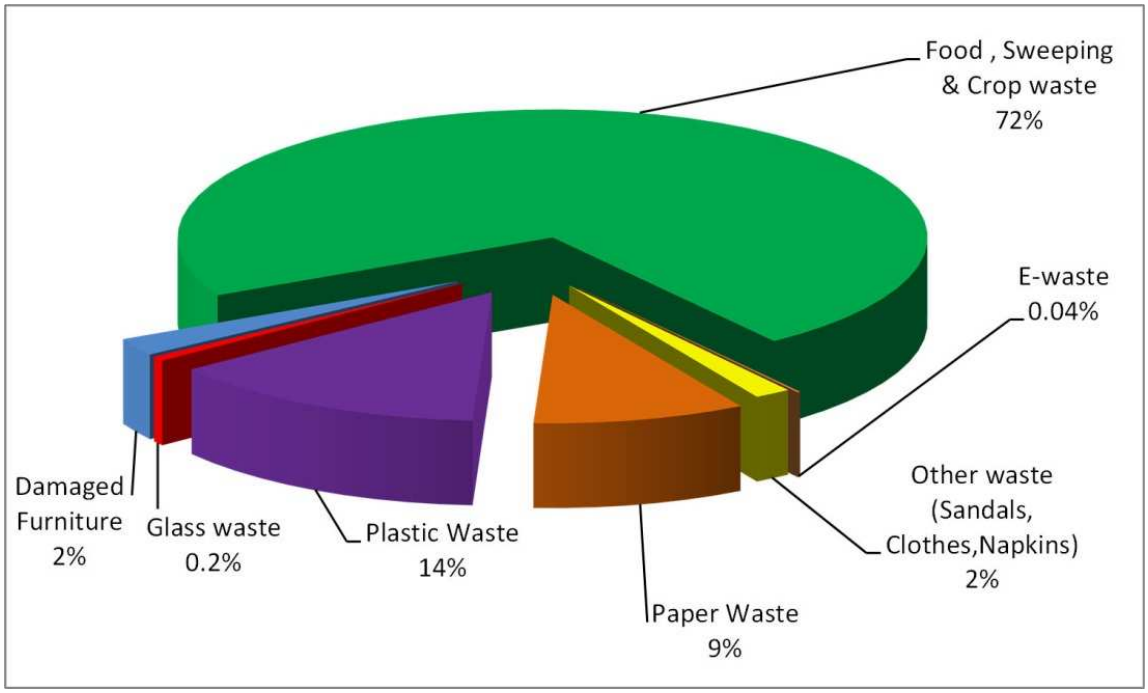


Fig. 20 Details of waste composition

Table 20 Waste generation from different blocks of the campus

Sl. No.	Different blocks	Paper waste (kg/year) biodegradable	Plastic waste (kg/year) non-biodegradable	Glass waste (kg/year)	Damaged furniture (kg/year) non-biodegradable	(Food , sweeping and crop waste) (kg/year)	E-waste (kg/year)	Other waste (sandals, clothes, napkins etc. (kg/year)	Total waste generated (kg/year)
1	Old academic block	73	91.25	6	24	1095	4	24	1317.25
2	New academic block	182.5	182.5	12	48	3650	5	42	4122
3	Administrative block and guest house	182.5	91.25	6	24	803	2	12	1120.75
4	MIIM	73	182.5	6	24	547.5	1	6	840
5	PG boys hostel	182.5	365	12	24	182.5	0	24	790
6	UG boys hostel	73	182.5	6	36	182.5	0	24	504
7	Girls hostel	73	182.5	6	24	182.5	0	12	480
	Total waste generated (kg/year)	839.5	1277.5	54	204	6643	12	144	9174

Category wise solid waste generation at various blocks

In the paper waste category, the amount of waste produced ranges from 73 to 182.5 kg/year (Table 20, Fig. 21). Old Academic Block, MIIM, UG Boys Hostel, Girls Hostel recorded the lowest value (73 kg/year) while New Academic Block, Administrative Block & Guest house and PG boys hostel exhibited the highest value (182.5 kg/year). The contribution of plastic waste varies from 91.25 kg/year to 365 kg/year in which Old Academic Block, Administrative Block & Guest house had minimum value while PG Boys Hostel showed maximum. The other blocks as such as New Academic Block, MIIM, UG Boys Hostel and Girls Hostel recorded 182.5 kg of waste generation in a year (Table 20, Fig. 21). Glass waste is found maximum in the New Academic Block and in PG Boys Hostel (12 kg/year), while minimum in Old Academic Block, Administrative Block & Guest house, MIIM, UG Boys and Girls Hostels (6 kg/year). Since worn-out and damaged furniture's are common in every institute, it is noted that the New Academic Block (48 kg/year) found to have more furniture wastes followed by UG Boys Hostel (36 kg/year) and other blocks (24 kg/year) respectively (Table 20, Fig. 21).

Food waste forms another major category in the campus. In addition to food waste, sweeping and garden waste are the major biodegradable waste. In the current investigation, New Academic Block was found producing more wastes (3650 kg/year) compared to any other blocks in the college while minimum amount of degradable waste were from hostels (182 kg/year – both boys and girls hostels) (Table 20, Fig. 21). Skyrocketing of e-waste is another major concern in any educational mechanism. E-waste production is noted from the academic blocks like New Academic Block (5 kg/year), Old Academic Block (4 kg/year), Administrative Block & Guest house (2 kg/year) and MIIM (1 kg/year) (Table 20, Fig. 21). The audit also revealed the status of other minor and unaccounted wastes. In the current study, it is noticed that the 'Other waste' category including discarded sandals, clothes, napkins etc., showed higher value in New academic block (42 kg/year). Old Academic Block, PG and UG Boys Hostels, Administrative Block & Guest House come next in the waste generation with minimum amount reported in Girls Hostel and MIIM (6 kg/year) respectively (Table 20, Fig. 21).

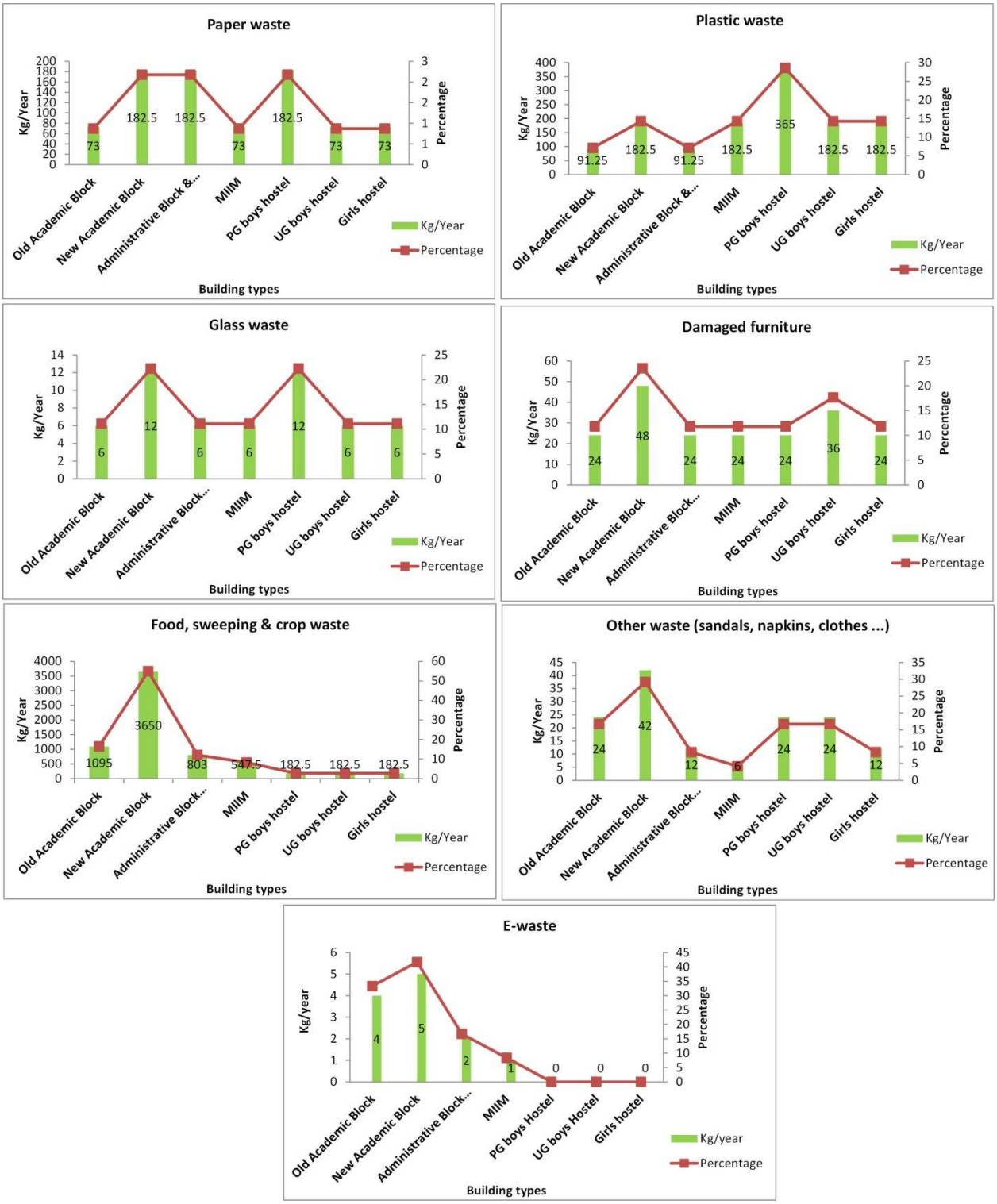


Fig. 21 Category wise waste generation from different blocks

Block-wise contribution of waste generation

Among the different blocks investigated, waste from the New Academic Block is contributing 45% of the total waste, which accounts to about 4122 kg/year (Table 20, Fig. 22), as this block with 7 floors remains as the main centre for various kinds academic activities.

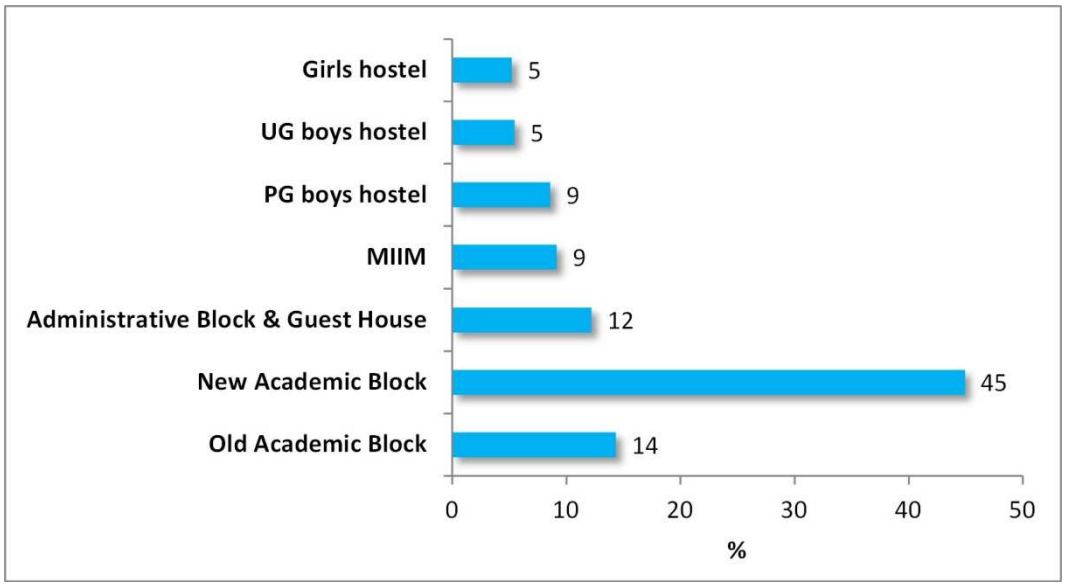


Fig. 22 Details of total waste generated from different blocks

Details of biodegradable and non-biodegradable wastes

In the present assessment, paper, food, garden waste etc. are categorized as the biodegradable type while plastic, glass and damaged furniture were put together as non-biodegradable. Apart from these, e-waste and other waste (sandals, clothes, napkins etc.) are the other two categories that are classified as miscellaneous. The results showed that biodegradable waste (81%) constitutes significant proportion of solid waste in the College while non-biodegradable component had a negligible share of 17% (Fig. 23). The miscellaneous waste category that were not considered under any of the major waste types (biodegradable and non-biodegradable wastes) mentioned earlier, had 2% share in the total waste generated from the college (Fig. 23).

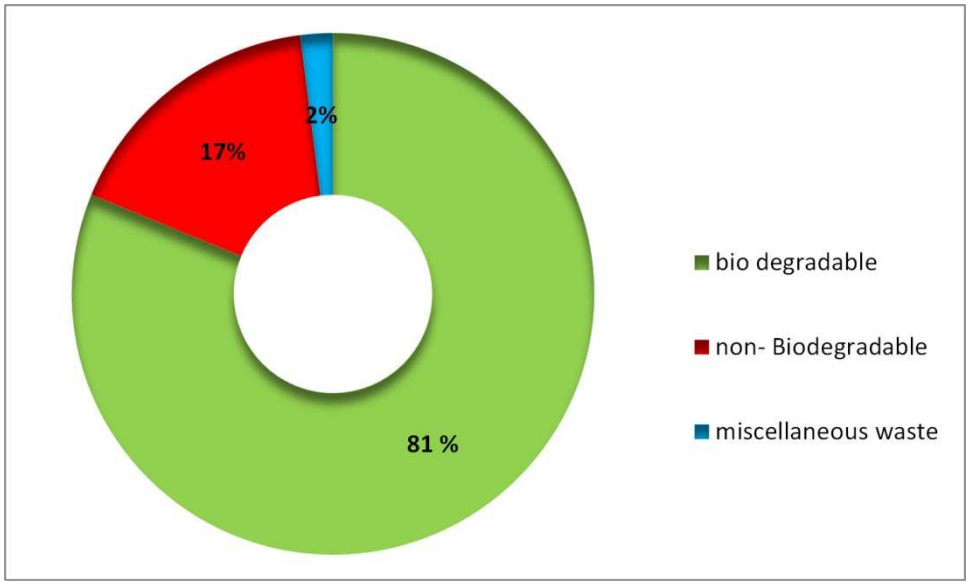


Fig. 23 Status of biodegradable, non-biodegradable and miscellaneous wastes

Major waste categories and their disposal strategies

It seems that the management follows appreciable level of strategies for the disposal of generated wastes in the campus (Table 21). Currently in the campus, there exists efficient mechanisms for utilizing the biodegradable wastes for vermicomposting, biogas production, vegetable farming practices etc. Besides, a portion of the biodegradable (food and vegetable) waste is collected as feed for the nearby pig farms. Paper and plastic waste generated are collected, segregated and sold to scrap merchants periodically. Incinerators are installed and used for disposing napkins, masks etc. is a noteworthy best practice of the college. Repair and reuse of damaged furniture is considered as a positive approach. Healthy practices like buy back policy with suppliers, handing over the used computers to schools and hardware training laboratories are also implemented. Such practices accounts for the lower quantity of e-waste in the campus. Apart from the above mentioned waste categories, construction and demolition wastes also accounts to the waste production in the campus. It is noted that these types of wastes are largely used for reclamation activities. Liquid waste generation and management is explained in details under water audit.

