GREEN , ENERGY & ENVIRONMENT AUDIT REPORT

2022-2023

MAHISHADAL RAJ COLLEGE

INSTITUTE OF NATURE RESEARCH AND CONSERVATION

INRC

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Reference No: …… *Date-13/11/23*

GREEN, ENVIRONMENT AND ENERGY AUDIT CERTIFICATE

ACADEMIC YEAR 2022--2023

This is to certify that ***Mahishadal Raj College****, located at* ***Garkamalpur, Mahishadal, Purba Medinipur, West Bengal,*** *has*

steadfastly strived to establish a robust and ecologically sustainable environment, dedicated to the preservation of nature and biodiversity. Institute of Nature Research and Conservation (INRC) expresses satisfaction following the successful completion of the Green, Environment, and Energy Audit for the academic year 2022-2023.

This accomplishment has been made possible through the active and moral support extended by the Honorable Principal, the IQAC Team, the dedicated teaching and support staff, and the enthusiastic student body ofMahishadal Raj College. Their collective efforts have significantly contributed to the creation of a positive and eco-friendly atmosphere on the campus.

The commitment demonstrated by both faculty and students towards environmental improvement and the conservation of biodiversity is truly commendable. This proactive approach aligns with the highest standards of ecological stewardship, reflecting a genuine dedication to sustainable practices.

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Reg. No.- 0239/2023

ACKNOWLEDGEMENT

On behalf of the Green, Environment, and Energy Audit Team at the Institute of Nature Research and Conservation (INRC), we extend our heartfelt gratitude to the management of Mahishadal Raj College for entrusting us with the vital task of conducting a Green & Environmental audit. Our sincere appreciation goes to the Principal of Mahishadal Raj College for their support.

We are grateful for the cooperation extended to our team throughout the audit process. The valuable inputs provided by the management were instrumental in facilitating our audit activities. We would also like to express our special thanks to the members of the Institutional Quality Assurance Cell (IQAC), as well as the dedicated teaching and non-teaching staff. Without their active involvement and support, our work would not have been possible.

AREAS OF CONCERN

GREEN AUDIT

- Diversity of Flora
- Diversity of Fauna
- Diversity index of MTS
- community structure Analysis and IVI

ENVIRONMENT AUDIT

- Water Management
- Water Management
- Air quality
- carbon footprint
- e-waste management

ENERGY AUDIT

- Energy consumption
- Energy management

RECOMMANDATIONS

- To reduce energy consumption and management
- Find out potential areas for environment management and green development
- Reduce biodiversity loss
- Find out potential areas for increase species richness in the campus

A dedicated committee, comprising esteemed Experts and Scientists from various reputable Institutes, conducted this audit. The Committee meticulously devised a questionnaire based on both central and state regulatory mandates. Subsequently, they collected and analyzed fundamental data.

Overall, the audit findings portray a favorable environmental landscape within the premises of Mahishadal Raj College. The committee has put forth a series of short-term and long-term recommendations aimed at enhancing environmental conditions to superior standards. The higher authorities and all stakeholders of the College have affirmed their commitment to diligently address these suggestions and seize opportunities for identified enhancements.

AUDIT COMMITTEE MEMBERS

An expert committee of 3 members was formed to conduct the Green, Environment and Energy Audit from different field of expertization such as Biodiversity, Taxonomy, Physics (Energy Science and management) and Conservation Biology.

The Committee members are listed below:

SL No.	NAME	Area in interest	Designation
1.	Dr. Sumit Manna	Ecology, Environment, Biodiversity Economics and Conservation	Assistant Professor HOD. Dept. of Botany and IQAC coordinator Moyna College
2.	Dr. Amit Manna	Energy management, green synthesis of Nano particle and characterization, Spectroscopic analysis	Vice President Institute of Nature Research and Conservation & Former Project Scientist Spectroscopic Analysis Team NASA
3.	Prof. Nilanjan Sadhukhan	Molecular Taxonomy and Biodiversity	Faculty, Dept of Botany Moyna College

The Audit team started the audit at the College Campus on 16th Jun, 2023

Important dates and of Initiative

SL NO	PURPOSE	DATE	REMARKS
1	Communication with College authority	12.05.2023	Discuss about term and condition
3	Collection information about the College	29.05.2023	Introduced to Administrative Officer
4	Campus visit and observation	16.06.2023	Outdoor observation with Photo camera and GPS coordinates
5	Campus enquiry	16.06.2023	Physically enquiry with expert
6	Departments visit and enquiry	16.06.2023	Laboratory enquiry
7	Interview with other stake holder	16.06.2023	Meet with others stake holder
8	Interview with staff	16.06.2023	Collected different information
9	Review data and Assessment	16.06.2023	Data generate and drown figures
10	Pre Closing meeting	16.06.2023	Meeting with IQAC
11	Closing Meeting	16.06.2023	Pre-submission of the Report
12	Submit audit report	13.11.2023	Submit of the Report

ABOUT THE MAHISHADAL RAJ COLLEGE

Mahishadal Raj College stands as a venerable institution, marking its place as the third oldest college in the erstwhile district of Midnapore was spearheaded by Kumar

Debaprasad Gagra Bahadur, the illustrious "Raja" of Mahishadal, renowned for his contributions to music and fine arts. Subsequently, the College became affiliated with Vidyasagar University from June 1, 1985, as per letter no. 983-Edn (U) dated May 23, 1985.

Nestled a mere twenty kilometers from both Haldia, a burgeoning industrial hub of West Bengal, and Tamluk, the administrative center of Purba Medinipur district, the College enjoys the serenity of its verdant surroundings. This picturesque backdrop has endowed the campus with a tranquil ambiance, blending rustic simplicity with urban sophistication.

The College's establishment coincided with the fervor of the Quit India Movement, which surged in Mahishadal, witnessing numerous sacrifices. Notably, Sri Satish Chandra Samanta, a revered native, led the first National Government during British colonial rule. Mahatma Gandhi himself graced the precincts, extending his unwavering support to the valiant patriots who dared confront the British Raj. It was also here that Nirala (Surya Kanta Tripathi), the eminent Hindi Poet, received his early education.

The ceremonial laying of the foundation stone for the main building was honored by Sir Federick John Burrows, the esteemed Governor of Bengal. The inauguration of the College Building took place on January 3, 1949, under the auspices of Sri Kailash Nath Katzu, the Hon'ble Governor of West Bengal. Subsequent milestones, including the inauguration of the Science Block by Prof. Satyendra Nath Bose on March 2, 1959, and the Lib-Lab Building by Sri K. V. Raghunath Reddy on February 3, 1996, have further enriched the institution's legacy. Notably, the Diamond Jubilee Memorial Building's foundation stone was laid by Sri Gopal Krishna Gandhi, the esteemed Governor of West Bengal, on August 1, 2005.

ACADEMIC DEPARTMENTS-

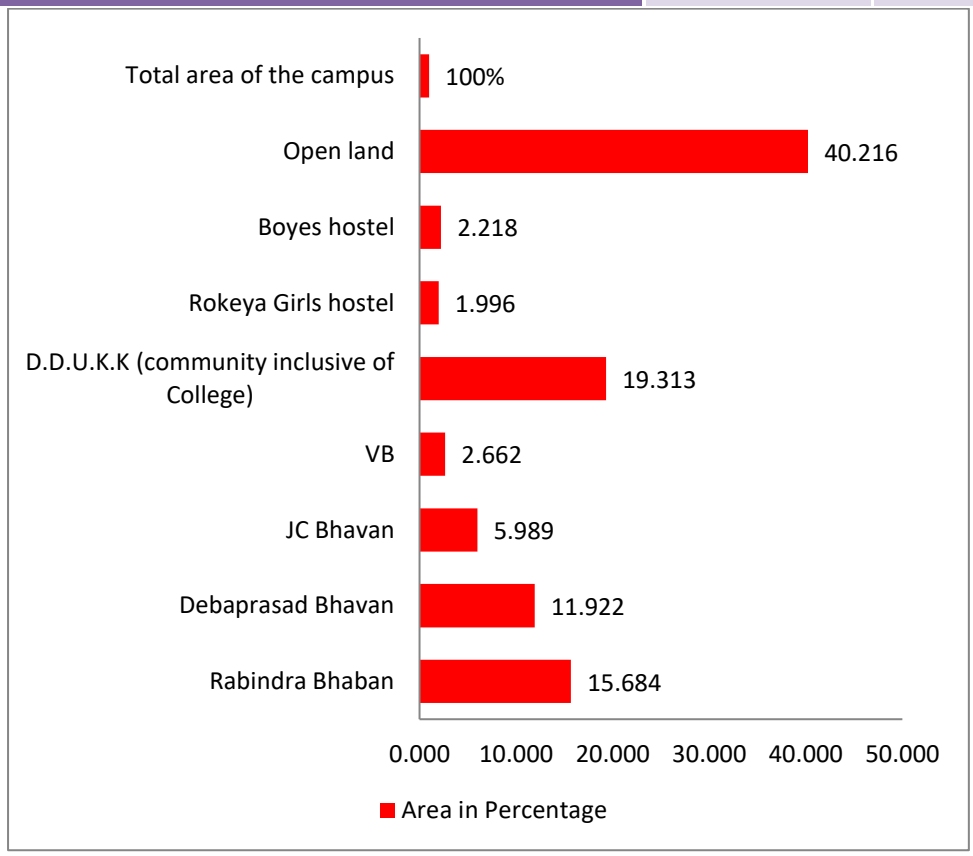
SL NO	Department of Arts	Department of Science	Dept. of Commerce	Other Coerces	PG
1	Bengali	Physics	B.Com	B. Voc	Chemistry
2	Education	Chemistry		Library	Zoology

				Dept.	
3	History	Mathematics			Physics
4	Political Science	Computer Science & BCA			Applied Mathematics with Oceanology and Computer Programming
5	English	Zoology			
6	Sanskrit	Botany			
7	Sociology	Geography			
8	Philosophy	Physiology			
9	Music	Industrial Chemistry			
10	Physical Education	Environment Science			
11	Military Science & NSS				
12	Human Rights Education				
13	Disaster Management				

Area Coverage of the college Campus:

College campus	Area in sq. Mts.	Area in Percentage
Rabindra Bhaban	28285	15.684
Debaprasad Bhavan	21500	11.922
JC Bhavan	10800	5.989

VB	4800	2.662
D.D.U.K.K (community inclusive of College)	34828	19.313
Rokeya Girls hostel	3600	1.996
Boyes hostel	4000	2.218
Open land	72525	40.216
Total area of the campus	**180338.4**	**100%**



Arial View of the Mahishadal Raj College Campus-1 depicting the Canopy cover, and concrete and building Areas.