Table 21 Major waste categories and their disposal strategies

Sl.No.	Categories of waste	Particulars	Types of disposal
1	Paper waste	A4 paper (print out papers), newspapers, paper plates, cups etc.	Scrap merchants
2	Plastic waste	Pen, refill, plastic water bottles and other plastic containers, wrappers etc.	Scrap merchants
3	Glass waste	Broken glassware	-
4	Damaged furniture	Worn-out and damaged furniture	Repair and reuse, Scrap merchants
5	Biodegradable waste	Sweeping waste, food waste, crop waste	Vermicomposting, biogas, pig farm
6	Construction waste		Land reclamation
7	E-waste	Computers, printers, other electronic gadgets	Sold to Scrap merchants, buy back policy, hand out to schools and hardware training labs
8	Other waste	Napkins, Masks etc.	Incinerator
9	Liquid waste	Waste water from Hostels, canteens, cafeteria, toilets	Sewage Treatment Plant

Healthy practices

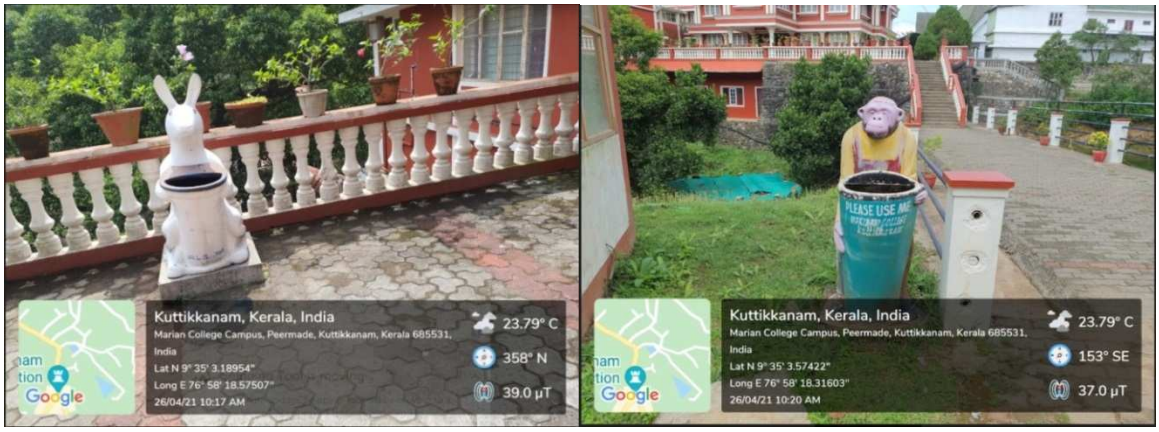
1. The institution's policy gives emphasis to waste recycling and reusing.
2. The campus has well efficient and advanced mechanisms for sorting and treating both solid and liquid wastes.
3. The institution has been following a green protocol for waste management throughout the campus based on the previous environmental audit.

4. Waste bins are placed in appropriate locations of the campus for the effective separation of solid waste at source.
5. As part of the reduction of paper waste, the use of digital platforms for public addressing, communication, and e-filing is encouraged in office. Printouts are generally avoided except in unavoidable circumstances.
6. Girls restrooms are provided with napkin vending machines and rubbish bins which are cleared and incinerated daily.
7. Biogas unit supplement fuel for cooking in the canteens.
8. Vermicomposting units are installed for the effective utilization of biodegradable waste and the manure produced from it is used in horticulture and vegetable growing purposes.
9. Old electronic equipments are exchanged through buy back policy with suppliers.
10. Used computers with older configuration in working condition are donated to the schools and are also used to set-up hardware training laboratories.
11. Sewage Treatment Plant (SWP) with a capacity of treating 50,000 litres/day is being built for treatment of waste water.
12. Waste water from the laboratories is disposed properly by flowing it to safely built pits.
13. Implementation of various green initiatives (fish farming, campus cleaning, gardening, vegetable production etc.) in the college provides an interactive learning environment for students in waste management.
14. A student volunteer corps in the form of Green Guardians Club and an audit team involving students and teachers were formed to conduct Environmental Audit and to implement the recommendations

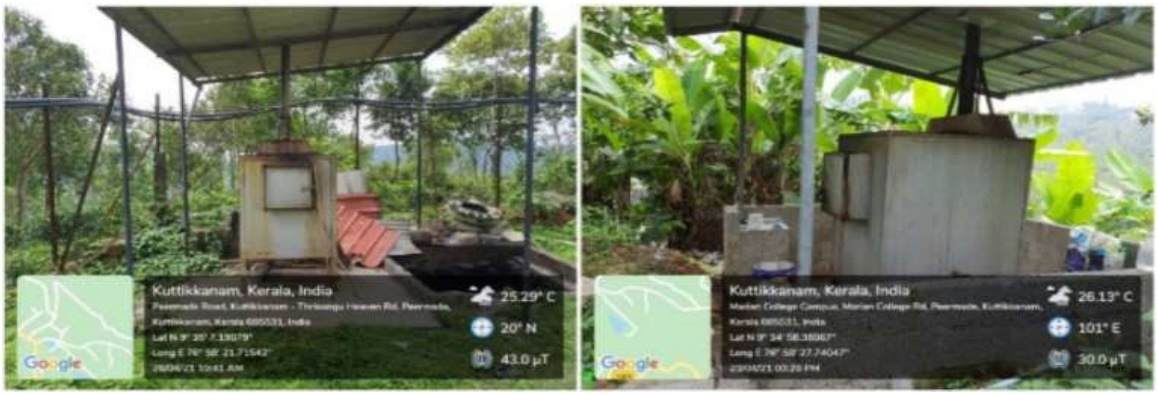
Recommendations

- Use different coloured bins (eg. Green – biodegradable waste, Blue –plastic and metal waste, Yellow – Paper waste, Black – E-waste, Red – Bio medical waste) for collecting, segregating different categories of waste from the buildings.
- Ash remaining at the bottom of the combustion chambers of incinerators requires a proper hazardous waste disposal mechanism.
- Regarding e-waste, instead of selling the electronic waste to scrap merchants, ensure that these electronic wastes should be handed out to authorized e-waste collection centers that are approved by Kerala State Pollution Board (KSPCB). Details can be obtained from the KSPCB website.
- In the case of non-biodegradable waste (especially plastic, glass waste), a tie-up is recommended with local body authorities (Panchayath) for their collection and disposal. With the approval of local body authorities, these wastes can be handed out to Haritha Karma Sena (HKS) members of concerned local body. This campaign is being executed with the support of Suchithwa Mission, Haritha Kerala Mission, Clean Kerala Company (CKC), local bodies and Kudambashree Mission.
- A kind of accountability is required for the Construction and Demolition waste produced in the campus. The collection, transportation, processing and disposal of these wastes should be treated under the provisions of Construction and Demolition Waste Management Rules, 2016.
- For the construction of new buildings in future, it is advisable to follow a Green Buildings rating system that facilitates 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. The predominant green rating frameworks in India are GRIHA (Green Rating for Integrated Habitat Assessment), IGBC (Indian Green Building Council), LEED (Leadership in Energy and Environmental Design), and BEE (Bureau of Energy Efficiency).
- Damaged furniture and glass waste are the other prominent institutional wastes that are found missing in this waste management strategies of Marian. So a proper, constructive mechanism is needed for the management of above mentioned wastes.

- It is advisable to have a quantified data about various kinds of biomedical waste (expired medicines, gloves, masks, napkins etc.) generated in the campus.
- Periodic appraisal of different kinds of waste generated is required and hence recommended for the campus.
- Regular monitoring and maintenance are required for biogas and sewage treatment plants.
- Various kinds of start-up programme related to waste management can be promoted in the Campus (toy making from waste raw materials, decorative items and other fancy items from waste materials etc.).
- Popularize various Waste Management Act and Rules, themes, day and year of importance, national level and state level campaigns (e.g. *Swachh Bharat Mission*, *Suchithwa Keralam* etc.) and slogan like My waste, My responsibility', which is adopted from the 'Polluter Pays Principle' in the campus.

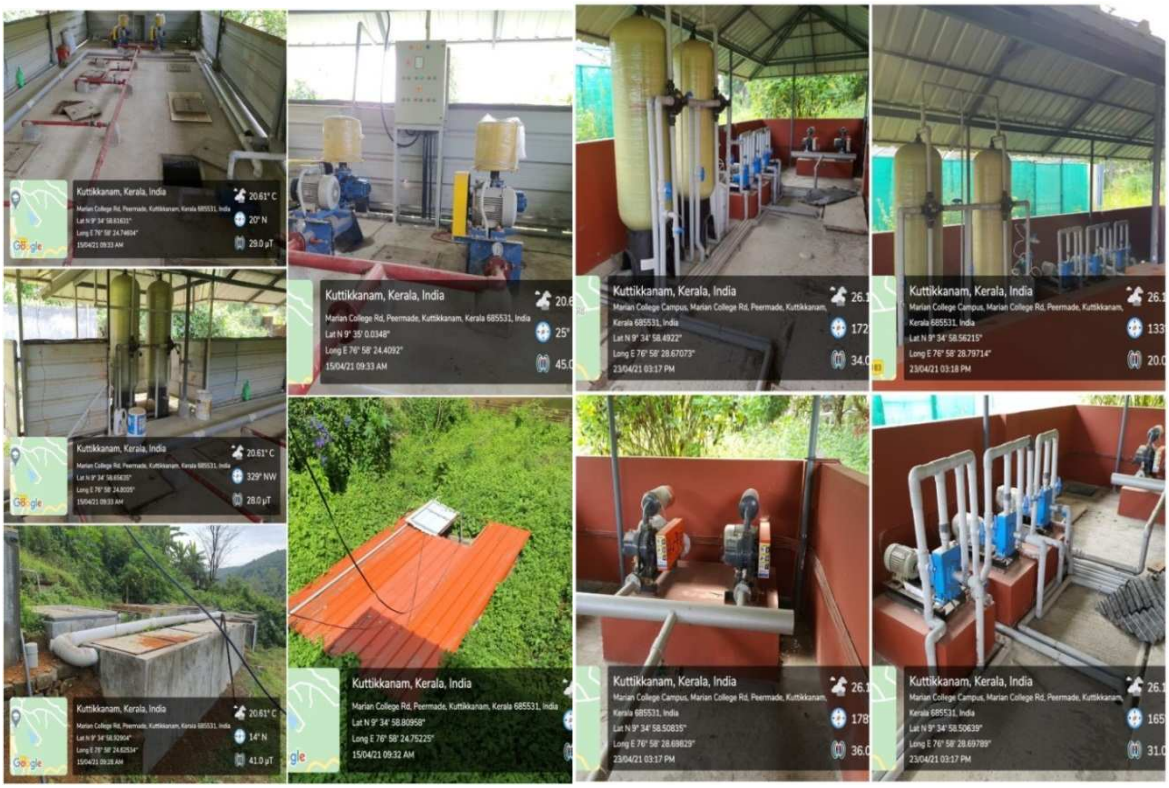


Solid waste management – Collection bins

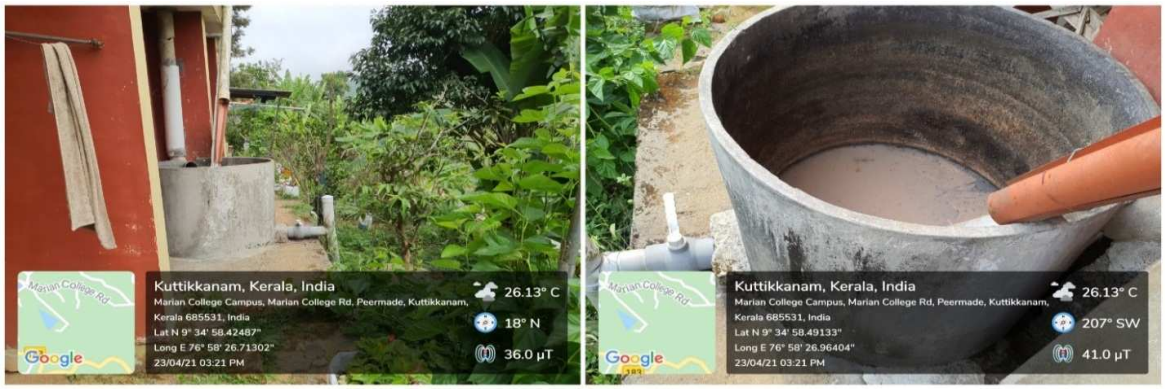


Waste disposal through properly installed incinerator for pollution mitigation

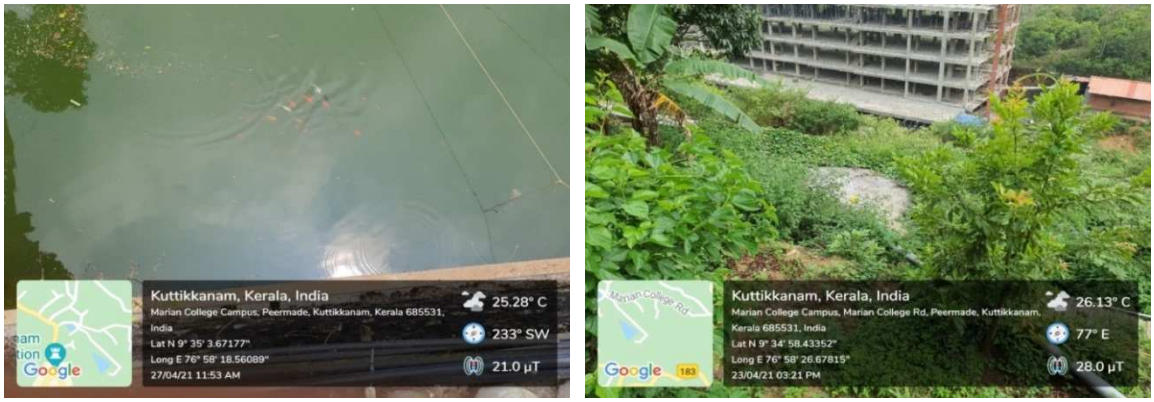
Vermicomposting unit **Organic farming and horticulture**



Sewage Treatment Plant (STP) at Marian **Sewage treatment in the hostel**



Biogas plants in the hostel



Fish farming at Marian **Waste water treatment system in the Campus**




Environmental related ativities

4. BIODIVERSITY AUDIT

Biodiversity audit comprises the observations and analytic findings of rapid biodiversity assessment of Marian College campus carried out by the Biodiversity Inventory Cell of the Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University. It highlights the environmental history of the area, current status of flora and fauna, best practices observed and recommendations for better management.

Environmental Audit (green audit) can be defined as systematic identification, quantification, recording, reporting and analysis of components of environmental diversity. The term 'green' means how far the human activities are eco-friendly and not damaging the environment. As part of the audit, biodiversity assessment was carried out, mainly focussing on the vegetation composition and faunal components, found in the college campus. The observations and recommendations are expected to contribute important inputs to the administration for the better management of its natural ecosystems, micro-habitats and biodiversity conservation of the campus. It will be helpful for the sustainable management and maintenance of healthy environment.

Biogeography and ecological history

Marian College is situated on the Kuttikkanam ridge, which is on the southern part of the High Ranges and the western edge of the Peermedu plateau of the Southern Western Ghats. It is one of the strikingly beautiful locations in Peermedu plateau along the Kottayam-Kumily state highway 13. Location of the campus is near Kuttikkanam junction which is roughly 3500 feet (1100m) above mean sea level and is the highest point along the highway. High Ranges in Kerala occupy a pivotal position in the Western Ghats south of the Palakkad Gap (Nair, 1994). As per early records, until mid- 1800's the tract remained a difficult terrain, heavily forested and sparsely inhabited by any human communities. Only few tribal communities occasionally foray into these forests for hill produce and wild game. It was the advent of the missionaries, military explorers, surveyors and adventurers from Europe brought the area into wider attention. According to the Plantation History in 1862, the Baker family acquired land in Peermedu and began clearing the forest under growths for coffee plantation, the first commercial crop of the region. It was 1872 the cart road between Kottayam and Peermedu was opened and 1885 when the Peermedu-Gudalur stretch was opened for transport, human habitations and commercial activities. It was during this time Kuttikkanam also served as a summer destination for Travancore royal family. The first botanical collection and documentation from Peermedu and adjacent areas was made by Beddome in 1882.

Hardly had coffee started flourishing in Peermedu when it was threatened by the leaf disease (*Hemilia vastatrix*) first seen in Ceylon in 1868-89. It struck Peermedu in 1875 and by 1886 only 12 planters remained in these hills. As the blight spread, experiments had begun to find a substitute crop. Cinchona, tea, cardamom and rubber were tried and

soon it became evident that tea was best suited to the Peermedu elevation. It was during that period maximum clearings of natural forests and forest covers might have happened in this terrain. As a high wind prone terrain, the opened-up areas remained as grasslands and patches of regenerated forests seen here and there. Some natural vegetation also remains in the valleys and hill-folds with many endemic species. However, subsequent labour demand for tea and cardamom plantations in and around the area brought many people both from eastern plains as well as from the western valleys. Today in addition to the plantations, many townships, commercial establishments, tourism facilities, educational institutions and transport amenities are established all over the Peermedu plateau.

Objectives

- To appraise the vegetation components
- To document the invertebrate fauna (dragonflies/damselflies and butterflies)
- To enumerate the vertebrate fauna (reptiles, birds, mammals etc.)
- To identify and document the invasive alien species
- To highlight best practices and suggest sustainable conservation measures

Biodiversity assessment methods

The biodiversity assessment team along with the campus inmates, as a group explored the campus covering all the paths, roads and criss-crossed the habitats where ever it is necessary for detailed or specific observations of flora and fauna. Standard protocols were followed for the assessment of faunal and floral components. Focal animal sampling,

visual encounter method, point count and visual estimation, transect walk etc. are the specific assessment methods followed.

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 species, garden as well as introduced species and the invasive-exotic species. Photographs were taken in certain cases for identification and confirmation of species. A systematic survey of fauna was carried out by direct observations and indirect evidences. Information from campus residents was also considered for certain species. Regional flora and authentic field guides were used for the identification. Field gadgets such as Nikon Ranger 8x40 binoculars, Canon SLR camera, Garmin Global Positioning System (GPS) etc. were used in the field assessment.

Vegetation and floral components

Based on our observation, the vegetation composition is categorised into a) native species, b) Secondary growth includes both native and exotic composition that emerged from the open or cleared areas and c) Introduced vegetation, which is further categorised into three sections, which comprises of i) ornamental plants; ii) crops including fruit trees and spices; and iii) exotic and invasive plants of the campus.

The vegetation composition of the campus includes exotic podocarps and pines, many varieties of avenue trees and large number of garden species. The open areas of the

campus consist of grass varieties of both exotic as well as few native species seen around. In the less intervened portions of the campus where one can see the growth of trees, shrubs, herbs and creepers together form secondary vegetation in the area. It would pave way for further succession of vegetation if left untouched. With the increase of human population and associated infrastructure, it is obvious that the current vegetation components are mostly planted or introduced varieties. Owing to the continuous construction activities and other infrastructure developments in the campus, the current vegetation cover is noted below 50%.

Native species

Based on our assessment, we noted that the majority of the vegetation in the campus is introduced for various purposes and when compared with the proportion of native species belonging to the high-ranges of Cardamom Hills and Peermedu Plateau is only meagre in number.

Table 22 List of native species

Sl. No	Species	Common name	Family	Habit	Remarks
1.	*Symplocos cochinchinensis* var.*laurina*	Laurel Sapphire berry; Pacchotti	Symplocaceae	Tree	Endemic
2.	*Mallotus philippensis*	Chenkolli	Euphorbiaceae	Tree	Endemic
3.	*Macaranga peltata*	Vattakumbil	Euphorbiaceae	Tree	
4.	*Maesa indica*	Wild Tea/Wind Berry	Primulaceae	Shrub	
5.	*Syzygium cumini*	Malabar plum	Myrtaceae	Tree	SW Endemic
6.	*Actinodaphne malabarica*	Kambilivirinji	Lauraceae	Tree	SW Endemic
7.	*Cinnamomum malabatrum*	Vayana/Vazhana	Lauraceae	Tree	WG Endemic
8.	*Vateria indica*	White Dammer	Dipterocarpaceae	Tree	Critically endangered
9.	*Mallotus tetracoccus*	Porivatta	Euphorbiaceae	Tree	
10.	*Rubus indicus*	Erumachulli	Rosaceae	Climber	
11.	*Dioscorea hispida*	Wild Dioscorea	Dioscoreaceae	Climber	Endemic to South India

Secondary vegetation is the type of plant composition that emerges and develops after disturbances by humans as well as forces of nature. The pioneer communities include

weeds and other ephemerals and few tree saplings that emerge and slowly develop into different layers if left undisturbed.

Table 23 List of common secondary growth vegetation

Sl. No.	Species	Common Name	Family	Habit
1.	*Adiantum caudatum*	Walking Maidenhair	Pteridaceae	Fern
2.	*Peperomia pellucida*	Shiny Bush	Piperaceae	Herb
3.	*Clerodendrum infortunatum*	Hill Glory	Lamiaceae	Shrub
4.	*Stachytarpheta jamaicensis*	Porter Weed	Verbinaceae	Herb
5.	*Tithonia diversifolia*	Tree Marigold	Asteraceae	Shrub
6.	*Gynura crepidioides*	Fire Weed	Asteraceae	Herb
7.	*Mimosa pudica*	Shame Plant	Fabaceae	Herb
8.	*Centella asiatica*	Indian Pennywort	Apiaceae	Herb
9.	*Pennisetum polystachion*	Mission Grass	Poaceae	Grass
10.	*Ficus racemosa*	Cluster Fig	Moraceae	Tree
11.	*Solanum torvum*	Turkey Berry	Solanaceae	Shrub
12.	*Oxalis corniculata*	Creeping Soral	Oxalidaceae	Herb
13.	*Senna hirsute*	Woolly Cassia	Fabaceae	Shrub
14.	*Macroptilium atropurpureum*	Purple bush-bean	Fabaceae	Creeper
15.	*Sambucus canadensis*	Elderberry	Adoxaceae	Shrub

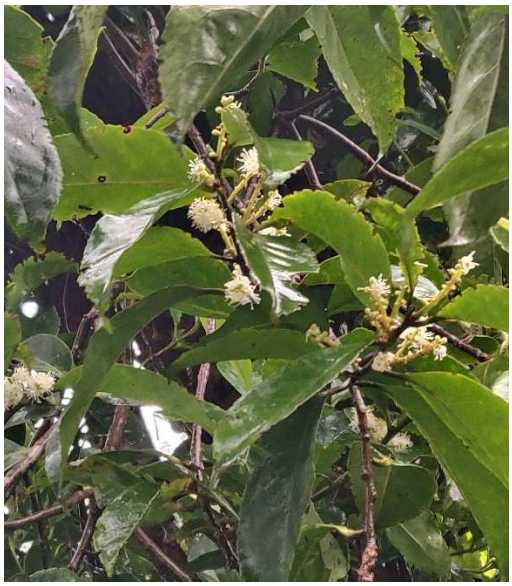
Introduced vegetation includes the various plant species either purposefully planted for garden and crop purpose. The exotics and invasives that are spreading along with the introduced ones particularly in the exposed areas also included under this category. A considerable number of alien and invasive species reported by the scientific institutions such as the Kerala Forest Research Institute are found here.

Table 13 List of introduced vegetation

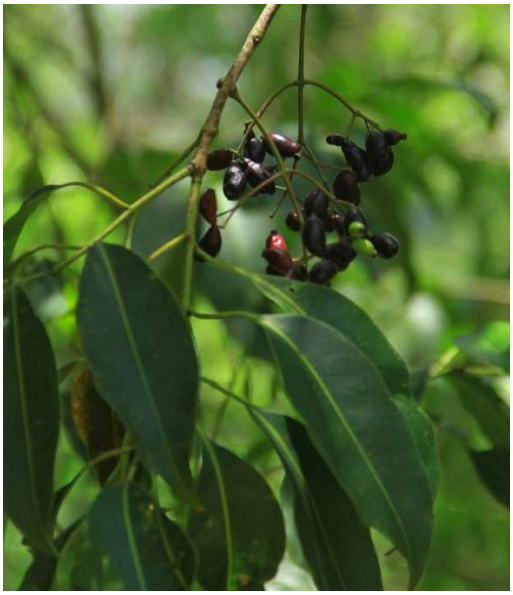
Sl. No.	Species	Common name	Family	Habit
A. Garden Species				
1.	*Samanea saman*	Rain Tree/Monkey pod tree	Fabaceae	Tree
2.	*Casuarina equisetifolia*	Whistling Pine tree	Casuarinaceae	Tree
3.	*Dypsis lutescens*	Golden Cane Palm/Yellow Palm	Arecaceae	Tree
4.	*Afrocarpus falcatus*	African Pine Tree	Podocarpaceae	Tree
5.	*Magnolia champaca*	Chambak	Magnoliaceae	Tree
6.	*Juniperus communis*	Common Juniper	Cupressaceae	Small Tree
7.	*Pelargonium spp.Hybrid*	Geranium	Geraniaceae	Shrub
8.	*Hibiscus* Hybrid	Rose Mallow	Malvaceae	Shrub
9.	*Hydrangea macrophylla*	French Hydrangea	Hydrangeaceae	Shrub
10.	*Rosa sp.* Hybrid	Rose	Rosaceae	Shrub
11.	*Croton spp.* Hybrid	Croton	Euphorbiaceae	Shrub
12.	*Anthurium andraeanum* Hybrid	Anthurium	Araceae	Herb
13.	*Coleus spp.* Hybrid	Coleus	Lamiaceae	Shrub
14.	*Cordyline fruticosa*	Ti Plant	Asparagaceae	Shrub
15.	*Rhododendron sp.*Hybrid	Azalea	Ericaceae	Shrub
16.	*Ixora* Hybrid	Ixora	Rubiaceae	Shrub
17.	*Bellis perennis* Hybrid	Common Daisy	Asteraceae	Herb
18.	*Asparagus spp.* Hybrid	Asparagus	Asparagaceae	Creeper
19.	*Petunia axillaris*	Large white Petunia	Solanaceae	herb
20.	*Kohleria tubiflora.* Hybrid	Tube Kohleria	Gesneriaceae	herb
21.	*Araucaria columnaris*	Christmas Tree	Araucariaceae	Tree
22.	*Bougainvillea* Hybrid	Bougainvillea	Nyctaginaceae	Woody climber
23.	*Hamelia patens*	Firebush	Rubiaceae	Shrub
24.	*Pinus* sp.	Pine Tree	Pinaceae	Tree
25.	*Libocedrus bidwillii*	New Zealand Cedar	Cupressaceae	Tree
26.	*Ficus religiosa*	Sacred Fig	Moraceae	Tree
27.	*Cycas revoluta*	Sago Palm	Cycadaceae	Tree
28.	*Phyllostachys aurea*	Fishpole Bamboo	Poaceae	Grass
29.	*Spathodea companulata*	African Tuliptree	Bignoniaceae	Tree
30.	*Jacaranda mimosifolia*	Blue Jacaranda	Bignoniaceae	Tree
31.	*Bauhinia variegata*	Garden Bauhinia	Fabaceae	Tree
32.	*Bambusa vulgaris*	Common Bamboo	Poaceae	Tall Grass

33.	*Cassia* sp. Hybrid	Drooping Cassia	Fabaceae	Shrub
34.	*Duranta erecta*	Golden Dewdrop	Verbenaceae	Shrub
35.	*Browallia Americana* Hybrid	Blue Lady	Solanaceae	Herb
36.	*Tagetes erecta* Hybrid	Marigold	Asteraceae	Shrub
37.	*Podranea ricasoliana*	Pink Trumpet Vine	Bignoniaceae	Creeper
B. Crops				
1.	*Mangifera indica*	Mango Tree	Anacardiaceae	Tree
2.	*Artocarpus heterophyllus*	Jackfruit Tree	Moraceae	Tree
3.	*Garcinia gummi-gutta*	Malabar Tamarind	Clusiaceae	Tree
4.	*Musa* sp. Hybrids	Banana	Musaceae	Herbaceous Plant
5.	*Psidium guajava*	Guava	Myrtaceae	Tree
6.	*Piper nigrum* Hybrid	Black Pepper	Piperaceae	Climber
7.	*Ricinus communis*	Caster	Euphorbiaceae	Shrub
8.	*Arundo donax*	Giant Reed	Poaceae	Tall Grass
9.	*Persea americana*	Avocado	Lauraceae	Tree
C. Alien andinvasive species				
1.	*Mikania micrantha*	Bitter wine	Asteraceae	Climber
2.	*Sphagneticola trilobata*	Trailing daisy	Asteraceae	Trailing herb
3.	*Ageratum conyzoides*	Goat weed	Asteraceae	Herb
4.	*Persicaria chinensis*	Chinese Knotweed	Polygonaceae	Twining herb
5.	*Ipomoea purpurea*	Common morning glory	Convolvulaceae	Climber
6.	*Bidens pilosa*	Beggar Tick	Asteraceae	Herb
7.	*Eleutheranthera ruderalis*	Ogiera weed	Asteraceae	Herb
8.	*Lantana camara*	Lantana	Verbenaceae	Shrub
9.	*Clidemia hirta*	Soapbush	Melastomaceae	Shrub
10.	*Pilea microphylla*	Rockweed	Urticaceae	Herb
11.	*Senna hirsuita*	Hairy Senna	Fabaceae	Shrub
12.	*Erigeron canadensis*	Horse weed	Asteraceae	Shrub
13.	*Pueraria phaseoloides*	Tropical Kudzu	Fabaceae	Creeper
14.	*Seigesbeckia orientalis*	Indian weed/St.Pauls wort	Asteraceae	Herb
15.	*Pteridium aquilinum*	Eagle Fern	Dennstaedtiaceae	Fern
16.	*Mimosa diplotricha*	Nila Grass	Fabaceae	Creeper

Native Species in the Campus



Symplocos cochinchinensis



Syzygium cumini

Mallotus philippensis

Maesa indica

Adiantum sp.