Waterbody Beside the College Campus

PURPOSE OF GREEN AND ENVIRONMENT AND ENERGY AUDIT

Purpose of Green and Environmental Auditing

- **Environmental Compliance:** Ensure that the college complies with local, regional, and national environmental regulations, including waste disposal, energy usage, and other relevant standards.
- **Resource Management:** Evaluate the efficient use of resources within the campus, such as water, energy, and materials. Identify opportunities for conservation and sustainable resource management.
- **Waste Reduction and Recycling:** Assess waste management practices and promote initiatives to reduce waste generation. Identify opportunities for recycling and proper disposal of waste materials.
- **Energy Efficiency:** Evaluate the energy consumption patterns of the campus and identify measures to improve energy efficiency, including the adoption of renewable energy sources.
- **Biodiversity and Green Spaces:** Assess the impact of campus development on local biodiversity. Promote the creation and preservation of green spaces, gardens, and natural habitats within the campus.
- **Transportation and Commuting:** Evaluate the environmental impact of transportation within the campus. Encourage sustainable transportation methods and reduce the carbon footprint associated with commuting.
- **Curriculum Integration:** Integrate environmental and sustainability themes into the academic curriculum. Foster awareness and understanding of environmental issues among students and staff.
- **Community Engagement:** Involve the campus community in environmental initiatives and awareness campaigns. Foster a sense of environmental responsibility among students, faculty, and staff.
- **Infrastructure Development:** Ensure that new construction and infrastructure development align with green building standards and sustainable design principles.
- **Climate Change Mitigation:** Identify opportunities to reduce the college's contribution to climate change. This includes assessing greenhouse gas emissions and implementing strategies to minimize the carbon footprint.
- **Cost Savings:** Identify cost-effective measures for improving environmental performance, leading to long-term financial benefits through energy savings, waste reduction, and sustainable practices.
- **Institutional Reputation:** Enhance the college's reputation as an environmentally responsible institution. This can positively impact enrollment, partnerships, and community relations.
- **Regulatory and Funding Compliance:** Align the college's environmental practices with regulatory requirements and leverage environmentally friendly initiatives for potential funding opportunities.

Purpose of Energy Auditing

- In any organization, the three primary operating expenses typically comprise energy (both electrical and thermal), labour, and materials. When assessing the manageability of costs or potential savings in these components, energy consistently emerges as a prominent factor, making the energy management function a strategic area for cost reduction.

- An Energy Audit plays a crucial role in comprehending the utilization of energy and fuel within an an institute, pinpointing areas susceptible to waste and areas with potential for improvement.

- It provides valuable insights that contribute to a positive orientation towards reducing energy costs, enhancing preventive maintenance, and improving quality control programs, all of which are critical for production and utility activities.

- This audit program facilitates a focused examination of variations in energy costs, the reliability of energy supply, decisions on an appropriate energy mix, identification of energy conservation technologies, and retrofitting for energy-efficient equipment. Essentially, the Energy Audit translates conservation ideas into practical solutions, offering technically feasible recommendations with due consideration to economic and organizational factors within a specified timeframe.

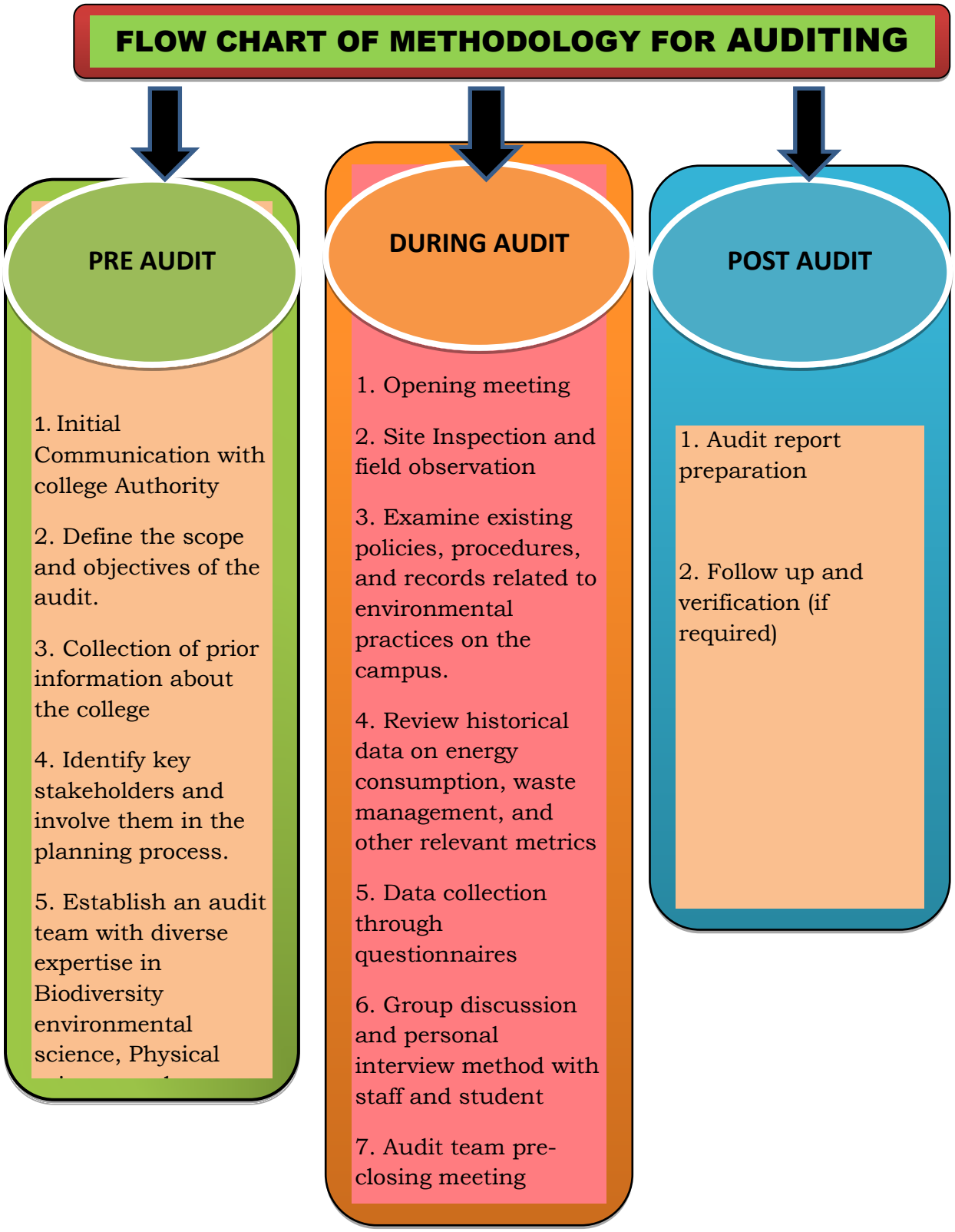
- The primary objective is to devise strategies for reducing energy consumption per unit of product output or lowering operating costs. Serving as a benchmark, the Energy Audit establishes a reference point for managing energy within the organization and forms the basis for planning more effective energy utilization throughout the entire organization.

- The eco-campus concept primarily emphasizes the efficient utilization and conservation of energy, aiming for savings in a sustainable manner. Additionally, it targets the reduction of carbon emissions, involves the calculation of carbon footprint, advocates for the procurement of star-rated equipment to ensure cost-effective and secure energy supply, promotes and enhances energy conservation in all buildings, strives to diminish the organization's overall energy consumption, minimizes landfill wastes, and incorporates environmental considerations into all contracts and services that are deemed to have substantial environmental impacts.

- Examining Energy Management through auditing involves a focus on energy savings and potential opportunities. While energy itself remains imperceptible, its presence is evident in wires, pipes, and other inanimate materials through observable effects such as heat, light, and power.
-
- The indicator for energy management encompasses considerations such as energy consumption, energy sources, monitoring, lighting, vehicle movement, electrical and electronic appliances, and transportation. Energy usage stands as a pivotal facet of campus sustainability, warranting its inclusion in assessments without further explanation.

- Despite the ubiquity of energy usage, attention to energy-saving possibilities remains crucial. For instance, a conventional incandescent bulb consumes approximately 60W to 100W, whereas an energy-efficient light-emitting diode (LED) uses less than 10W, highlighting the positive impact on energy savings. Energy auditing is integral to conservation efforts and the implementation of methods to curtail consumption, thus mitigating environmental degradation. Moreover, audits yield valuable suggestions and recommendations that contribute to effective energy-saving measures.

METHODOLOGY AND SURVEY SCHEDULES



SITE VISIT:

- We embarked on an extensive campus exploration to meticulously observe and document various environmental elements, encompassing waste management zones, energy infrastructures, verdant landscapes, and water conservation systems.
- Our survey delved into the rich biodiversity of campus flora, meticulously cataloging diverse floral and faunal species, accompanied by detailed photographic documentation. Furthermore, we gathered valuable data from the medicinal garden, cafeteria, library, all academic departments, administrative offices, edifices, and parking facilities.
- Methodically, we recorded the quantity and diversity of vehicles utilized by stakeholders, meticulously examining fuel consumption for each vehicle in collaboration with users. Additionally, we scrutinized the usage of LPG cylinders in laboratories, the cafeteria, and residential kitchen facilities.
- During our thorough assessment of water fixtures, we uncovered several instances of leaky taps and overflowing reservoirs, highlighting areas for immediate attention during the site visit.

DIFFERENT TYPES OF SURVEY ARE CONDUCTED IN COLLEGE CAMPUS:

- **Energy Efficiency Assessment:**
- Investigate energy consumption trends across various campus structures. Identify avenues for enhancing energy conservation and efficiency.
- **Water Resource Management Analysis:**
- Assess water origins, usage trends, and wastewater treatment capabilities. Offer suggestions for water preservation and fostering sustainable water practices.
- **Waste Handling Evaluation:**
- Examine waste production rates and disposal methodologies. Propose tactics for diminishing waste output, fostering recycling initiatives, and ensuring proper disposal practices.
- **Transportation and Commute Analysis:**
- Scrutinize commuting behaviors among students and faculty. Suggest eco-friendly transportation alternatives and enhancements to infrastructure.
- **Biodiversity and Greenery Inquiry:** Assess the condition of green areas, gardens, and natural habitats. Propose measures to enhance biodiversity and preserve green spaces.
- **Curriculum Integration and Awareness Survey:**

- Evaluate the integration of environmental themes in the academic curriculum. Assess the level of environmental awareness among students and staff.
- **Infrastructure Development Survey:**
- Examine the sustainability features of new construction projects.
- **Community Engagement Survey:**
- Evaluate the level of engagement and participation in environmental initiatives. Collect feedback from the campus community on environmental awareness programs.
- **Regulatory Compliance Survey:**
- Verify compliance with environmental regulations and standards. Identify areas where adjustments are needed to meet regulatory requirements.
- **Financial and Cost Savings Survey:**
- Assess the financial implications of proposed environmental initiatives. Identify potential cost savings through energy efficiency and waste reduction measures.