Rubus indicus

Plants in Disturbed Patches

Senna hirsute

Sambucus canadensis

Solanum torvum

Tithonia diversifolia

Oxalis corniculata

Solanum torvum

Pteridium aquilinum

Persicaria chinensis

Garden Plants

Browallia americana Hybrid

Kohleria tubiflora. Hybrid

Drooping Cassia

Azalea Hybrid

Pink Trumpet Vine

Hydrangea macrophylla

Tagetes erecta Hybrid

Petunia axillaris

Jacaranda mimosifolia

Spathodea companulata

Cycas revoluta

Phyllostachys aurea

Ficus religiosa

Hamelia patens

Crop-related Plants

Musa paradisiaca Hybrids

Arundo donax

Pennisetum polystachion

Purple bush-bean

Alien & Invasive Species

Ageratum conyzoides

Erigeron canadensis

Ipomoea purpurea

Ipomoea hederifolia

Clidemia hirta

Mimosa diplotricha

Invertebrate fauna

Odonates (damselflies and dragonflies)

Odonates are important bio-indicators as well as bio-control agents of any ecosystems. The study recorded fifteen species of odonates, which included both damselflies and dragonflies, from the campus (Table 24). They were mainly found along the moist and wet parts of the campus. The list of observed species from the campus premises is given below:

Table 24 List of Odonates (damselflies and dragonflies)

Sl. No.	Scientific name	Common Name
A.	**Damselflies**	
1	*Vestalis apicalis*	Black-tipped Forest Glory
2	*Vestalis gracilis*	Clear-wing Forest Glory
3	*Ceriagrion cerinorubellum*	Orange-tailed Marsh Dart
4	*Ceriagrion coromnadelianum*	Coromandel Marsh Dart
5	*Copera marginipes*	Yellow Bush Dart
6	*Agriocnemis splendidissima*	Splendid Dartlet
7	*Caconeura risi*	Wayanad Bambootail
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
6	*Cratilla lineate*	Emerald Banded Skimmer
7	*Trithemys aurora*	Crimson Marsh Glider
8	*Ictinogomphus rapax*	Indian Common Clubtail

Damsel Flies

Agriocnemis splendidissima - male

Caconeura risi - male

Ceriagrion cerinorubellum - male

Ceriagrion coromandelianum - male

Copera marginipes - male

Dragon Flies

Cratilla lineata - male

Ictinogomphus rapax - male

Orthetrum luzonicum - male

Orthetrum pruinosum - male

Trithemis aurora - male

Butterflies

Butterflies are important pollinators and colourful representatives of the biodiversity. The study recorded twenty-six species of butterflies from the campus. The list of observed species is given in the Table 25. Peermedu Plateau serves as the type locality of several butterfly species found in the Western Ghats. However, due to the absence of associated native vegetation and microhabitats, the butterfly diversity observed in the campus is relatively lower than the nearby protected areas. This may be due to the paucity of many larval food plants in the campus area.

Table 25 List of butterflies

Sl. No.	Scientific name	Common Name	Status
1	*Catopsilia pomona*	Common Emigrant	C
2	*Danaus chrysippus*	Plain Tiger	C
3	*Papilio polymnestor*	Blue Mormon	UC
4	*Papilio polytes*	Common Mormon	C
5	*Eurema hecabe*	Common Grass Yellow	C
6	*Mycalesis perseus*	Common Bushbrown	C
7	*Moduza procris*	Commander	C
8	*Parthenos sylvia*	Clipper	LC
9	*Ariadne aridnae*	Angled Castor	LC
10	*Neptis hylas*	Common Sailor	C
11	*Junonia iphita*	Chocolate Pansy	C
12	*Tirumala limniace*	Blue Tiger	C
13	*Euploe core*	Common Crow	C
14	*Chilades trochylus*	Grass jewel	C
15	*Junonia hierta*	Yellow pansy	R
16	*Ypthima huebneri*	Common four-ring	C
17	*Euthalia aconthea*	Common Baron	LC
18	*Graphium sarpedon*	Common bluebottle	C
19	*Celaenorrhinus leucocera*	Common Spotted Flat	LC
20	*Appias lyncida*	Chocolate Albatross	LC
21	*Mycalesis patina*	Glad-eye bushbrown	C
22	*Ariadne merione*	Common castor	LC
23	*Matapa aria*	Common Redeye	LC
24	*Papilio helenus*	Red Helen	UC
25	*Lampides boeticus*	Pea blue	C
26	*Udaspes folus*	Grass Demon	LC

Butterflies

Common Crow

Grass Demon

Common Sailor

Blue Bottle

Common Baron

Blue Tiger

Pea Blue

Common four-ring

Common Bushbrown

Common Redeye

Common Spotted Flat

Plain Tiger

Fishes

Fishes were recorded based on actual sightings as well as from catch. A total of seven fish species were noted, Carps and Tilapia predominate (Table 26). Recorded species of the campus are introduced ones of exotic origin.

Table 26 List of fishes

Sl. No.	Scientific name	Common Name	Status
1	*Oreochromis mossambicus*	Mozambique Tilapia	Vu
2	*Oreochromis* sp.	Gift Tilapia	LC
3	*Carassius auratus*	Goldfish	LC
4	*Cyprinus rubrofuscus*	Koi Carp	LC
5	*Cyprinus carpio*	Common Carp	CR
6	*Catla catla*	Catla	LC
7	*Labeo rohita*	Rohu	LC

Reptiles

The reptiles recorded from the site includes Common Garden Lizard *Calotes versicolor*, Indian Monitor Lizard *Varanus bengalensis,* Skink sp., Common Krait *Bungarus coeruleus,* Spectacled Cobra *Najanaja,* Common Rat-snake *Ptyasmucosus,* Russell's Viper *Daboia russeli,* Indian Rock Python *Pythonmolurus,* Pit Viper sp., Wolf snake sp., Green Vine Snake, etc. (Table 27). Owing to its strategic position in the Western Ghats, various endemic species of snakes (Shield-tailed Snake sp.) and lizards (*Cnemaspis* sp.) are found in this area.

Table 27 List of reptiles

Sl. No	Scientific name	Common Name	Status
1	*Calotes versicolor*	Common Garden Lizard	LC
2	*Eutropis carinata*	Golden Skink	LC
3	*Varanus bengalensis*	Indian Monitor Lizard	
4	*Bungarus coeruleus*	Common Krait	
5	*Naja naja*	Spectacled Cobra	
6	*Ptyas mucosus*	Common Rat-snake	
7	*Daboia russeli*	Russell's Viper	
8	*Python molurus*	Indian Rock Python	
9	*Trimeresurus* sp.	Pit Viper sp.	
10	*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 forty-six species of birds belonging to 27 families were listed (Table 28). Indian Pitta, Brown Shrike, Thick-billed Warbler, Blyth's Reed Warbler, Greenish Warbler, Indian Blue Robin, Green Sandpiper and Grey Wagtail are the migratory species recorded from the campus. Crimson-backed Sunbird and Nilgiri Flower pecker are the two endemic species recorded from the campus. No threatened species were observed. But being its core position in the Western Ghats, only two Western Ghats endemic bird species were recorded from the campus. Majority of the bird species found in the campus belonging to the forest birds, even though seven wetland and wetland dependent species were recorded, this is due to the two check-dams inside the campus. Compared the bird diversity of the adjoining natural habitats the campus holds only about 20% of species found in the nearby forest area.

Table 28 List of birds

Sl. No.	Common name	Scientific name	Status
	Family Phasianidae		
1	Red Spur fowl	*Galloperdix spadicea*	Resident
2	Grey Jungle fowl	*Gallus sonneratii*	Resident
	Family Columbidae		
3	Rock Pigeon	*Columba livia*	Resident
4	Spotted Dove	*Spilopelia chinensis*	Resident
	Family Cuculidae		
5	Greater Coucal	*Centropus sinensis*	Resident
6	Asian Koel	*Eudynamys scolopaceus*	Resident
7	Common Hawk-Cuckoo	*Hierococcyx varius*	Resident
	Family Apodidae		
8	Indian Swiftlet	*Aerodramus unicolor*	Resident
9	Little Swift	*Apus affinis*	Resident
	Family Rallidae		
10	White-breasted Water hen	*Amaurornis phoenicurus*	Resident
	Family Scolopacidae		
11	Green Sandpiper	*Tringa ochropus*	Migrant
	Family Phalacrocoracidae		
12	Little Cormorant	*Microcarbo niger*	Resident
	Family Ardeidae		
13	Cattle Egret	*Bubulcus ibis*	
14	Indian Pond-Heron	*Ardeola grayii*	Resident
	Family Alcedinidae		
15	Common Kingfisher	*Alcedo atthis*	Resident
16	White-throated Kingfisher	*Halcyon smyrnensis*	Resident
	Family Megalaimidae		
17	White-cheeked Barbet	*Psilopogon viridis*	Resident
	Family Aegithinidae		
18	Common Iora	*Aegithina tiphia*	Resident
	Family Pittidae		
19	Indian Pitta	*Pitta brachyuran*	Migrant
	Family Laniidae		
20	Brown Shrike	*Lanius cristatus*	Migrant
	Family Corvidae		
21	House Crow	*Corvus splendens*	Resident

22	Large-billed Crow	*Corvus macrorhynchos*	Resident
	Family Cisticolidae		
23	Common Tailorbird	*Orthotomus sutorius*	Resident
24	Ashy Prinia	*Prinia socialis*	Resident
	Family Acrocephalidae		
25	Thick-billed Warbler	*Iduna aedon*	Migrant
26	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Migrant
	Family Hirundinidae		
27	Dusky Crag-Martin	*Ptyonoprogne concolor*	Resident
	Family Pycnonotidae		
28	Red-vented Bulbul	*Pycnonotus cafer*	Resident
29	Red-whiskered Bulbul	*Pycnonotus jococus*	Resident
30	Yellow-browed Bulbul	*Acritillas indica*	Resident
	Family Phylloscopidae		
31	Greenish Warbler	*Phylloscopus trochiloides*	Migrant
	Family Zosteropidae		
32	Indian White-eye	*Zosterops palpebrosus*	Resident
	Family Timaliidae		
33	Tawny-bellied Babbler	*Dumetia hyperythra*	Resident
34	Indian Scimitar-Babbler	*Pomatorhinus horsfieldii*	Resident
	Family Sturnidae		
35	Common Myna	*Acridotheres tristis*	Resident
	Family Muscicapidae		
36	Oriental Magpie-Robin	*Copsychus saularis*	Resident
37	Indian Blue Robin	*Larvivora brunnea*	Migrant
38	Malabar Whistling-Thrush	*Myophonus horsfieldii*	Resident
39	Pied Bushchat	*Saxicola caprata*	Resident
	Family Dicaeidae		
40	Nilgiri Flowerpecker	*Dicaeum concolor*	Resident
	Family Nectariniidae		
41	Crimson-backed Sunbird	*Leptocoma minima*	Resident
	Family Chloropseidae		
42	Golden-fronted Leaf bird	*Chloropsis aurifrons*	Resident
	Family Passeridae		
43	Black-throated Munia	*Lonchura kelaarti*	Resident
44	House Sparrow	*Passer domesticus*	Resident
	Family Motacillidae		
45	Grey Wagtail	*Motacilla cinerea*	Migrant
46	White-browed Wagtail	*Motacilla maderaspatensis*	Resident

Birds

Malabar Whistling Thrush

Red-whiskered Bulbul

Yellow-browed Bulbul

Grey Jungle Fowl

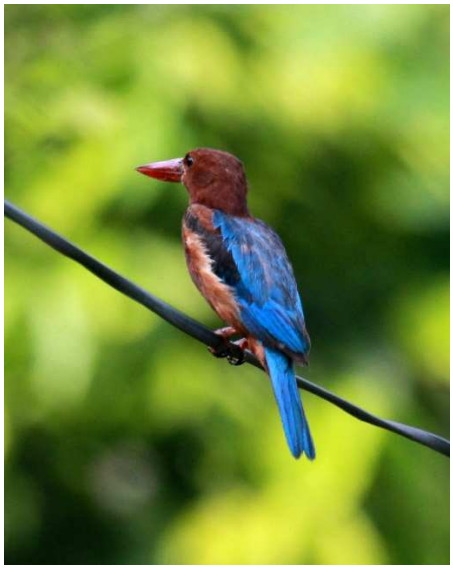
Spotted Dove

Common Tailorbird

Common Myna

Green Sandpiper

Pied Bushchat



White-throated Kingfisher

Grey wagtail

Common Iora

Mammals

The assessment carried out within the campus including the immediate surroundings. The survey team observed direct sightings of five species of mammals, Barking Deer *Muntiacus muntjak,* Indian Grey Mongoose *Herpestes edwardsii,* Wild Pig *Sus scrofa.* Malabar Giant Squirrel *Ratufa indica indica* and Jungle Striped Squirrel *Funambulu stristriatus*. Indirect evidence (pellets) of the Black-naped Hare *Lepus nigricollis* was observed (Table 29). Besides, nocturnal mammal species of bats and rodents could be seen around.

Table 29 List of mammals

Sl. No	Scientific name	Common Name	Status
1	*Funambulus tristriatus*	Jungle Palm Squirrel	LC
2	*Muntiacus muntjak*	Indian Muntjac	LC
3	*Lepus nigricollis*	Indian Hare	LC
4	*Herpestes edwardsii*	Indian grey mongoose	LC
5	*Ratufa indica*	Malabar Giant Squirrel	LC
6	*Sus crofa*	Wild Pig	LC
7	*Bandicota* sp.	Bandicoot Sp.	

Healthy Practices

- The campus has an excellent collection of rare and beautiful ornamental species and varieties.
- The wide varieties of flowers attract butterflies and pollinating insects to the campus.
- It is appreciated to retain some of the large and old fruit yielding Jamun Trees (Njaval) in the campus irrespective of the landscape alterations.
- Fish-pole bamboo and giant reed *Arundo* sp. planted along the two water bodies is fore sighted to prevent soil erosion and sliding of edges into the tanks.
- Retaining of many fruit species in the campus helps not only the human inmates but also the members of natural fauna such as birds, butterflies, other pollinators and frugivorous species.

- The two water-bodies form an important habitat in the campus for various aquatic insects, wetland birds and associated fauna.
- These water-bodies facilitate the drainage and ground water recharge of the campus.

Recommendations

- Since the location of the campus has proximity to the forest lands, it is recommended to choose native trees and shrubs where ever it is required replanting.
- The open and soil-exposed areas of the campus may be restored with suitable vegetation cover such as grasses, herbs, shrubs and trees.
- Steep as well as sloppy terrains have to be protected with soil-binding species such as local species of reeds, bamboo and other grass species, especially around the lower check dam area. This will in turn stabilise the dam by reducing the uncontrolled soil erosion and siltation.
- Since majority of the biota is confined to the surroundings of check-dam, adequate care may be taken to preserve the ecological balance of this area.
- A portion of the campus can be maintained as less-intervened natural butterfly garden, which can resemble a sacred groove, where the management can restore native trees, shrubs, lianas etc.
- Allow natural re-generation of the endemic and native species, particularly trees, wherever it is possible.
- Periodical and careful removal of exotic species, which are hindering the natural regeneration in the campus, should be monitored.
- Garden wastes out of trimming and disposal of excess seedlings should be done carefully to avoid further invasion into the natural areas.
- And most importantly a conservation part of the campus may be set apart and kept away from any further developmental activities. As a natural habitat, this area may serve as an abode for biodiversity and can attract many species of insects, birds, reptiles and mammals. The conservation area may suitably designate as “Marian woods/ sacred grove/ green grove/ Forest/ ….....”

Recommended native trees and shrubs for restoration activities

Sl.No.	Scientific name	Common name
1	*Persia macrantha*	Kulamavu
2	*Bombax ceiba*	Elavu
3	*Garcinea cambogea*	Kudampuli
4	*Sterculia villosa*	Para Vakka
5	*Vernonia arborea*	Chamatha
7	*Dillenia pentagyna*	Pattipunna
9	*Grewia tiliifolia*	Unnam, Chadachi
10	*Alstonia scholaris*	Eazhilampala
11	*Holarrhena antidysenterica*	Kudakapala
12	*Pavetta brevifolia*	Malampichi
13	*Tabernaemontana heyneana*	Koonanpala
14	*Mimusops elengi*	Elanji
15	*Mimusops* sp.	Malaelanji
16	*Schleichera oleosa*	Poovam
17	*Litsea coriacea*	Vettithali
18	*Chionanthus mala-elengi*	Elanji
19	*Rauvolfia verticillata*	Amalpori
20	*Canna indica*	Canna lilly
21	*Ensete superbum*	Kalluvazha
22	*Cinnamomum verum*	Illvangam
23	*Smilax zeylanica*	Karivilanthivalli
24	*Argyreia nervosa*	Perunkurumpa
25	*Hydnocarpus macrocarpa*	Malamarotti

While allowing the saplings of natural pioneer species to come up, few native grass species such as *Vetivera zizanoides* (Ramacham) and suitable *Ochalandra* sp. may be planted to prevent soil erosion, particularly on the steep and sloppy areas.

Conclusion

Overall, the list of species and the biodiversity composition of the campus certainly shows an appreciable level of richness. There is no doubt that there may be many more species to be recorded if the assessment and observations are made periodical covering subsequent seasons. However, the campus maintains considerable amount of green cover, despite continuous ecological disturbances and degradation due to various developmental activities in the region. The campus is situated in an ecologically important as well as fragile landscape with elevated ridge which is prone to heavy wind and rainfall in seasons. Without proper natural barriers, it may lead to disasters like landslides. Hence, it requires improvement in terms of restoration with suggested native vegetation. Being surrounded by plantations and human habitations, it still serves as an abode for many native species of flora and fauna. It is expected that the proper implementation of the suggested restoration activities and continuation of the best practices will enrich the biodiversity and ecological stability towards an ideal eco-friendly and sustainable campus.

5. CARBON AUDIT

Worldwide, increasing Greenhouse Gas emission (GHG) has resulted in associated environmental challenges like global warming and climate change. Approximately each year eight billion tons of carbon dioxide (CO_2) was emitted in the atmosphere by human activities. As per the Paris Climate Change Agreement, India has targeted to reduce GHG emissions of its gross domestic product up to 35% during 2005-2030, against its old obligation of reducing up to 25%. In order to attain the target of minimum greenhouse gas emission and sustainable development constant efforts have been taken at various levels like implementing the emission reduction policies and continuously monitoring the industries, organizations etc. The growing awareness concerning the environmental impact and sustainability growth of organizations and developed sectors also include the higher educational sectors. Education institutions, which plays a pivotal role in the growth of a nation deals with significant community of people and involves an array of intense energy consuming activities. Based on several reports and studies, educational institutions significantly influence in greenhouse gas emissions and subsequent climate change impacts. Hence it is inevitable to account the institutional GHG production in terms of carbon footprints (CF) emissions through an efficient carbon audit is a present day need.

Carbon foot print refers to the possible climatic impact (Global Warming) of the Greenhouse Gases (GHG) emitted directly or indirectly due to an organization's activities. Carbon dioxide is one of the greenhouse gases (GHG) and the most significant contributing component to GHG, which is around 30%, followed by CH_4 and N_2O. The amount of GHG is denoted by carbon dioxide equivalent (CO_2- eq) or Global Warming Potential (GWP) which is a combination of a large GHG impact based on radiation power and the length of time GHG in the atmosphere.

Disclosure of the carbon foot print of an educational institute is inevitable to identify the source and sink of emissions and the best possible mitigation measures that can be adopted towards the carbon reduction. Moreover, the assessment enables the institute to identify the carbon emitting hotspots in the campus in order to devise immediate mitigation measures to implement. Furthermore, the assessment of CF of an educational institution helps to turn the campus more sustainable and assist to create a more environmental responsive student community.

Significance of the study

The higher education sector continues to undergo unprecedented transformations and accommodates a significant population globally. The number of students attending colleges has grown exponentially over the years and this trend is expected to continue under most business scenario in the future.

Objectives

- To identify the carbon emission sources and hotspots in the campus
- To quantify the direct and indirect carbon emissions
- To appraise the existing carbon sink status
- To compute the carbon footprint of the campus
- To suggest efficient measures for reducing the carbon footprint

Methodology

Quantitative and qualitative data regarding the emissions were collected from primary and secondary sources. Onsite visits, personal interviews and discussions, data compilation from institutional records, documents and other sources were taken up for the effective acquisition of informations.

Present survey utilized the GHG protocol of for the estimation of the total CO_2 emissions from sources that are owned or controlled directly by the campus, indirect emissions from electricity consumption, and other indirect emissions with three scope definition.

Scope 1: Accounting of the direct emissions of GHGs from the campus-owned facilities.
Scope 2: Accounting of the indirect GHG emission from the purchased electricity.

Scope 3: Accounting of other indirect GHG emissions (other than scope 2 emissions).

In order to calculate the CO_2 emission from the unit of activity data (e.g. KWh of electricity consumed, Kg of fuel used), the values are multiplied with their respective conversion factors and expressed in terms of kg CO_2 equivalent ($kgCO_2e$). Emission factor adopted from national and International standards were utilised.

Limitation and disclosures

Paucity of exact data regarding the travel details, newly installed devices, floating population in the campus etc. are considered as major limitations. The information

provided by the institution is used for the carbon footprint computation and hence missing information are omitted during evaluation.

Scope 1 - Identified carbon source and related GHG emission

Direct CO_2 emission sources:

Both mobile and stationary combustion sources that are owned and operated by the institution accounts for the direct emission points. These include combustion of fuels in vehicles, stationary combustion source like LPG cylinders in canteens, laundry and laboratories furnaces, incinerators etc. Emissions from refrigerators, air conditioners accounts for the fugitive emission. The identified direct emissions accounts for scope 1 of the inventory.

Scope 2 - Indirect CO_2 emission sources:

The purchased unit of electricity consumed during the concerned time period by the institution accounts for the indirect emission source. CO_2 emission rates are noted proportional to the consumed electricity by the organisation and accounts for the scope 2 of the CF survey.

Scope 3 - Other Indirect CO_2 emission sources:

The indirect CO_2 emission sources identified from outsourced activities like the daily commuting of students, teachers and other staff, paper consumption in different blocks, generation of garden and other wastes fall in the operational boundary of scope 3 of this inventory.

1. Carbon emission details :

As per the data provided by the institution the total number of students, teachers and staffs considered for the CF assessment is as follows:

The scope-wise distribution of carbon emissions from the various sources of the campus is analysed as -

Scope 1 Emissions

It is estimated that under Scope 1, the total annual equivalent CO_2 emission was recorded as 55.22 TCO_2. The figures depict the percentage contribution of CO_2 from various fuel consumption in the campus. Maximum GHG emission is contributed by LPG consumption (35.64 TCO_2) as 60 cylinders are used in the canteen for cooking and related activities in hostels and laundry for drying purposes, which account for a total of 64.5% of the total CO_2 emission annually. Consumption of diesel increased from former years and accounted for a total annual equivalent of 16.08 TCO_2. Diesel is mainly utilised in diesel generator to provide power backups for the campus during power cuts to maintain the regular campus activities.

Table 30 Scope 1 Emissions

Sl. No.	Source	Annual Eq. of CO_2
1	LPG consumption	35.64
2.	Diesel consumption	16.08
3.	Fugitive emissions	3.5

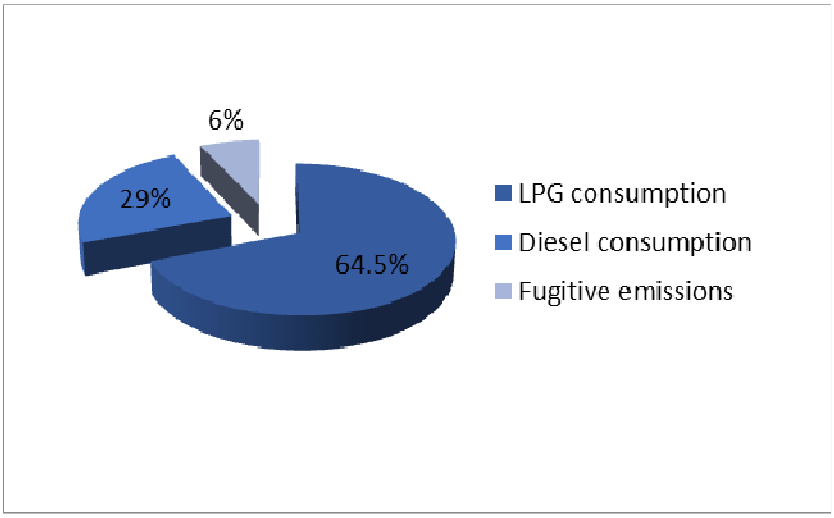


Fig. 24 Percentage distribution of Scope 1 emissions of different activities

Under the Scope 1 emissions, fugitive emission from the refrigerators and air conditioners installed in the campus recorded the least emission values (3.5 TCO_2). Owing to the practical intricacy in collecting data regarding fugitive emissions, reliance on empirical measures and methods are considered as the limitations.

Scope 2 Emissions

Scope 2 emission category contributed the highest contribution of GHG emission and the total electricity consumed by the college represent this category. The annual electrical energy consumption of the college is 181184 kWh and the emission estimated is 163.07 TCO_2 for the computing year.

During the survey the maximum consumption of electricity was noted during the month of March and minimum during May. Considering the trend, maximum GHG emissions were recorded during the active academic period of the year in the campus. Compared to the findings of the previous carbon audit, a substantial reduction in CO_2 emission of approximately 46% was noted. This reduction in turn relates to reduced consumption of purchased electricity in the campus. The successful installation and working of solar power unit helps in this emission reduction.

Scope 3 Emissions

Scope 3 emission computed for the college is approximately 99699.60 CO_2 or 109.9 TCO_2. The commuting activities of students, teachers and non-teaching staffs contributed the maximum emission in this category and accounted for about 94% in the campus. This can be explained by the transportation habits of the staff and student community, as well as the distances they travel. This observation reinforces the fact that indirect emissions of people and processes within the campus can be a major contributor to total impacts. Paper consumption and waste generation which includes food waste, sweeping and garden waste contributed to a negligible proportion of CO_2 emission in the campus. A well maintained waste management system is operating in the campus and as such the biodegradable wastes including food waste, sweepings and garden wastes are used effectively as substrates for the production of compost and biogas.

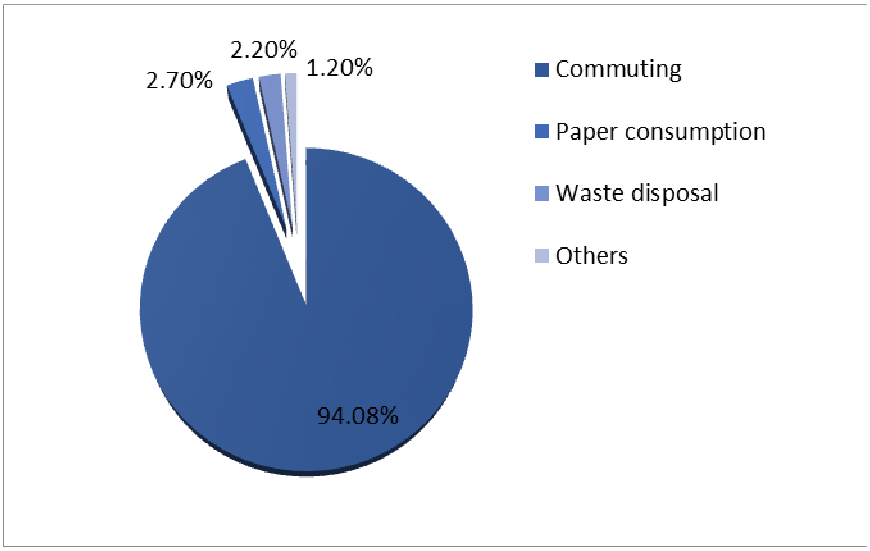


Fig. 25 Proportion of CO_2 emissions

Table 31 Source of CO_2 emissions

Scope activity	**Carbon emission (TCO_2)**
Commuting (staffs, students etc.)	103.4
Paper consumption	3.0
Waste disposal	2.5
Others	1.0

Compared to the previous carbon assessment, it is seen that the emission from commuting have reduced considerably (approximately 59%) and this may be attributed to the prevalence of the Covid pandemic and associated travel restrictions.

The total CO_2 emission of the campus is computed as 328.19 TCO_2. In comparison with the earlier reports, a significant reduction had been achieved in the total CO_2 emissions from the campus, which accounts for approximately, 48.9 % (289.75 TCO_2).

Table 32 Category and quantity of TCO_2

Category	**TCO_2**
Scope 1 emission	55.22
Scope 2 emission	163.07
Scope 3 emission	109.9
Total	**328.19**

Carbon foot print analysis and evaluation

From the analysis, the per capita carbon foot print for the College is computed as 0.158 $TCO_{2,}$ which is significantly lesser than the earlier reported value (0.311 TCO_2). Nearly 49% reduction has been successfully achieved in the per capita CO_2 emission in the campus. Hence the campus can be designated as green and carbon sustainable campus.

Carbon sink

Since there is mounting concern and importance in quantifying the storage capacity of carbon sinks for inclusion in carbon emission inventories, there is a need to compute and trim down an organization's carbon footprint. Moreover, it is noteworthy to assess the carbon sink of the Marian College, since it is noted that the management has taken sincere endeavours with due importance to improve the carbon sink capacity of the campus.