STEPS OF DATA COLLECTION:

- Initially, the audit team divided into two separate units. The seasoned members of the first unit commenced data collection for the energy audit, while those in the second and third units concentrated on gathering information pertinent to the environmental and sustainability assessments.
- Each team member traversed through diverse sections of the college premises, encompassing gardens, dining areas, culinary spaces, the library, and every academic department along with its respective laboratories.
- A thorough questionnaire was devised and disseminated among stakeholders to procure comprehensive data relevant to the environmental, sustainability, and energy evaluations ahead of on-site visits.
- Information and data were amassed through a blend of direct observation, individual interviews, and collective deliberations with various stakeholders.
- Environmental parameters across different spots on the college grounds were evaluated utilizing an array of electronic devices such as atmospheric oxygen and carbon dioxide gauges, alongside total dissolved solids (TDS) meters, with readings meticulously recorded.
- The diameter at breast height (DBH) of significant tree species was gauged, phenological states were scrutinized, and GPS coordinates of notable trees were logged.

- The plant community makeup was dissected using the quadrat technique.
- During field excursions, an array of fauna including mammals, birds, reptiles, amphibians, butterflies, and dragonflies were observed, cataloged, and identified. Moreover, the untamed habitats within the college perimeter were documented, with wildlife-related data garnered through collective discussions and one-on-one interviews with stakeholders.

DATA ANALYSIS:

- Determination of the extent of green space, paved areas, and water bodies within the college grounds.
- Estimation of energy consumption alongside the generation capacity from sustainable energy sources.
- Evaluation of groundwater resources and the protocol for rainwater harvesting and reuse.
- Assessment of waste generation rates and the protocols for disposal and management.
- Monitoring and recording of atmospheric oxygen and carbon dioxide levels across the college campus.
- Computation of the Biodiversity Index within the campus utilizing recognized metrics.
- Examination of Total Dissolved Solids (TDS) levels in water bodies and storage tanks.
- Analysis of plant community attributes including density, frequency, abundance, relative density, relative frequency, and Importance Value Index (IVI).

GREEN AUDIT

Mahishadal Raj College stands as a revered institution dedicated to fostering academic brilliance and holistic growth. Embracing the need to evolve with the times, the college acknowledges the vital significance of embedding sustainable principles into its functioning. Hence, the initiation of a Green Audit signifies a noteworthy stride towards championing environmental guardianship and fostering sustainability.

Importance of Green Audit at Mahishadal Raj College:

In today's global arena, the necessity of conducting a Green Audit at Mahishadal Raj College cannot be overstated. With communities worldwide grappling with the formidable challenges presented by climate change, dwindling resources, and environmental degradation, educational institutions stand at the forefront of fostering sustainable mindsets and practices. As a bastion of knowledge dissemination and societal influence, Mahishadal Raj College acknowledges the gravity of its role in this sphere.

The Green Audit serves as a comprehensive assessment tool, delving into the institution's ecological footprint, resource management strategies, waste management protocols, and overall environmental impact. Through this thorough scrutiny, the college aims to identify areas ripe for improvement and enact sustainable initiatives that align with its commitment to environmental stewardship.

Going beyond mere regulatory obligations, the Green Audit acts as a catalyst for cultivating a culture of environmental awareness among students, faculty, and staff alike. By weaving sustainable principles into the fabric of the institution, Mahishadal Raj College not only contributes to the global sustainability agenda but also instills within its community a profound sense of responsibility towards the planet and its ecosystems.

METHODOLOGY ADAPDTED FOR GREEN AUDIT

The Green Audit team meticulously explored every corner of the Mahishadal Raj College campus, meticulously cataloging the diverse array of plant and animal life. On-site, species were identified and, where necessary, samples were carefully collected for further analysis. The team also made sure to capture photographs of many of the species encountered during the survey.

The flora was organized into various categories, including Major Tree Species (MTS), shrubs and herbs, aquatic plants, algae, fungi, and lichens. Additionally, butterflies, dragonflies, birds, and amphibians were spotted and identified during the team's fieldwork.

Furthermore, the team embarked on a study of the college's natural habitats, consulting with both teachers and students to document any wildlife encountered during the research period.

FLORAL DIVERSITY AT MAHISHADAL RAJ COLLEGE CAMPUS

A total of 61 species of flowering plants has been recorded during the study out of which 23 species were considered as MTS, 19 species belong from under tree and shrubs and 19 species were grouped in herbs. Out of 61 species of plants 26 species have medicinal potentiality, as evidenced by published literature.

It is interesting to note that all the 23 species of MTS belong from 15 different taxonomic families which represents that the taxonomic diversity of the college campus was very high (Table 1).

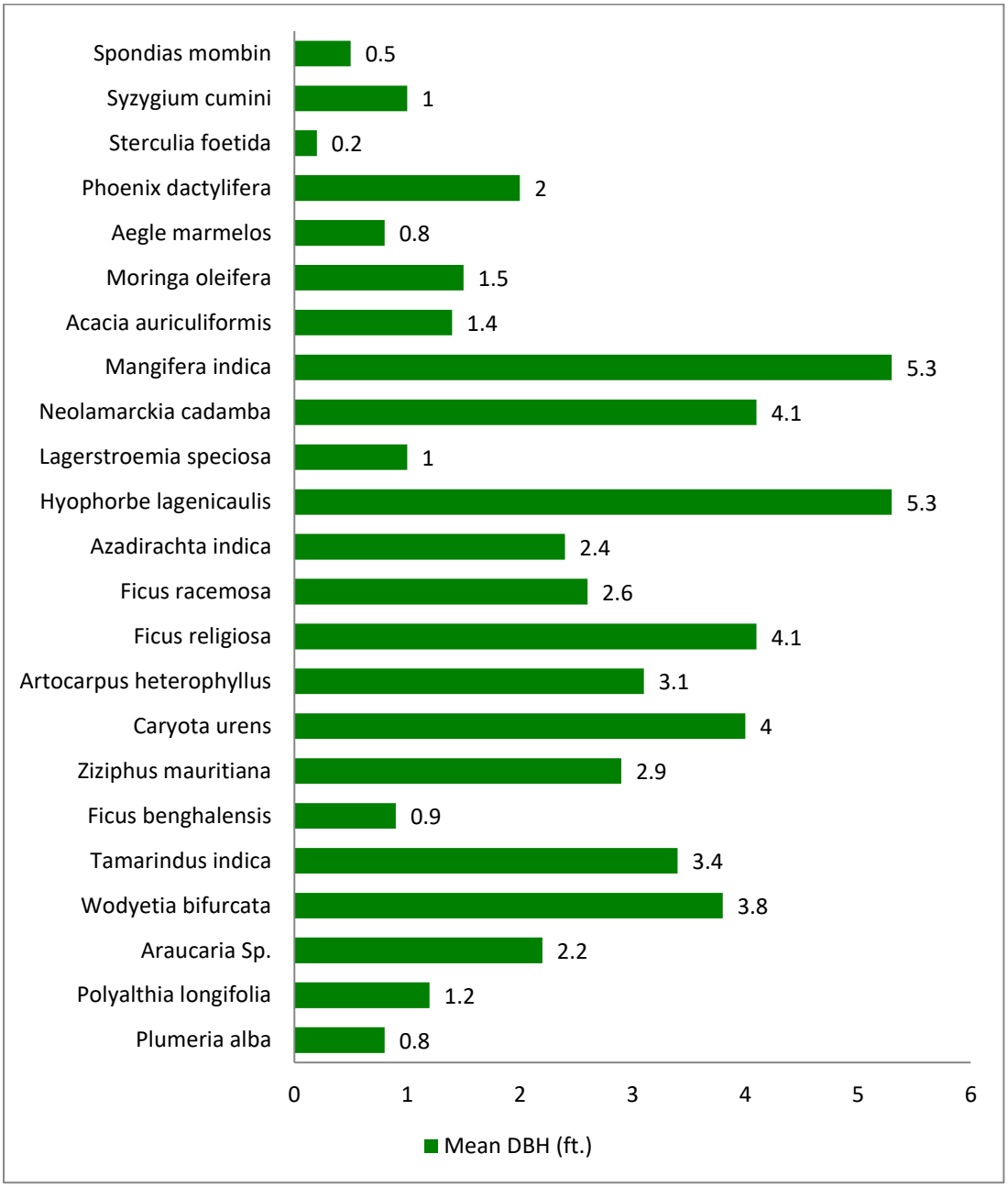
Table 1. Diversity of Major Tree Species (MTS) in Mahishadal Raj College Campus

Sl. No.	Name of the Species	Family	No. of Individual	Phenological Stage	Mean DBH (ft.)	Frequency %	Local Status
1	*Plumeria alba*	Apocynaceae	3	2M	0.8	4.348	C
2	*Polyalthia longifolia*	Annonaceae	6	6M	1.2	8.696	LC
3	*Araucaria Sp.*	Araucariaceae	5	5M	2.2	7.246	LC
4	*Wodyetia bifurcata*	Arecaceae	5	4M	3.8	7.246	LC
5	*Tamarindus indica*	Fabaceae	2	1M	3.4	2.899	LC
6	*Ficus benghalensis*	Moraceae	3	0M	0.9	4.348	C
7	*Ziziphus mauritiana*	Rhamnaceae	3	1M	2.9	4.348	C
8	*Caryota urens*	Arecaceae	2	1M	4	2.899	LC
9	*Artocarpus heterophyllus*	Moraceae	2	1M	3.1	2.899	C
10	*Ficus religiosa*	Cupressaceae	2	1M	4.1	2.899	C
11	*Ficus racemosa*	Moraceae	3	2M	2.6	4.348	C
12	*Azadirachta indica*	Moraceae	4	1M	2.4	5.797	C
13	*Hyophorbe lagenicaulis*	Arecaceae	5	5M	5.3	7.246	LC
14	*Lagerstroemia speciosa*	Lythraceae	2	0M	1	2.899	C
15	*Neolamarckia cadamba*	Rubiaceae	2	1M	4.1	2.899	C
16	*Mangifera indica*	Anacardiaceae	3	1M	5.3	4.348	C
17	*Acacia auriculiformis*	Fabaceae	4	2M	1.4	5.797	C
18	*Moringa oleifera*	Moringaceae	3	1M	1.5	4.348	C
19	*Aegle marmelos*	Rutaceae	2	1M	0.8	2.899	C

20	*Phoenix dactylifera*	Arecaceae	1	1M	2	1.449	LC
21	*Sterculia foetida*	Sterculiaceae	2	0M	0.2	2.899	LT
22	*Syzygium cumini*	Myrtaceae	3	1M	1	4.348	LT
23	*Spondias mombin*	Anacardiaceae	2	0M	0.5	2.899	LC

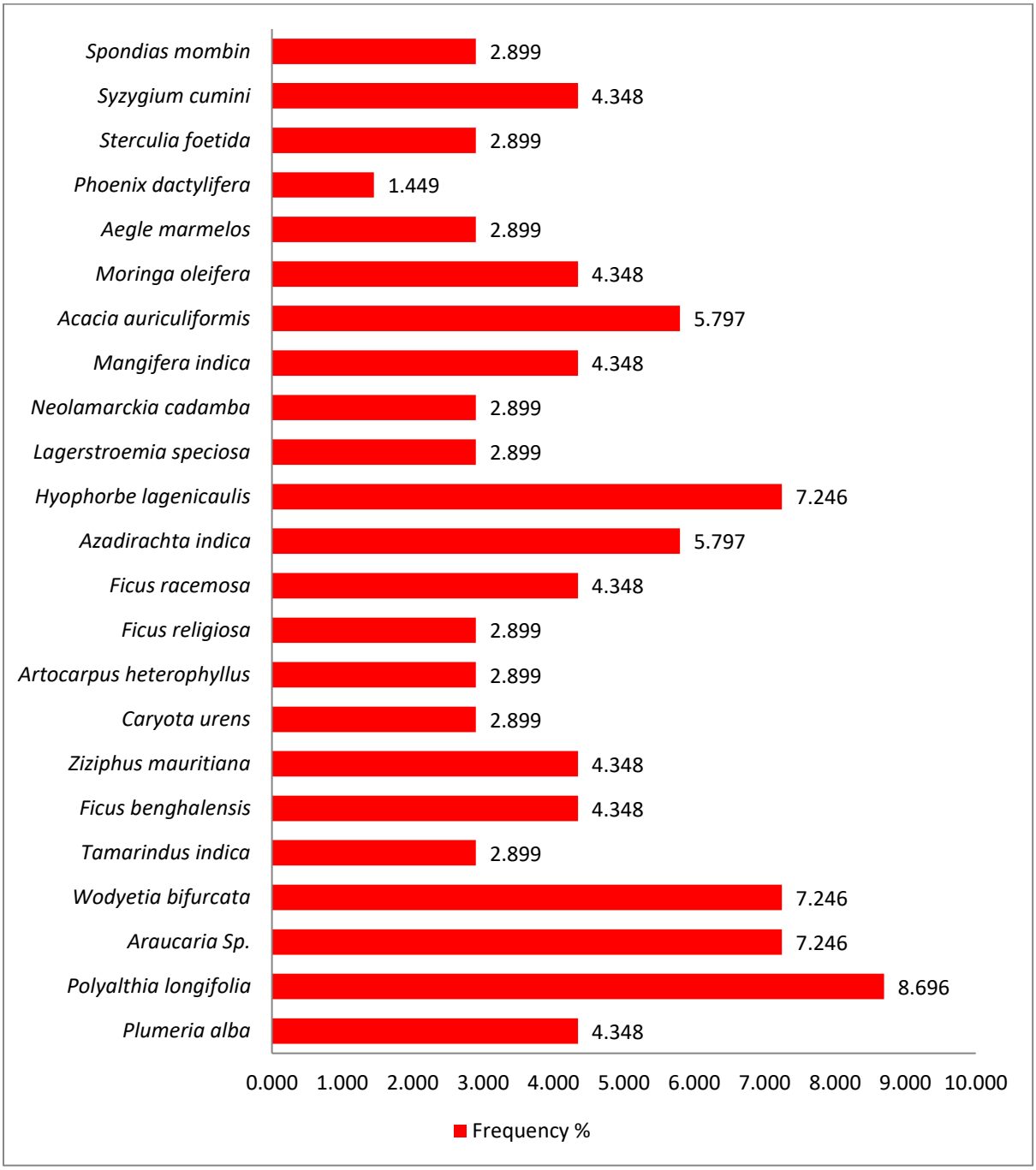
Out of these 23 MTS, *Mangifera indica* and *Hyophorbe lagenicaulis* has shown its highest diameter at breast Height (DBH) (5.3 ft.) followed by *Neolamarckia cadamba* and *Ficus religiosa.* (Fig. 1).

Figure 1. Mean DBH of the MTS



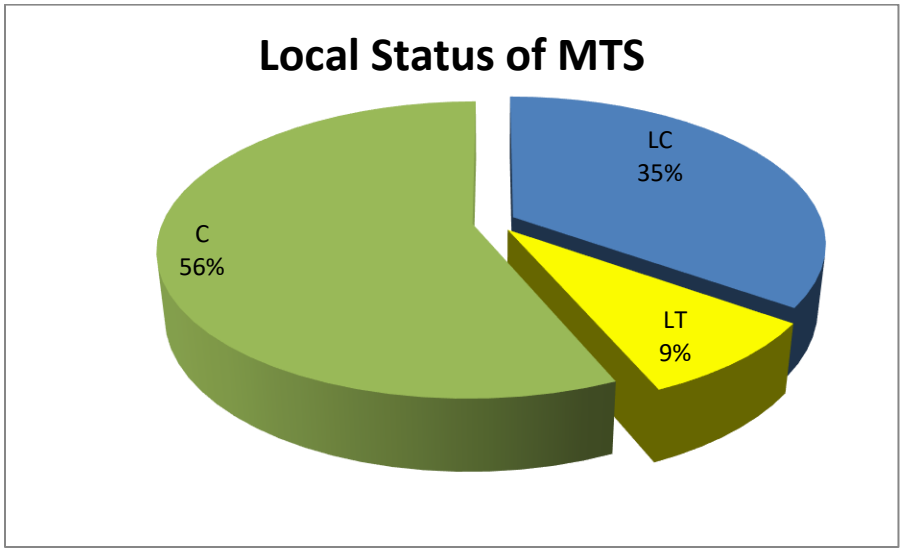
When the frequency percentage of these MTS was calculated it was observed that the F% of *Hyophorbe lagenicaulis*. (7.24 %) is highest followed by *Acacia auriculiformi*. And *Azadirachta indica* (Though planted) (Fig. 2).

Figure 2. Frequency percentage of different Major Tree Species (MTS)



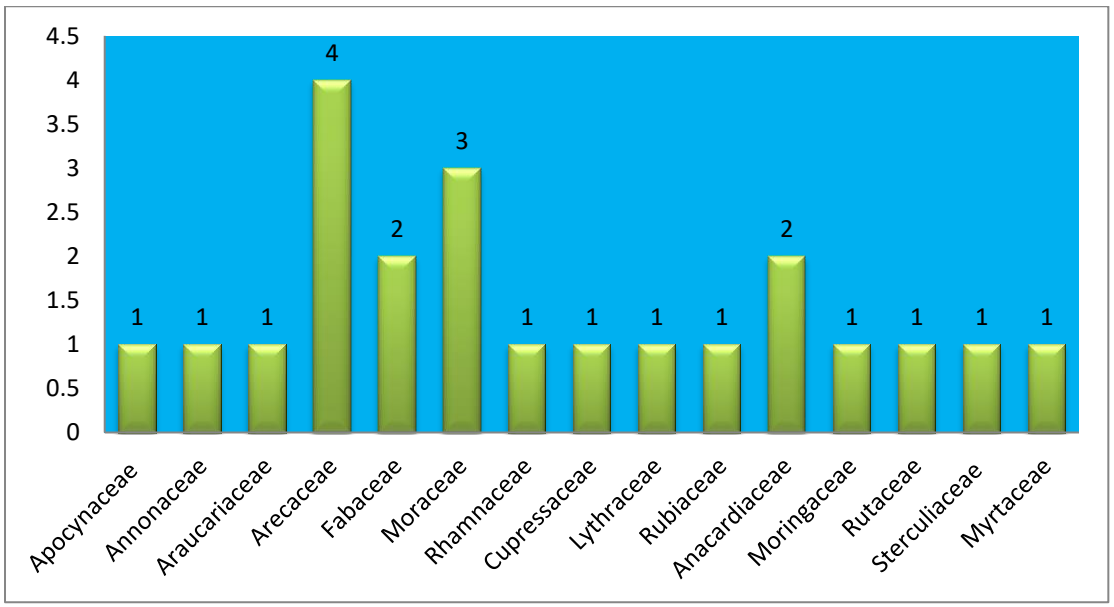
Out of these 23 Major Tree Species (MTS) 9% and 35% of them are locally threatened and less common in these region respectively (Fig. 3). This indicates The college took important role for conservation of some locally important tree species.