Carbon sequestration is the method of incorporating atmospheric carbon into the various components like plants, soils, and water. The resources or processes that incorporate atmospheric carbon are designated as carbon ***sinks*** owing to their capacity to incorporate, as opposed to emit, GHG emissions especially CO_2. However, carbon sequestration calculations can be difficult to perform, due to data requirements, complexity of estimation methodologies and uncertainties. Many factors, including geographic location, temperature, humidity, and species dominance, will affect the rate of carbon sequestered by the biomass in a given area. In the present study the application of remote sensing (RS) and Geographic Information System (GIS) possibilities were utilised for assessing the carbon sink of the campus.

a. Normalised Difference Vegetation Index (NDVI)

The Spectrally-based Normalized Difference Vegetation Index (NDVI) derived from RS platforms, is a common indicator used to monitor biophysical conditions and vegetation cover. NDVI computed using following formula

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

b. Estimation of above ground biomass

The above ground biomass was estimated using doubled the value of Carbon.

The major carbon sinks of the campus identified are:

1. Vegetation

Vegetation and related biomass carbon is a potential component to offset carbon foot print of the campus through increased carbon sequestration. The campus, which sprawls over 27 acres of land, encloses luxuriant vegetation which includes, trees, shrubs, herbs and grass varieties (details are covered under the biodiversity section). The floral representation of the campus is potential candidates which stores biomass carbon. Nearly 900 trees and plants were added to the existing diversity during 2018 and as such an annual increment in biomass and subsequent carbon adsorption is expected. A part of the campus at the lowest reach encloses a forest portion of the carbon sink. The presence of large trees in the campus aids in the incorporation of considerable amount of carbon in biomass. It is estimated that one ton of carbon storage in a tree represents the removal of 3.67 ton of carbon from the atmosphere and the release of 2.67 ton of oxygen back into the atmosphere.

Luxuriant vegetation composed of large tree species and grass varieties are noted along the check-dam and adjoining areas, significantly accounts for increased biomass carbon sequestration in the campus.

The change in carbon sequestration potential and CO_2 emission was estimated for the campus. Carbon sequestration is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide. From the biomass carbon analysis using remote sensing it is noted that the campus holds 215.098 T of standing biomass. The carbon storage capacity of the campus is estimated as 107.54 T which is equivalent to 394.70 TCO_2.

Hence it can be stated that the present vegetation carbon pool of the campus significantly act as a major carbon sink and aids in substantial CO_2 reduction. Taking advantage of the sequestered carbon in the existing biomass and promoting further planting of new biomass aids in further reduction of the carbon foot print of the campus. It is recommended to incorporate carbon adsorption measurements from the existing biomass quantity of the campus and determining the annual carbon adsorption capacity through annual increment in biomass.

2. Soil

Soil is a key compartment for climate regulation as a source of greenhouse gases (GHGs) emissions and as a potential sink of carbon. The presence and predominance of forest lateritic soils in the campus and adjacent region denotes the occurrence of rich organic matter content in the form of soil organic carbon (SOC).

Soil organic carbon (SOC) is the balance between plant inputs and biologically mediated losses. Transportation and sedimentation activities may also increase the humus content of the soils here. Besides, the presence of extensive grass cover can increase the soil carbon content.

The amount of SOC is large compared to anthropogenic CO_2 fluxes to the atmosphere as small changes in the SOC pool could have a major impact on the concentration of CO_2 in the atmosphere. This can be seen as a threat, but also as an opportunity for possible mitigation measures.

Best practices

Installation of Solar Photo Voltaic (SPV) System

As per the recommendation in the previous audit, the management has successfully set up 30 kWp rooftop solar system and connected to the distribution system of KSEB during 2019 as the first phase of installation. The installation provides a reasonable harvest of 4 kWh energy per day for the energy requirement of the campus. The per day total power requirement of the institution is computed as 199 kW of which the SPV system provide nearly 80 kW energy and accounts to meet approximately 40% of the total energy requirement. This has led to the considerable emission reduction derived from electricity usage.

Biogas plant installation

The implementation of food waste based biogas plant in the hostel help to reduce the waste derived emissions and also production of energy to substitute LPG in the hostel. Besides, the waste is utilised for preparing compost and also given to outside agencies for compost preparation and as feed for pig farms. As such, it is not thrown in a haphazard manner and hence resulted in low waste derived emissions.

Organic farming activities

The campus owns organic farming grounds where substantial carbon sequestration in biomass and soil occurs.

Tree planting and gardening

In special occasions, planting of tree saplings are promoted which in turn help to increase the vegetation carbon pool of the campus. Moreover, extensive gardening activities also contributes to the standing biomass carbon content of the campus.

Plastic ban

Plastic is banned in the campus and as such disposal and open incineration of plastic and subsequent emission are negligible in this green campus.

Recommendations

Install biogas plant for waste disposal in other hostels

At present there are four hostels in the campus, of which one is equipped with food waste derived biogas generation facility. The use of firewood for cooking purpose was noted in the hostels, which can lead to intensive emissions. Hence it is recommended to construct biogas plants in other hostels also for waste management and energy generation.

Tapping of the full potential of the campus for Solar Photo Voltaic (SPV) System installation

As per the previous audit there is a potential to install 150 kWh SPV system in the campus. Hence it is recommended to install the full capacity to tap maximum solar energy.

Organise GHG Information Management System

It is advocated to constitute a carbon management crew consisting of student, staff representatives of the college. Capacitate the team to collect and archive data regarding the emission sources, rate of emissions, carbon emission measurement methods and prospects etc. Periodic progress assessment of the team is also required.

Establish campus emission reduction targets

It is recommended to establish emission reduction targets for the campus on short/ medium and long term basis. For this baseline GHG emission data status has to be

collected and compiled upon which benchmarks can be prepared. Formulate Green mottos and slogans for emission reduction target programmes.

Disclosure of the campus as a sustainable carbon footprint model

The college can disclose their best practices and green initiatives towards achieving emission reduction to the public through a common platform with an appreciable GHG accounting and management systems. This can generate awareness and confidence in other institutions and to the public to adopt such green initiatives. The stewardship towards nature gains recognition and a leading role for the college as a torch bearer for green initiatives in academic sector. Moreover, exchange of green ideas and techniques can occur in such venture.

Strengthen and revitalise campus green policy

The existing environmental policy of the campus needs to be revitalised and strengthened by giving stress to emission reduction and adoption of green substitutes. The policy should be well communicated and showcased across the campus.

Promote Green events

It should be made mandatory for every event held in the campus to be held under low carbon emission profile. This can be executed with the help of the green crew (Green Marians).

Appreciations and awards

Rewards in the form of eco-friendly labels, medals and trophy can be implemented for different groups, departments and association of the campus who aids in maximum emission reduction. This can turn as a motivation to walk towards the green.

Institute Eco-funds and Eco-suggestion boxes in the campus

It is appreciable to constitute a green fund from the saving made from sustainable initiatives and further using the amount for more green initiatives in the campus. It is recommended to place eco-boxes or caskets to collect suggestions and other green innovative ideas for the campus to embrace sustainability.

Campus landscaping

The all-time inviting green premises of the Marian Campus are breathtakingly beautiful. However, landscaping activities associated with infrastructure development is found as a threat to the existing green spaces. It is inevitable to incorporate green landscape designs into the future construction plans of the campus. Moreover, design the landscape to use the minimum space to preserve the natural settings promoting wilderness, tranquillity and calmness in the Marian Campus.

Additionally, it is recommended to assign green grounds for outdoor academic purposes, allow more natural vegetation and micro habitats to increase the carbon sequestration potential of the campus. Realise the spectrum of green benefits associated with the incorporation of sustainability into new campus infrastructure and innovations.

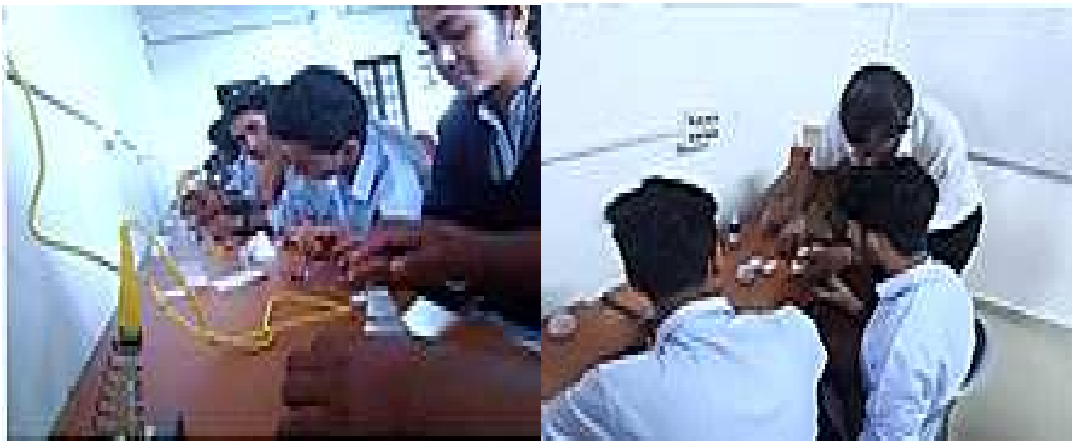
IV

ENVIRONMENTAL OUTREACH ACTIVITIES AND GREEN CAMPUS INITIATIVES

The prestigious Marian College, apart from imparting knowledge and reshaping society by creating consciousness has initiated remarkable and unique programmes towards contributing to the environment in myriad ways. Understanding their pivotal role in resource utilisation and environmental implications, the management have taken significant steps to go green. Below are some of the major environmental outreach activities of the institution.

1. LED bulb assembling training (September 2018)

Marian College has signed MoU with KEL Electricals Mundakkayam for regular supply of LED bulbs and to buy-back the damaged LED bulbs. Besides, training has been given for the students on LED making.



LED bulb assembling training

2. Disaster management programme

Fire and safety training programme (July 2019)

As part of the activities of the women cell, a fire and safety programme was conducted for the students to raise the awareness of fire hazards in the work place and had demonstration on how to act safely on event of emergency.

First aid training programme (September 2019)

Provided training on first aid treatment for faculty and students

3. Eco-friendly bag making training (January 2020)

The college conducted a training programme on eco-friendly bag making using recycled paper as a part of plastic evasion campaign.

4. River restoration activities (September 2018)

An effort has been taken up by the NSS volunteers of the college towards the cleaning and restoration of the Koruthodu River. Besides an awareness regarding the importance of water bodies and the need of conservation was also imparted to the nearby inhabitants.

5. Cleaning of Vagamon, a tourist destination (2019 and 2020)

As an outreach programme, the NCC volunteers of the college, cleaned Vagamon, a famous tourist hotspot during 2019 September and 2020 January. Sincere effort has been taken up from the student volunteers and college management to extend the activities in order to keep the natural setting of the region.

6. Camp 'Suvarnam' (September 2019)

As a part of the extension department the college and the NSS unit , a seven day camp has been conducted towards the betterment of a school in Koottikkal by cleaning the school premise and started a vegetable garden.

7. School programmes (November 2019)

As part of the children's day celebration, the extension department of the college conducted an outreach programme at the Government LP School, Kozhimala, which includes various awareness programmes and formed a vegetable garden and emphasis the need of sustainability.

8. 'Ottamarathanal' Programme (November 2019)

The Ottamarathanal programme is noted as a major green outreach programme of the institution which launched an array of environmental friendly, green programmes like

waste management aiding activities (waste disposal pit construction and awareness), vegetable garden, cleaning of the road premises in Peruvanthanam Panchayath. Besides, inculcated the importance of healthy living close to the nature has also been dissipated to the community.

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ദിദിന ക്യാമ്പ്

9. 'Vimukthi' - Anti plastic campaign (November 2019)

The institution launched an anti plastic programme entitled as 'Vimukthi', through enlightened the common public and students regarding the importance and need of plastic avoidance in our daily life. Besides, ways and means to live in tune with the nature through the utilization of sustainable measures also has been communicated.

10. **Garden for school**

The extension team members created a organic vegetable garden for St. Thomas LPS in Amalagiri as part of “Ottamarathanalil.” And it was created with the participation of Amalagiri's little kids. They created a small but lovely garden for them. Under the direction of Fr. Jose Valiyakunathu, they also created a garden for the St. Thomas Church in Amalagiri.

11. Road cleaning

The road cleaning initiative was launched in collaboration with the Kudumbasree Unit. With the goal of reducing the number of road accidents, they cleaned both sides of the road and made a safe walkway for the passers. On November 30th, Smt. Moly George, ward member of Amalagiri, inaugurated the green initiative programme. It created a sense of social responsibility and a role model to the local community and students of Peruvanthanam Panchayath. Wisterians planted several trees on the roadside to provide shade for people and to reduce waste dumping along the roadside.

12. Organic vegetable farming

Marian College created an organic vegetable garden at Govt. Harijan Welfare UP School, Kattadikkavala.

Green initiatives

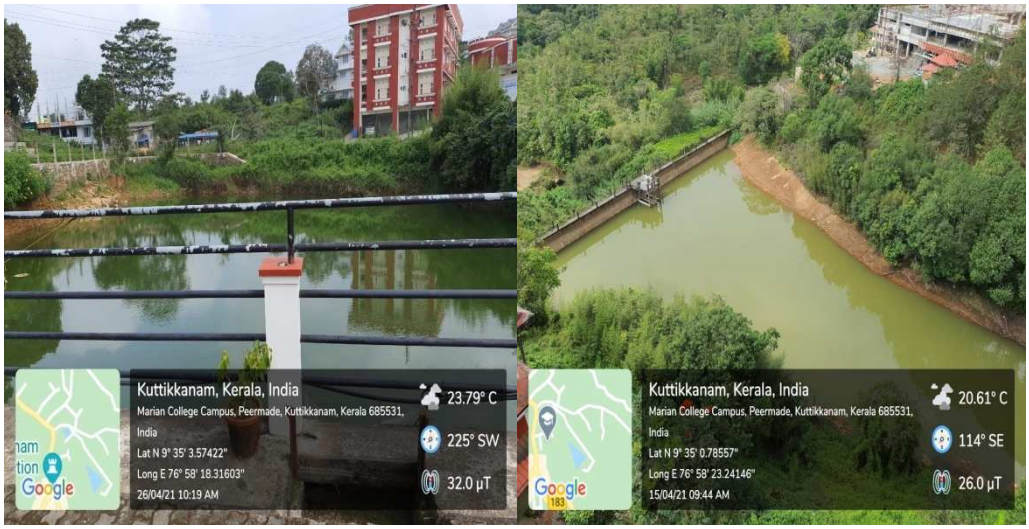
1. Solar Energy

As per the recommendation of the previous Environmental Audit towards electricity consumption reduction, the management installed solar power panels in the campus during 2019, a 30 kW installation has setup as 1st phase. From the power requirement details provided by the management, it is assumed that 40% of the electricity requirement is met from the installation. The energy thus generated is largely utilized for water filter and purification mechanism. Besides the energy is also used for the working of heaters and LED lights. This initiative is marked as a highly appreciable green endeavour of the campus which makes it unique towards the path towards energy efficiency.