Figure 3. Local status of the MTS



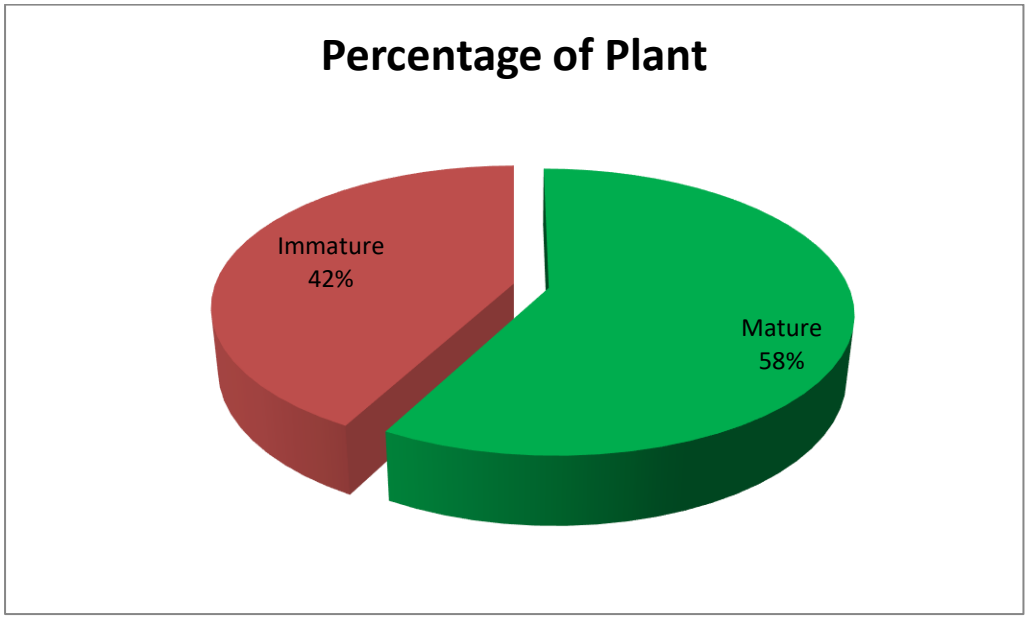
Out of 15 families from which these 23 MTS belongs from, Arecaceae is the family from which most of the MTS belongs (4 species). This is followed by Moraceae and Fabaceae and then Anacardiaceae (Fig 4). This result indicate that the taxonomic diversity is high in the Mahishadal Raj College Campus.

Figure 4. Number of Genus under different Taxonomic Family indicating dominance



It was noted that 58% of the MTS achieved their phonological stage which represent that the MTS community is considerable mature and causes high carbon sequestration and their control over different niche of the ecosystem (Fig. 5).

Figure 5. Phenological status of different MTS



Considering the species richness and evenness when the Simpson's Diversity Index of the MTS was calculated using the formula (EQ-1)

D =1- ($\sum n(n-1)/N(N-1)$)……(EQ-1)

It was observed that the diversity of MTS in the Mahishadal Raj College campus is so high (**D =0.0370**) which depict the importance of the green belt of the college campus in biodiversity conservation.

Apart from these Wild major tree species some other spice plants and shrubs and under tree has been recorded from Mahishadal Raj College Campus such as ***Cycas revolute, Cocos nucifera, Juniper sp., Nerium indicum, Lawsonia inermis, Albizia lebbeck, Litchi chinensis, Citrus limetta, Areca catetue, smilax zeylanic, Lantana camara, Annonus reticulate, Putranjiva roxburghii, Cassia fistula, Cinnamomum tamala, Cinnamomum veruna, Switenia magagoni, Caesalpinia pulcherima, Pogostemon cablin***

Study of Herbaceous plant community

To study the herbaceous plant community random quadrat of (4 X 4) ft. size has been plotted in the open areas of the college campus. Prior to that minimum size of the quadrat has been determined (4X 4) ft. A total of 8 quadrats has been plotted randomly and the individual of each herbaceous species has been counted. Farther to study the community structure Density, Frequency, Abundance, Relative density and Relative frequency was estimated using standard protocol. After that the Importance Value Index (IVI) was also calculated using standard formula (Table 2).

To know the maximum control in the formation of herbaceous plant community structure the Importance Value Index (IVI) was estimated for each species. It was found that *Nicotiana plumbaginifolia* shown its highest IVI value (189.11) followed by *Evolvulus elsinoides* (186.29) (Fig. 7). These findings depict that these plants have maximum contribution in herbaceous plant community structure formation and thus have maximum control over the community (Table 2).

Table 2. Community structure of herbaceous species

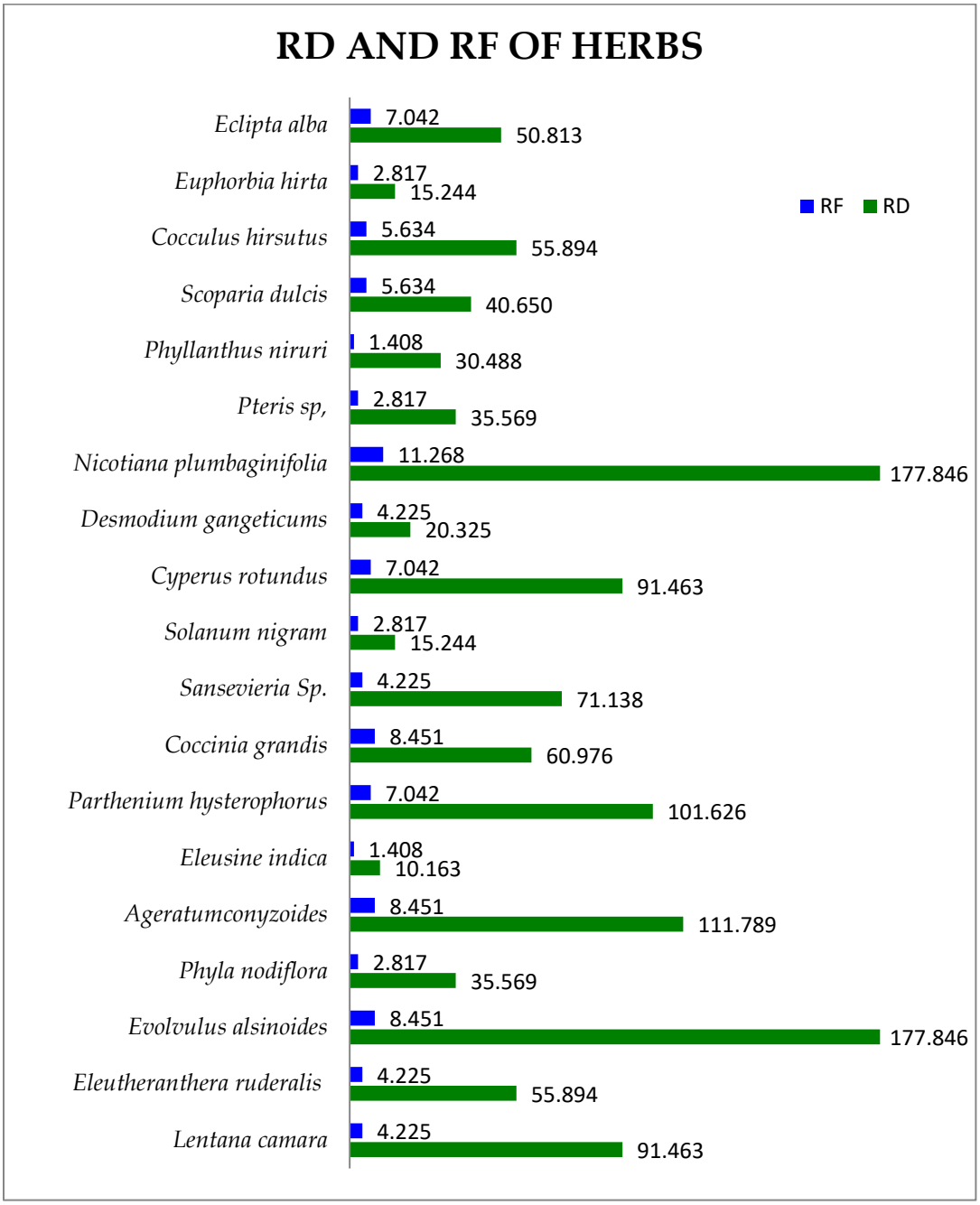
SL. No.	Plant Species	D	F	AB	RD	RF	IVI
1	*Lentana camara*	225.000	37.500	6.000	91.463	4.225	95.689
2	*Eleutheranthera ruderalis*	137.500	37.500	3.667	55.894	4.225	60.120
3	*Evolvulus alsinoides*	437.500	75.000	5.833	177.846	8.451	186.296
4	*Phyla nodiflora*	87.500	25.000	3.500	35.569	2.817	38.386
5	*Ageratumconyzoides*	275.000	75.000	3.667	111.789	8.451	120.239
6	*Eleusine indica*	25.000	12.500	2.000	10.163	1.408	11.571
7	*Parthenium hysterophorus*	250.000	62.500	4.000	101.626	7.042	108.668
8	*Coccinia grandis*	150.000	75.000	2.000	60.976	8.451	69.426
9	*Sansevieria Sp.*	175.000	37.500	4.667	71.138	4.225	75.364
10	*Solanum nigram*	37.500	25.000	1.500	15.244	2.817	18.061
11	*Cyperus rotundus*	225.000	62.500	3.600	91.463	7.042	98.506
12	*Desmodium gangeticums*	50.000	37.500	1.333	20.325	4.225	24.551
13	*Nicotiana plumbaginifolia*	437.500	100.000	4.375	177.846	11.268	189.113
14	*Pteris sp,*	87.500	25.000	3.500	35.569	2.817	38.386
15	*Phyllanthus niruri*	75.000	12.500	6.000	30.488	1.408	31.896
16	*Scoparia dulcis*	100.000	50.000	2.000	40.650	5.634	46.284
17	*Cocculus hirsutus*	137.500	50.000	2.750	55.894	5.634	61.528
18	*Euphorbia hirta*	37.500	25.000	1.500	15.244	2.817	18.061
19	*Eclipta alba*	125.000	62.500	2.000	50.813	7.042	57.855

In the study it was observed that *Nicotiana plumbaginifolia* followed by *Evolvulus elsinoides* shown its highest relative frequency and relative density throughout the Mahishadal Raj College campus. (Fig. 6). This finding represents the fabulous microhabitat for these species which cover the ground of the open land of the college campus and create a diverse form of ecological niche for different types of insects.

***Adiantum* raddianum** **Smilax zeylanica**

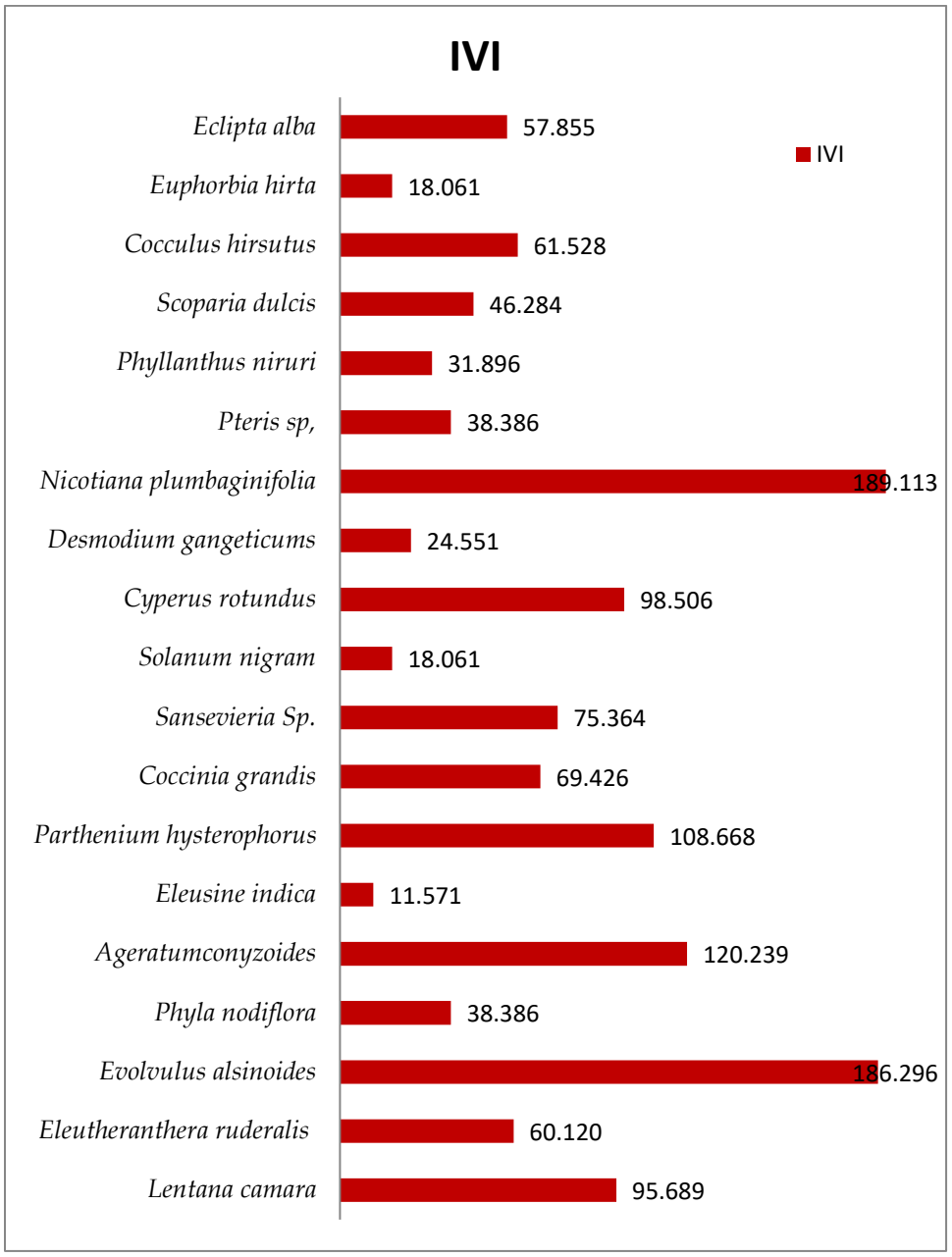
Lantana camara ***Imperata cylindrica***

Figure 6. Relative Density and Relative Frequency of the Herbaceous plant community



IVI data indicate that *Nicotiana plumbaginifolia* followed by *Ageratum conyzoides* took the maximum role in herbaceous community structure formation in the college campus. They have shown their maximum control over this community (Fig. 7)

Fig. 7 Importance Value Index of Herbaceous plant community



FAUNAL DIVERSITY AT MAHISHADAL RAJ COLLEGE CAMPUS

A total of 12 species of butterfly was recorded from the present study. Presence of different host plants like *Glycosmis pentaphylla* and nectar plants like *Tridax procumbens*, *Eupatorium odoratum* etc. in the college campus and its surroundings may be the reason of this high butterfly diversity (Table 3).

Table 3. Diversity of Butterfly and their common name

Sl. No.	Name of the species	Common name
1	*Eurema blanda*	Three-spot Grass Yellow
2	*Papileo demoleus*	Lime Butterfly
3	*Catopsilia pomona*	Common Emigrant
4	*Catopsilia pyranthe*	Mottled Emigrant
5	*Eurema hecabe*	Common Grass Yellow
6	*Leptosia nina*	Psyche
7	*Cepora nerissa*	Common Gull
8	*Appias libythea*	Striped Albatross
9	*Ariadne merione*	Common Castor
10	*Junonia lemonias*	Lemon Pansy
11	*Junonia almanac*	Peacock Pansy
12	*Junonia atlites*	Grey Pansy

A total of 5 species of Dragon fly also recorded from the Mahishadal Raj College campus. Though the species may increase if seasonal study was conducted (Table 4).

Table 4. Diversity of Dragonfly and their common name

Sl. No.	Name of the Species	Common Name
1	*Crocothemis servilia*	Ruddy Marsh Skimmer
2	*Diplacodes trivialis*	Ground Skimmer
3	*Neurothemis tullia*	Pied Paddy Skimmer
4	*Orthetrum Sabina*	Green Marsh Hawk
5	*Pantala flavescens*	Wandering Glider

During the study for Green Audit a total of 20 species of Birds has been recorded in and around the college campus. And the nest of few species has also been observed. Out of 20 species 1 schedule I bird species i.e. *Acccipter badius* was also observed during the study. High diversity of MTS can be positively correlated with the high bird diversity in the college campus (Table 5)

Table 5. Diversity of Birds and their common name

Sl. No.	Zoological Name	English name	Schedule Status in Wildlife	Bengali Name

			Protection Act	
1	*Acccipter badius*	Shikra	I	Choto Baj
2	*Phalacrocorax*	Indian Cormorant	IV	Bok
3	*Bubulcus ibis*	Cattle Egret	IV	Go Bok
4	*Ardeola grayii*	Indian Pond Heron	IV	Bok
5	*Dendrocitta vagabunda*	Rufous Treepie	IV	
6	*Corvus splendens*	House Crow	IV	Kak
7	*Corvus macrorhynchos*	Large-billed Crow	IV	Dar kak
8	*Oriolus xanthornus*	Black-hooded Oriole	IV	Bene Bou
9	*Dicrurus macrocercus*	Black Drongo	IV	Finge
10	*Copsychus saularis*	Oriental Magpie Robin	IV	Doyel
11	*Acridotheres tristis*	Common Myna	IV	Salik
12	*Dinopium benghalense*	Black-rumped Flameback	IV	Kath thokra
13	*Halcyon capensis*	Stork-billed Kingfisher	IV	Machranga
14	*Halcyon smyrnensis*	White-throated Kingfisher	IV	Sada bukh Machranga
15	*Eudynamys scolopacea*	Asian Koel	IV	Kokil
16	*Centropus sinensis*	Greater Coucal	IV	Harichacha
17	*Streptopelia chinensis*	Spotted Dove	IV	Ghugu
18	*Amaurornis phoenicurus*	White-breasted Waterhen	IV	Dak Pakhi
19	*Orthotomus sutorius*	Common Tailorbird	IV	Tunyuni
20	*Turdoides striatus*	Jungle Babbler	IV	Chatare

Table 6 . Diversity of Mammals and their common name

A total of 4 species of wild mammals were noted from the recall data of the college students and staff (Table 6) Presence of different wild habitats in the college surroundings helps to conserve of these species

Sl.	**Zoological Name**	**English name**	**Schedule Status in**

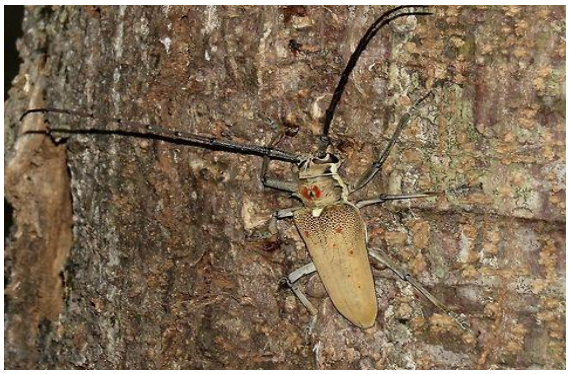
No.			Wildlife Protection Act
1	*Bandicota indica*	Large Bandicoot-rat	V
2	*Funambulus pennantii*	striped palm Squirrel	
3	Urva edwardsii	Mongoose	V
4	Paradoxurus hermaphroditus	Palm Civet	V

Four species of reptiles was also recorded during the study (Table 7). Apart from that, habitatof Snake, Varanus and Jackle was also notices in and around the college campus and in the bank of Pond of the second campus of the college..

Table 7. Diversity of Reptiles and their common name

Sl. No.	Zoological Name	English name	Schedule Status in Wildlife Protection Act
1	Varanus bengalensis	Go sap	IV
2	Ptyas mucosa	Daras Sap	
3	Daboia russelii	Russel Viper	
	Naja naja	binocellate cobra	IV

Polyalthia longifolia



Batocera rufomaculata

Cycase Sp (With male cone)

Butterfly in *Thuja* plant

Garden Plants

Monarch butterfly

Dragon fly

The species richness in the college campus is high and the evenness is low. So, in conclusion it may be said that the Mahishadal Raj College campus is rich in Biodiversity.

1. Butterfly Garden of 170 Sq.Fr area with recommended number of host and nectar Plants
2. Adapted Miyawaki forest by the college which was previously maintained by Haldia Development Authority (HAD)
3. Formed Roof Top Medicinal Plant Garden
4. Increased 75% MTS in the college campus compare to the record of 2020-2023 Green Audit report Data
5. Took initiative for " Keep wildness in wild" project in the campus
6. Launched Rain Water Harvesting in the college campus
7. Launched Bioremediation unit in the college campus for the proper treatment of water drained out from Chemistry laboratory before release in to nature.
8. Started e-waste management unit in the college campus
9. Increased bio degradable and bio non degradable waste been in different floor of all buildings.

CONCLUSION

The Green Audit at Mahishadal Raj College is not just a formal obligation; rather, it's a deliberate pledge towards constructing a greener and more sustainable future. It mirrors the college's earnestness in becoming a conscientious global participant and equipping its affiliates to confront the trials of an swiftly evolving environmental realm. As Mahishadal Raj College initiates this profound expedition, it serves as a model for fellow educational establishments to emulate, fostering a unified endeavor towards a more sustainable and robust planet.

ENVIRONMENT AUDIT

Campus Survey and Enquiry

Conducting an environmental audit within the college campus is a pivotal endeavor. This entails a thorough assessment of environmentally friendly practices, resource usage, and the ecological footprint within the campus premises. The objective of the audit is to appraise and improve sustainability measures, thereby fostering a healthier and more environmentally conscious environment for the college community. The findings and recommendations derived from this audit play a vital role in advancing the collective effort to instill environmental responsibility within the educational institution. The data gathered from this assessment is meticulously documented in our report.