2. Rainwater harvesting

Water conservation through accurate rain water collection systems installed in the campus is noticeable from a sustainable resource conservation perspective. With respect to the empirical estimation of potential water harvest capacity of the campus as per the previous environmental audit, nearly 89,340 sq. ft. roof top is available for water harvesting. Considering the annual rainfall of the region, approximately 29.86 million Litre rain water harvesting capacity is computed from the available roof tops of the institute. Presently, the efficient rainwater harvesting system of the campus is extracting this potential to its maximum capacity.

Moreover, the harvested rainwater is efficiently channelled to the nearby check dams through proper networking. Hence effective water harvesting system of the campus is considered as a vital activity by the management and received due importance.



3. Sewage treatment plant and waste water recycling

The sewage treatment plant of the campus is an advanced facility with a treatment capacity of 50,00 Litre water per day. The treated water is efficiently used for various purposes like flushing in toilets, gardening and farming purposes. More than 65 % of the fresh water utilization is reduced by this system. The water conservation strategies and its utilization efficiency of the campus is quite satisfactory and remains as a striking example which can be followed by other educational institutions.

Sewage Treatment Plant (STP) at Marian

4. **Biogas plant**

   Based on the recommendations from the previous audit, the management successfully implemented a high efficient biogas plant in the campus. This is an appreciable effort which sustainably utilizes the wet and degradable waste (like food waste) generated in the campus and results in energy production also.

5. **Shifting to LED lights**

   Another notable activity in the path of greening in the campus is the replacement with LED bulbs. The fluorescent lamps and CFL are replaced with 20 w LED lights. Presently about 90% of the lights in the campus are of LED category. Energy and associated cost saving was achieved due to the shifting to LED lights. Besides the college has signed MoU with KEL Electrical, Mundakkayam for regular supply of LED bulbs and also to buy back the damaged LED bulbs.

6. **Introduction of energy efficient dynamic modular UPS systems**

   Based on the recommendation on the previous audit almost all the old working UPS systems were optimized with energy efficient dynamic modular UPS systems and this initiative contributed to increase the energy efficiency of the campus.

7. **Adoption of buy-back policy for electronic equipment's**

   Inefficient electronic devices in terms of energy consumption are systematically sold out to vendor on an annual basis. The campus has successfully adopted the policy of buy back with the suppliers through which a lot of worn-out electronic equipment's are exchanged. This significantly contributes to reduce the E waste load in the campus.

8. **Introduction of energy saving automated timer machines**

   As a sustainable energy initiative the introduction of automated timer machines in the heaters and in the high mast light of the institution is a noteworthy activity. This saves considerable electricity of the campus.

High-mast light with timer **Heater with timer**

9. Construction of tanks and bunds

Meticulous effort was taken from the management for the construction of tanks especially for storing rain water and runoff from the campus. The high capacity tanks act as better water reservoir for the campus and helps to increase the water availability and in ground water recharge. This water body makes the campus water sufficient.

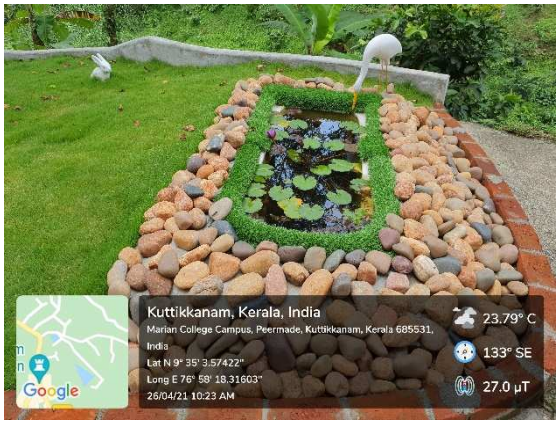
10. Plastic ban

Marian college stands exclusive for having a separate green protocol for the campus. A stringent attitude is taken towards wading of plastic wastes from the campus through this protocol. Usage of all most all types of plastic items are banned or replaced by organic and sustainable items in the campus. Use of plastic pens is highly discouraged. The campus promotes the use of recycled papers for posters, brochures and flyers. Moreover, plastic substitutes are encouraged in the campus for decoration purposes. The general awareness prevailing in the campus towards eliminating the indiscriminate usage of plastic shows the care and consideration of Marians towards Mother Earth.

11. Landscaping with trees and plants

The institution has varieties of trees such as pine, jack, mango, bamboo, avocado, guava, and other ornamental plants. Some of the fruit bearing trees and soil binding

vegetation is planted along the reservoir banks. The lawns in the campus prevent soil erosion and helps in reducing water loss due to evaporation. Apart from these there is an exotic garden of ornamental plants, herbal garden, and a vegetable garden situated in the campus. All these were created with the participation of college students and faculty.



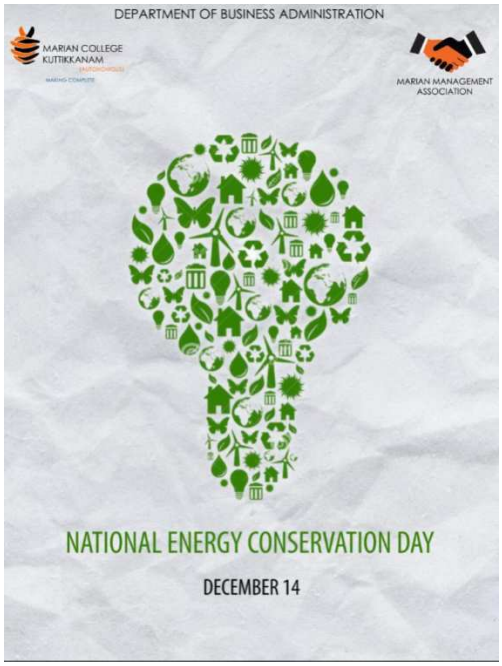
Well maintained garden

12. Restricted entry of automobiles

Marian college has restricted automobile access inside the campus. Student's vehicles shall be allowed only up to the designated parking area. Entry beyond that point is strictly prohibited.

13. Observance of important environmental and relevant days

Marian college has celebrated important environmental days like National Energy Conservation Day, National Pollution Control Day, Ozone Day, Earth Day, and World Environmental Day etc.

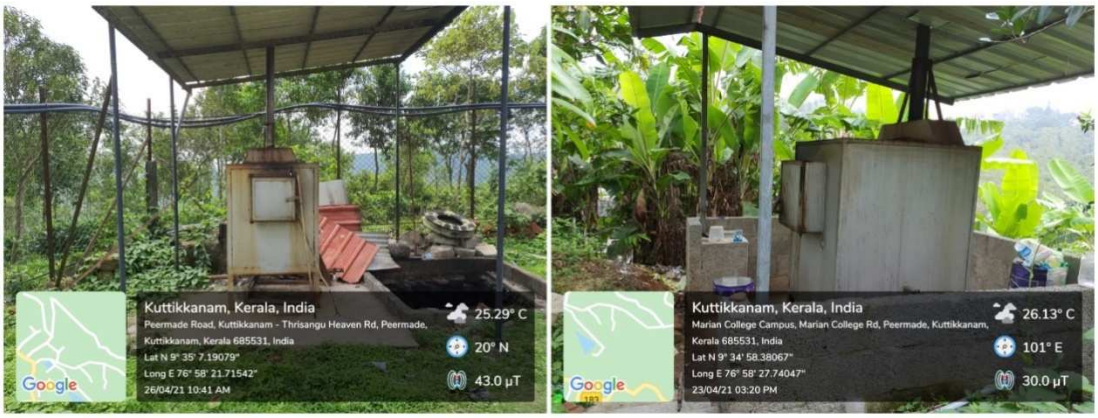


14. Activities and programmes of National Service Scheme (NSS)

Marian NSS has been conducting periodical programs and events on sustainable development, environment, and other related topics. Students from the institution took part in the summer internship programs of the Swatch Bharat Mission. NSS volunteers also assisted in the flood relief efforts and volunteered in the cleaning of flood-damaged houses. They also participated in campus beautification activities such as gardening, vegetable cultivation, and cleaning of water bodies. Water and waste management surveys were periodically conducted.

15. Installations for pollution mitigation

In order to prevent and reduce pollution from littering, an incinerator is installed for the proper disposal of wastes generated in the campus. In light of the pandemic, Covid-19 a large number of masks are deposited in bins as bio-medical waste, and they are immediately removed and incinerated. A sufficient number of support staff are employed for collection, segregation, and disposal of wastes in the campus. Marian is dedicated to the implementation of best practices in reducing and managing wastes. Solid waste is separated at the source, and a large number of waste-bins are placed at various locations in the campus. Napkin vending machines are available in the girls' restrooms, and waste bins are cleared daily by hygiene staff.



16. Fish farming

Participatory fish farming practices were done at Marian college Campus. Both ornamental and edible fishes are cultivated in fish farming.

17. Vermicomposting

Bio-degradable waste produced from various building of Marian College is used for making vermicomposting and organic manure produced from it is used for farming and horticulture.

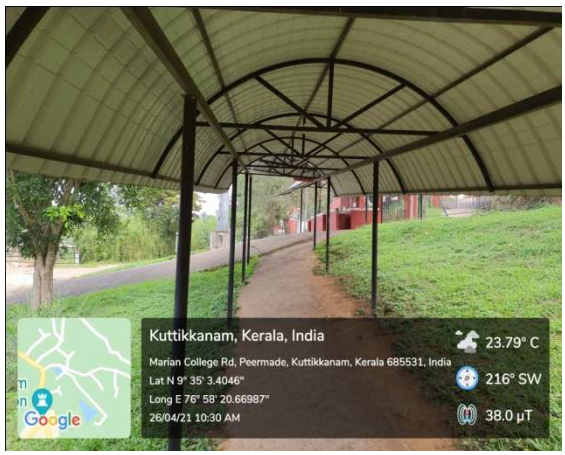
18. Organic farming

Marian College's NSS unit and extension department have established a vegetable farm in the campus to promote organic and pesticide-free vegetables. The main goal of this initiative was to give students hands-on experience with organic

vegetable cultivation. The extension department, market these vegetables with the label of “grown on campus”.

19. Pedestrian friendly pathways

The college has walkways that are suitable for pedestrians as well as differentially abled members. Most of the pathways are linked to the college buildings.



20. Centre for sustainable and inclusive development (CSID)

The Centre for Sustainable and Inclusive Development (CSID) is a new initiative f Marian college for promoting the idea of Sustainable development, through educational activities. The main aim of this centre is to disseminate awareness about environment and development among the public in general and the students particular from attaining the Sustainable Development Goals (SDG) perspective. In this context, CSID of Marian college has conducted the following programmes for spreading the awareness of sustainable development.

21. Green Lecture Series (Jan 7, 2018)

The programme was arranged to generate the student awareness in the emerging environmental issues and the lecture focused on 'Environmental Impact Assessment'.

22. Sustainability Ambassador Programme (SAP) (June 26, 2019)

Is an initiative of the Applied Economics Programme and Centre for Sustainable and Inclusive Development (CSID), Marian College Kuttikkanam. The programme was intended to create environmental awareness and to measure the level of awareness in the minds of the people.

As a part of the programme a project entitled 'Greening the Young Minds' (GYM) of Idukki was executed. The project emphasised the importance of interrelation ship between environment and development that resulted in the enhancing of green capacity building of the people of Idukki district.

23. Other green activities

Apart from the above mentioned initiatives, other notable and outstanding green programs of the campus makes Marian College a distinct entity in the path of environmental stewardship. The following points are noteworthy and bears the green signature of the Campus.

- Seminars and conferences follow green protocol
- Banning of plastic pens and other stationery items
- Promotion of recycled paper for posters, brochures, flyers etc.
- Utilisation of social media, digital sources and online resources for communications
- Banning of Plastic, polystyrene, thermocol, etc. for decoration. Promotion of banners derived from discarded bags and papers.
- Aversion to PET bottles and cups and promotion of glass, steel tumbler and glass containers are placed for drinking water usage
- Use of reusable steel and ceramic utensils in cutlery

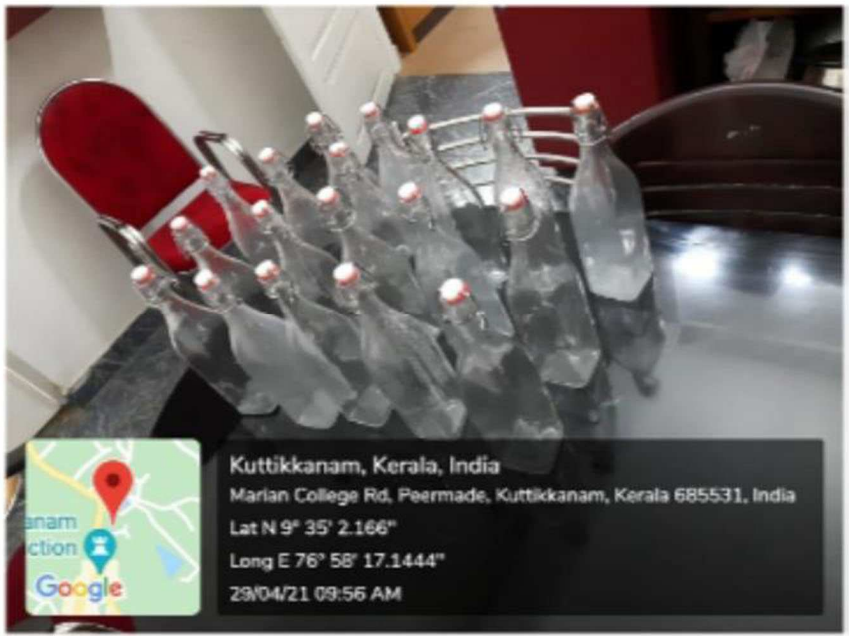
- Indoor decorations with plants and reused bottles
- Promotion of the use of reusable and refilled white board markers
- Promotion of domestically grown spices as gifts for visitors and guests. The gift packages include '*Ramacham'* pouches made by women SHGs.