Establishing an eco-friendly college campus involves the implementation of sustainable practices aimed at minimizing environmental impact. This encompasses a range of initiatives geared towards reducing carbon emissions, conserving resources, and nurturing a healthier ecosystem. Essential components of an eco-friendly campus include the adoption of energy-efficient buildings, the implementation of waste reduction and recycling programs, the provision of green transportation alternatives, and the integration of renewable energy sources. Furthermore, cultivating environmental awareness through educational initiatives and promoting eco-friendly behaviors among students and staff are fundamental aspects of building a sustainable college community. These endeavors contribute not only to the overall well-being of the campus and its surroundings but also to the cultivation of a collective sense of environmental stewardship among its members.

The Audit covered the following major areas:

1. Average Foot fall
2. Water Efficiency and Water Management
3. Air Quality and Carbon foot print and Management
4. Waste and Waste Management
5. E-waste management
6. Environmental disaster management
7. Biodiversity and Green Zone and management

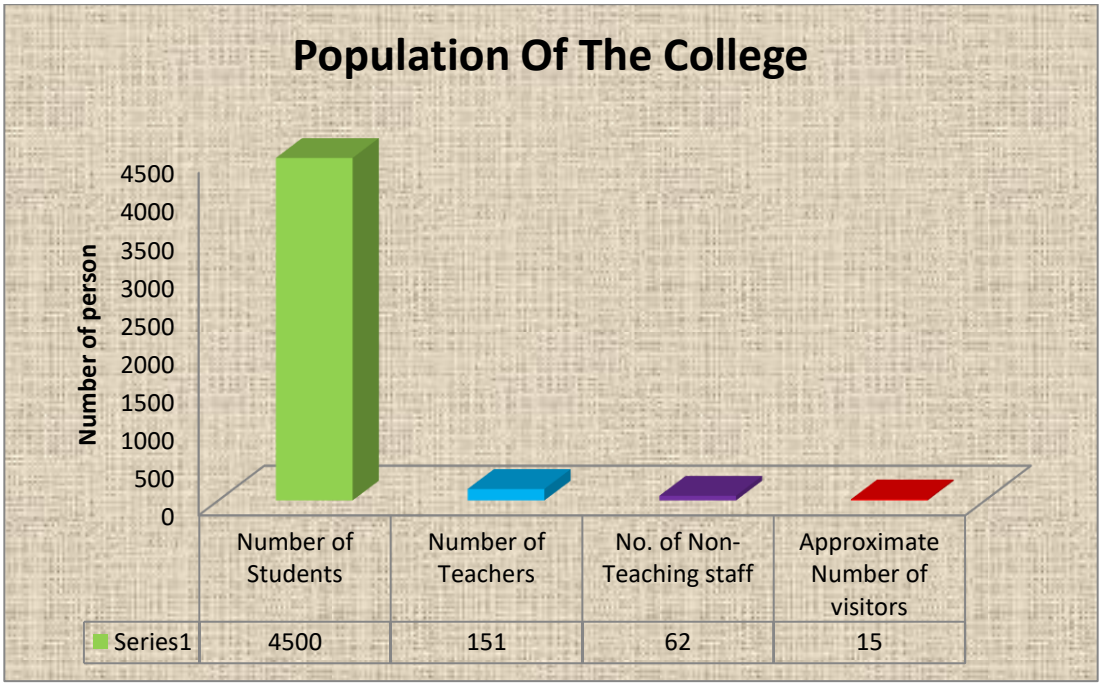
Total population of the college campus – Foot fall

Number of Students	4500
Number of Teachers	151
No. of Non-Teaching Administrative Staff including Casual Staff	27
No. of Library Staff including Casual Staff	4
No. of Hostel Staff including Casual Staff	9
No of Non-Teaching staff in the Department of Physics including Casual Staff	4
No of Non-Teaching staff in the Department of Chemistry including Casual Staff	**8**
No of Non-Teaching staff in the Department of Zoology including Casual Staff	**2**
No of Non-Teaching staff in the Department of Computer Science & BCA including Casual Staff	**1**

No of Non-Teaching staff in the Department of Geography including Casual Staff	**1**
No of Non-Teaching staff in the Department of Botany including Casual Staff	**1**
No of Non-Teaching staff in the Department of Nutrition including Casual Staff	**1**
No of Non-Teaching staff in the Department of Physiology including Casual Staff	**1**
No of Non-Teaching staff in the Department of Bengali including Casual Staff	**1**
No of Non-Teaching staff in the Department of English including Casual Staff	**1**
No of Non-Teaching staff in the Department of Military Science and N.C.Cincluding Casual Staff	**1**
Approximate Number of visitors	**15**
Total population	**4728**

75% of the footfall of the total population may be considered as the average footfall in the college per day. This represent the footfall is moderate considering the total space of the college campus.

Foot fall based on Total population



1. **Water Efficiency and Water Management**

Water, the essence of life, is a finite and precious resource essential for sustaining ecosystems, supporting livelihoods, and ensuring human well-being. However, in an era marked by population growth, urbanization, and climate change, the pressure on water resources has intensified, necessitating a concerted effort towards water efficiency and effective water management practices. This introduction aims to delve into the critical importance of water efficiency and water management in addressing contemporary water challenges.

Water efficiency encompasses strategies and technologies aimed at optimizing water use, reducing waste, and maximizing the productivity of water resources. From households to industries, agricultural fields to urban landscapes, enhancing water efficiency is essential for meeting water demand while minimizing environmental impact.

In the context of college campuses, the principles of water efficiency and water management take on added significance, as these institutions serve as both centers of learning and microcosms of society. With bustling populations of students, faculty, and staff, coupled with diverse facilities and activities, college campuses present unique challenges and opportunities for water conservation and sustainable water management. This introduction aims to explore the importance of prioritizing water efficiency and effective water management within the confines of the college campus environment.

College campuses, like any other community, rely heavily on water for various purposes including drinking, sanitation, landscaping, research, and recreational activities. However, the sheer scale of water consumption within these environments, combined with the potential for inefficiencies and wastage, underscores the need for concerted efforts to optimize water use and minimize environmental impact.

By embracing water efficiency measures such as installing low-flow fixtures, implementing water-saving technologies, and promoting water-wise behaviors among campus constituents, colleges can significantly reduce their water footprint while simultaneously saving on operational costs. Moreover, adopting comprehensive water management strategies that encompass water conservation, reuse, stormwater management, and pollution prevention can further enhance the resilience and sustainability of campus water systems.

Beyond the practical benefits, integrating water efficiency and management initiatives into the fabric of college campuses presents invaluable educational opportunities. Through experiential learning, research projects, and community engagement initiatives, students can gain firsthand knowledge and skills in sustainable water practices, nurturing a generation of environmentally conscious leaders and changemakers.

As institutions entrusted with shaping the minds and behaviors of future generations, college campuses have a unique role to play in advancing water sustainability. This introduction sets the stage for exploring the multifaceted dimensions of water efficiency and management within the college campus context, emphasizing the potential for innovation, collaboration, and positive impact on both campus and broader societal scales. Through collective action and commitment, college campuses can serve as models of responsible water stewardship, inspiring communities to embrace a more sustainable relationship with this vital resource.

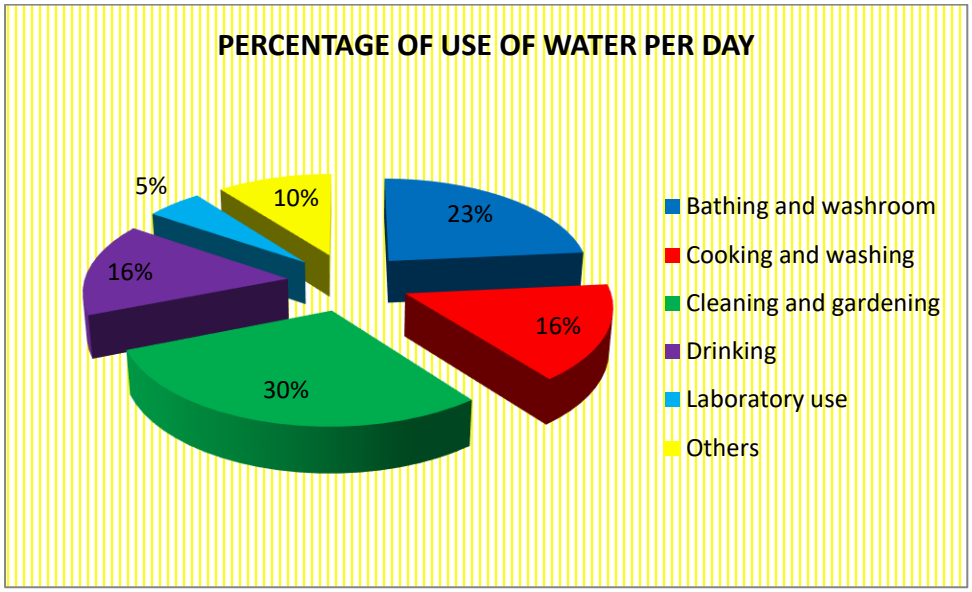
Implementing water efficiency and effective water management on a college campus is essential for environmental sustainability, cost savings, and promoting a culture of responsibility among students and staff. A water audit helps in understanding how water is used in different areas of the campus, including academic buildings, dormitories, recreational spaces, and landscaping. This identification of consumption patterns is crucial for targeting specific areas where water conservation efforts can be most effective.

At this college Maximum percentage of water was found to be used in cleaning and Gardening (29.50%) followed by Bathing and Washroom (23.50%). 15.50% of the total used water is used for drinking purpose after proper purification. Though a few amount was drained out in this process.

Use of water in Different Purpose of College Premises

Use of water in Different Purpose Per Day	Use in Percentage
Bathing and washroom	23.50
Cooking and washing	16.00
Cleaning and gardening	29.50
Drinking	15.50
Laboratory use	5.10
Others	10.40

Percentage of use of water at Mahishadal Raj College Campus



Factors	Weightage
Quality of Water	H
Re-use of water	L
Water Harvesting & Recharge	L
Use of Surface Water	M

* H denote- Taken management policy level above 60%

** M denote- Taken management policy level 40%-60%

*** L Denote-Taken management policy level below 40%

After conducting an examination aided by Water pH meters and TDS meters, we have determined that the quality of drinking water on campus is highly favorable for human health, resulting in a high rating (H) for Water Quality. However, our observations indicate a lack of operational Rechargeable units and absence of water harvesting plants in the campus vicinity. Additionally, we have noted inadequacies in managing water reuse and surface water utilization within the campus premises. Consequently, the current level of effectiveness of the water management policy is assessed as Low (L).