Use of steel tumblers for the campus events

Refilling of white board markers

Bottles are used to keep plants in class rooms

Participation of students in the campus gardening



Glass bottles are used to serve water during campus events

V

GREEN PROTOCOL OF MARIAN COLLEGE KUTTIKKANAM (AUTONOMOUS)

1. Encourage and promote the idea of ‘respect, rethink, reduce, reuse, and recycle (5Rs) principle in the campus.
2. Foster a responsible culture in the campus to avoid resource wastage.
3. Develop a sense of aversion towards use and throw away culture / consumerism.
4. Endorse the usage of reusable utensils in the campus for dining and drinking purposes, especially during functions.
5. Facilitate the segregation and handling of waste under biodegradable, non-biodegradable, and hazardous categories.
6. Promote biodegradable waste composting to produce organic manure as a soil amendment (waste to wealth approach)
7. Encourage the use of campus's Materials Recovery Facility to collect throw away items including paper.
8. Encourage the exclusion of plastic covered bouquets, flex/ plastic/thermocol like non- degradable decoration items during functions
9. Encourage the exclusion of plastic/rexine coated binding materials for projects and proposals
10. Recommend the use of cloth banners, metal boards and electronic displays instead of flex and other hoardings.
11. Encourage the use of reusable items like ink pens, jute/ cloth/paper derived bags during workshops and seminars.
12. Recommend proper storage, handling and disposal of e-waste as per the e- waste management regulations
13. Foster a sense of personal responsibility towards resource utilisation, waste generation and carbon footprint reduction

14. Nurture a sense of belonging, an attitude of minimalism, and an approach of eco-sustainability in the campus
15. Popularise the message of green literacy and eco-consciousness
16. Incorporate and conduct periodic green audit
17. Upgrade and extend the existing green initiatives and best practices of the campus to attain environmental sustainability
18. Guarantee the involvement of green crews of the campus to monitor the environmental health of the campus
19. Inculcate programs and initiatives to foster environmental stewardship and awareness
20. Promote community responsibility and engagement through increased co-operation with students, staff and community on environmental initiatives and extension programmes

VI
SWOC ANALYSIS

SWOC analysis is a frame work for identifying and analysing an organisation's strengths, weaknesses, opportunities and challenges. It helps in the planning process for improvement, competitiveness and excellence.

SWOC analysis of an Environmental Audit in college can create an efficient green strategy that can positively impact the decision-making procedures of the management. It helps in evolving proper management initiatives, demands and expectations towards achieving environmental sustainability.

Presently SWOC analysis was conducted for the domains under consideration to analyse the existing gaps and to identify the resource and other potentials for the Marian College in its path towards excellence. Moreover, it permits coherent decision making and management. It is expected that this analysis may help in providing a consistent outline for the appraisal of the present situation and design strategies that are in tandem with available resources and technical competency.

The analysis revealed the potentialities of the college in creating a suitable and eco-friendly campus. Based on the SWOC analysis, it is possible to devise a green management plan that can be amalgamated into the wide span of prosperity of Marian College. Appropriate remedial actions can be taken based on the identified weaknesses and challenges. The analysis thus forms a foundation upon which the environmental policy of the college can be revised or updated. It is expected that, the SWOC analysis sharpens and increases the precision of Environmental Audit as a tool to chisel the path to environmental sustainability of the college.

Domain	Strength	Weakness	Opportunity	Challenge
Energy	• Provision for taping further renewable energy (solar power and biogas) • Green initiatives and best practices to conserve energy • General awareness and energy consciousness of campus • Technological competence in energy efficiency • Environment stewardship and social commitment • Conducive climate and geographical position	• Over dependence on non-renewable energy sources • Lack of standardised system to account carbon footprint	• Further potential for extracting renewable energy (solar power, wind energy, hydro power and waste derived biogas) • Human resource utilisation for energy consumption monitoring and carbon accounting • Possibility to implement energy management system • Opportunity to reduce carbon footprint	• Increasing energy demand • Carbon emission accounting • Increase in transportation • Infrastructure development
Water	• Year-round water resources • Rain water harvesting potential • Water storage facility and groundwater recharge • Geographical location facilitating water drainage and storage • Waste water treatment	• Underutilisation of roof-top rainwater harvesting potential	• Scope for Increased rain water harvesting • Grey-water recycling • Micro-hydal power unit	• Possible climate extremes • Increasing per capita water usage • Waste water generation and treatment • Pollution-testing and prevention

	facility • Green water initiatives • Campus-wide awareness and consciousness			
Waste	• Waste minimisation through reuse, reduce and recycling • Food waste derived biogas generation facility • Waste derived bio-fertiliser production • Green policies and initiatives • Buy back policy activation • Plastic ban • Emphasis on digital platforms • Existence of institutional green policy	• Lack of waste characterisation and quantification methods • E-waste handling • Underutilisation potential for biogas facility extension	• Biodegradable waste derived energy production potential • Waste to wealth programmes	• Increased per capita resource utilisation • Communication and awareness • Greenhouse gas emission • E-waste generation and disposal • Reduction of paper usage and wastage
Carbon	• Reduced per capita carbon footprint • Increased use of renewable energy • Natural carbon sinks like vegetation, soil etc.	• Lack of carbon emission assessment and awareness	• Scope of renewable energy harvest facilities • Green initiatives to reduce emission • Carbon sequestration sink potential	• Assessment method • Data reliability and accuracy • Technical expertise

Biodiversity	• Geographical position in the Western Ghats • Substantial floral and faunal diversity • High resilience capacity of the region • Natural tranquillity • General campus attitude to live with nature • Sense of belonging and compassion towards nature • Region with high endemism and rare biodiversity	• Disproportion of native vegetation • Limited conservation area • Lack of sufficient technical knowledge	• Potential for establishing micro-forest system • Green initiatives to foster rare and endemic plants and animals • Butterfly park or garden • Medicinal garden	• Resource utilisation • Infrastructure development • Natural disasters like landslides and erosion • Developments in the surroundings (e.g. roads, plantations, tourism)

ENVIRONMENTAL AUDIT CERTIFICATE

The Environmental Audit presented herewith has been carried out following standard accepted procedures mandated for environmental audits and governance of academic institutions. Marian College Kuttikkanam (Autonomous) has all the strength and potential to emerge as a leading academic institution envisioned in their vision and mission.

The college has provided the required informations needed for assessment that greatly helped in deriving the audit conclusions. The data provided has been thoroughly assessed and clarified with the documents maintained by the college. The institution gave wholehearted support for physical inspection and interviews. There was periodic interaction with the manager, principal, selected faculty and administrative staff members as well as students.

The green policy and the audit process have been set to ensure that practices and derived values will be followed by the academic and administrative community of Marian College. Conservation of nature through green initiatives and healthy habits of the citizens is what is envisaged by the nation. The potentiality and the work habit of the institution, no doubt, gives strength for the implementation towards the much sought environmental cause.

The sustainable approach towards resource utilization (water and energy), waste management, biodiversity conservation, and the best practices are commendable. The Environmental Audit of the college depicted a substantial reduction in the per capita carbon footprint (in terms of carbon dioxide emission) compared to the previous survey. It is also found that the pollution status (environment quality) is highly appreciable and the quality indicator values are notably within the national standards.

The healthy practices and steps taken up by the College can maintain its green status, as a model emanating noble message of environmental sustainability that others can follow.

Director

Advanced Centre of Environmental Studies and
Sustainable Development (ACESSD)
Mahatma Gandhi University

ENVIRONMENTAL AUDIT STATEMENT

The Environmental Audit of Marian College, Kuttikkanam (Autonomous) is an earnest endeavor by the Advanced Centre for Environmental Studies and Sustainable Development (ACESSD), Mahatma Gandhi University to appraise the ways in which Marian College interact with the Environment.

The present audit was conducted for 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 these activities towards embracing eco-sustainability. The domains under consideration revealed appreciable and satisfactory performance and found to give emphasis to unique green initiatives. The college has adopted significant steps to reduce the energy consumption and also to increase the energy efficiency. The current energy utilization has been reduced significantly owing to the dependence on renewable energy generation (Solar) within the campus.

The college is currently following outstanding water harvesting and conservation methods. The green initiatives of the campus ensures water conservation practices as well as optimal and conscious water usage. As a signature of compassion *'Vellathotti'* an initiative of the campus stands to quench the thirst of birds and animals.

The biodiversity of the campus is highly appealing. The diverse flora and the associated fauna including the teeming aquatic forms and above all, the campus attitude of 'live with nature' helps to safe guard the tranquillity and greenness of the campus as an eco-system.

The campus has a competent and advanced mechanism for managing both 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 in hostel 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 substantial reduction in the carbon footprint achieved by the college as gauged through the audit revels the magnitude of meticulous green efforts for an eco-friendly campus.

Annexures

Energy Audit

Outdoor Lighting								
Sl. No.	**Location**	**Tree cover***	**No. of light point**	**Type of light#**	**Power Rating (W)**	**Units used per day**	**Units used per week**	**Units used per year**

***** **Rich/ Moderate/ Poor**

 # CFL/ LED/ Tube light/ Filament light

Indoor Lighting (Academic block)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

*** Classrooms/ Halls/ Library/ Laboratory/ Canteen/ Hostels**
 # CFL/ LED/ Tube light/ Filament light

Electrical gadgets and their energy use (Academic block)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**

*** Laptops/ Ceiling fan/ Emergency light/ Table fan/ Computer/ Projector/ Cooler/ Speaker/ Fridge/ Grinder/ Purifier/ Iron box/ Stabilizer/ Mike/ Amplifier/ Printer/ Photostat Machine/ AC/ TV etc.**

Indoor Lighting (Administrative building)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Administrative building)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**

Indoor Lighting (New academic block)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (New academic block)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**

Indoor Lighting (Guest house)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Guest house)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**

Indoor Lighting (MIIM)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (MIIM)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**
1							
2							
3							
4							

Indoor Lighting (Men's UG hostel)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Men's UG hostel)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**
1							
2							
3							
4							

Indoor Lighting (Men's PG hostel)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Men's PG hostel)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**
1							
2							
3							
4							

Indoor Lighting (Ladies hostel)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Ladies hostel)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**
1							
2							
3							
4							

Indoor Lighting (Kitchen)							
Sl. No.	**Type***	**No. of light point**	**Type of light#**	**Hours of per day**	**Units used per day**	**Units used per week**	**Units used per year**

Electrical gadgets and their energy use (Kitchen)							
Sl. No.	**Type**	**Equipment***	**Power Rating (W)**	**Average hourly use per week**	**Units used per day**	**Units used per week**	**Units used per year**
1							
2							
3							

Monthly Electricity Bill					
Sl. No.	**Month**	**College**	**Ladies Hostel**	**Men's Hostel**	**Total**

Building Energy Consumption			
Sl. No.	**Name of Building**	**Power Consumption (kW)**	**Percentage load share**
1	Academic block		
2	Administrative building		
3	New academic block		
4	Guest house		
5	MIIM		
6	Men's UG hostel		
7	Men's PG hostel		
8	Ladies hostel		
9	Kitchen		
Total Power			

Details of UPS									
Sl. No.	**Building**	**UPS rating in kVA**							**Total connected UPS load**
		3	**5**	**7.5**	**10**	**15**	**20**	**25**	
Total									

Suggested Capacity of Solar Panels at Various Buildings				
Name of Building	**Available Area at Rooftop (sq.m)**	**Suggested System Capacity**	**Average Units Generation per day (kWh)**	**Approximate Investment required after subsidy (Rupees in Lakh)**

Details of LPG Consumption and Bio waste generated		
Name of Hostel	**Average LPG Consumption per month (no. of cylinders)**	**Average Quantity of Food/Vegetable Waste Available**

Water audit

Table 1. Total Water Usage							
Sl. No.	**Fixtures**	**Measurement of Water use (Per day)**					
		Rate of Discharge (litre/min)	**Duration of use (min)**	**Average quantity per use (litre)**	**No. of Uses**	**Total Daily Uses (in litres)**	**Per Capita Daily Use (in litres)**
1	Kitchen Tap						
2	Utility Taps						
3	Bathroom Faucet-1 (Ladies Hostel)						
4	Bathroom Faucet-2 (Men's Hostel)						
5	Bathroom Faucet-3 (College)						
6	Other Bathroom Faucet						
7	Shower-1 (Ladies Hostel)						
8	Shower-2 (Men's Hostel)						
9	Outside Tap						
10	Lab Taps						
11	Others						

Table 2. Consumption of Water in the College	
Particulars	**Quantity of water (in litres)**
Total daily use of water	
Per capita daily use of water	

Table 3. Storage capacity and frequency of filling water tanks in the college				
Sl. No.	**Type of building with water tank**	**Capacity**	**Frequency of filling per day (depends upon usage-average)**	**Average amount of water usage (litres/day)**
1	**College**			
2	**Men's Hostel**			
3	**Ladies Hostel**			
4	**Others**			
Total				

Table 4. Total loss of water per day due to leaking taps	
Item	**Quantity**
No. of leaking taps	
Quantity of water loss per day through leaking taps	

Waste Audit

Data sheet

Sl. No.	Type of building	Total number of people (on an average/ day)	Paper Waste (Kg/ day) non	Plastic Waste (Kg/ day) non	Glass waste (Kg/ month) non	Damaged Furniture (Kg/ month) non	Biodegradable Waste (Sweeping waste, food waste, crop waste) (Kg/day)	Construction Waste (Kg or volume /year)	E-waste (Kg/year)	Hazardous waste (Kg/month) Batteries,- normal batteries, ups/inverter batteries, mobile phone batteries, solar batteries, CFL lamps	Other waste (sandals, clothes, etc., (Kg/month)
1	Old Academic Block										
2	New Academic Block										
3	Administrative Block + Guest House										
4	MIIM										
5	PG Boy's Hostel										
6	UG Boy's Hostel										
7	Ladies Hostel										
8	Kitchen										

Waste categories and their current disposal strategies

Sl No	Categories of Waste		Particulars	Types of Disposal
1	Paper Waste		A4 Paper (Print out papers), Newspapers, Paper plates &cups etc..	
2	Plastic Waste		Pen, Refill, Plastic water bottles and other plastic containers, wrappers etc	
3	Glass waste		Broken glass wares from buildings	
4	Damaged Furniture		Furniture from different buildings	
5	Biodegradable Waste		Sweeping waste, food waste, crop waste	
6	Construction Waste			
7	E-waste		Computers, Printers, other electronic gadgets	
10	Liquid waste		Waste water from Hostels, canteens, cafeteria, toilets	
11	Other waste	1. Sandals 2. Clothes		

Waste treatment units, quantity of waste treated and energy &manure production details

Sl. No	Waste treatment units	Total quantity treated (Kg/day)	Approximate quantity of gas generated in Volume per day/month basis (specify accordingly)	Any other related information regarding biogas
1	**Biogas**			
Sl. No	Waste treatment units	Total quantity treated (Kg/day)	Organic manure produced from vermi compost used for farming and horticulture. (Kg/month or Kg/year – specify accordingly)	Any other related information including the name of earthworms used for vermi composting
2	**Vermi compost**			
Sl. No	Waste treatment units	Total quantity treated (Kg/day)		
3	**Incinerator**			
Sl. No	Waste treatment units	Total quantity treated (Kg/day)	Quantity of fish harvested (kg/year)	Any other related information including the name of fishes used for farming
4	**Fish farming**			

Details regarding the Sewage Treatment Plant

Sl. No	Total quantity of water used (m^3)	Total quantity of waste water generated	Total quantity of water treated

Biodiversity audit

Floral Diversity of the Campus (Trees & Medicinal plants)					
Sl. No.	**Scientific name**	**Malayalam Name**	**English Name**	**No.**	**Trees (T)/ Medicinal Plants (MP)**

Faunal Diversity of the Campus			
Sl. No.	**Scientific name**	**Malayalam Name**	**English Name**

Butterfly Diversity of the Campus			
Sl. No.	**Scientific name**	**Malayalam Name**	**English Name**

Odonate Diversity of the Campus			
Sl. No.	**Scientific name**	**Malayalam Name**	**English Name**