3. Air Quality and Carbon Footprints:

Amount of CO_2 (ppm)in different location of the college Campus

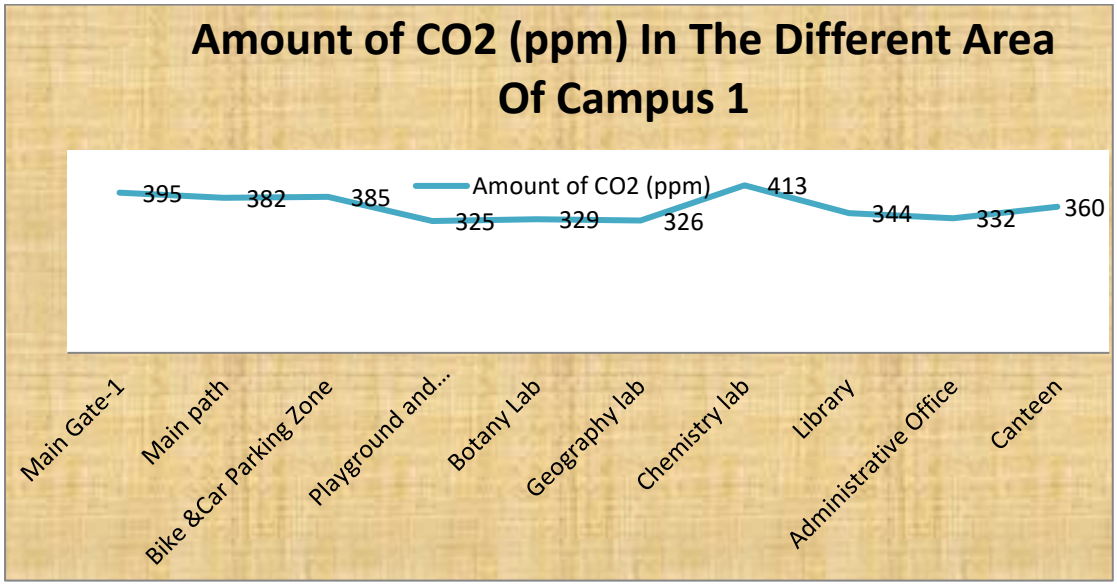
College	Different location of the college campus	Amount of

campus		CO2 (ppm)
Campus 1	Main Gate-1	395
	Main path	382
	Bike &Car Parking Zone	385
	Playgroundand fallow land	325
	Botany Lab(Jagadish Chandra Block)	329
	Geography lab(Jagadish Chandra Block)	326
	Chemistry lab (Satyen Bose Block)	413
	Library(Jagadish Chandra Block)	344
	Administrative Office	332
	Canteen(Administrative Block)	360
Campus 2	Gate- 2	380
	Gymnecium	360
	Girls hostel	365
	Community college	365
	Boyes hostel	370
	Guest House	350

The presence of carbon dioxide (CO2) in the air serves as an indicator of air quality within a specific area and is directly linked to human health. Assessing air quality holds particular importance in areas with high levels of foot traffic, such as schools, colleges, and universities. Elevated levels of CO2 can lead to various health issues including headaches, fatigue, stuffiness, poor concentration, increased heart rate, and nausea.

At Mahishadal Raj College, we conducted assessments of CO2 levels at various locations using atmospheric CO2 measurements. Our observations revealed that CO2 levels are low at the playground and fallow land, but higher at the Chemistry department and in front of Main Gate-1. However, it's important to note that despite these fluctuations, the CO2 levels remain within permissible limits for human health.

Amount of CO_2 at different site of Mahishadal Raj College



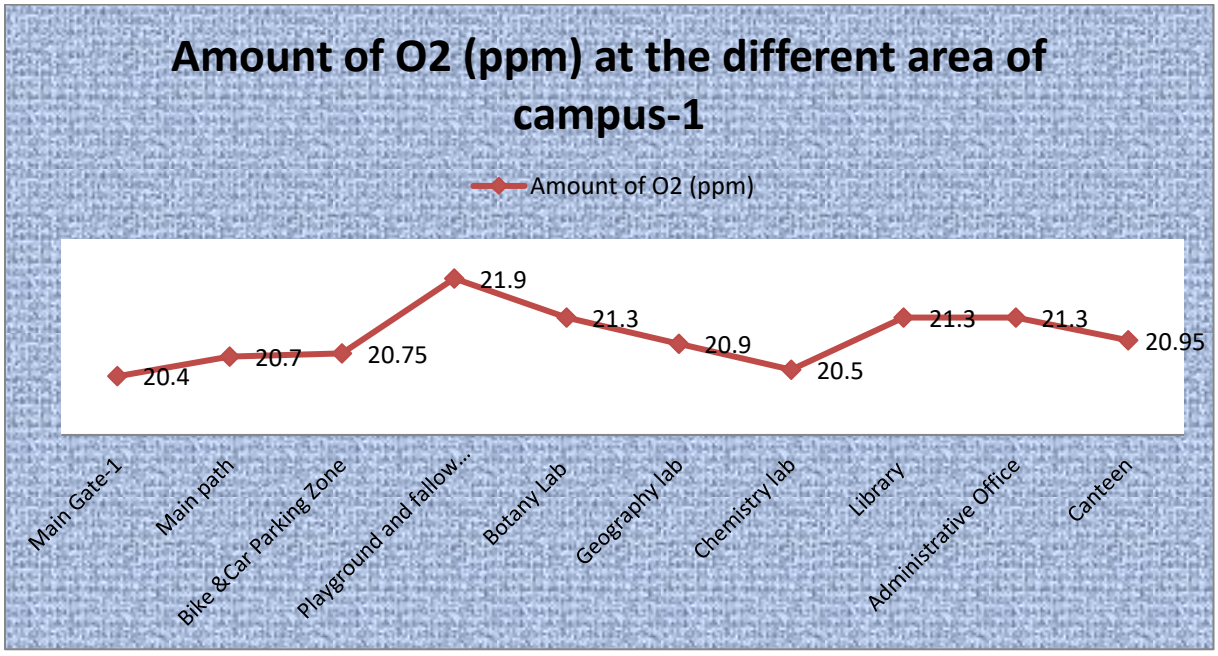
In the typical atmosphere near the Earth's surface, oxygen comprises 20.9% of the volume. However, regulations from the Occupational Safety and Health Administration and various confined-space guidelines specify that an atmospheric oxygen concentration of at least 19.5% is necessary for safe entry into such spaces. At Mahishadal Raj College, the oxygen levels in the atmosphere range from 20.4 ppm to 21.9 ppm. The highest concentration was recorded at the Playground and fallow land, while the lowest was observed at Main Gate-1. The level of oxygen is influenced by the number of people present in a confined space, being inversely proportional to congestion and directly proportional to proper ventilation and open areas. Overall, the oxygen level at Mahishadal Raj College is moderately high and does not pose any adverse effects on human health.

Amount of O_2 (ppm)in different location of the college Campus

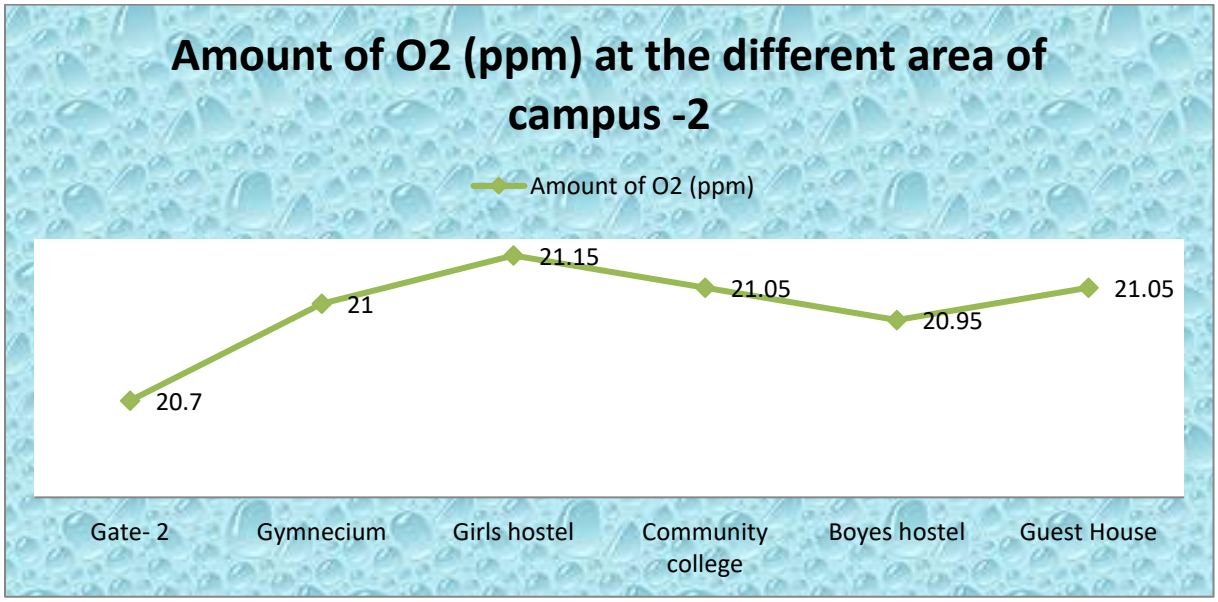
College campus	Different location of the college campus	Amount of O2 (ppm)
Campus 1	Main Gate-1	20.40
	Main path	20.70
	Bike &Car Parking Zone	20.75
	Playgroundand fallow land	21.90
	Botany Lab(Jagadish Chandra Block)	21.30
	Geography lab(Jagadish Chandra Block)	20.90
	Chemistry lab (Satyen Bose Block)	20.50
	Library (Jagadish Chandra Block)	21.30

	Administrative Office	21.30
	Canteen(Administrative Block)	20.95
Campus 2	Gate- 2	20.70
	Gymnecium	21.00
	Girls hostel	21.15
	Community college	21.05
	Boyes hostel	20.95
	Guest House	21.05

Amount of CO_2 at different site of Mahishadal Raj College



Amount of O_2 at different site of Mahishadal Raj College



Generation of Waste and Waste Management

In every facet of human activity, from consumption to production, waste generation is an inevitable consequence. The management of this waste, therefore, becomes an essential aspect of environmental stewardship and sustainable development. This introduction delves into the critical importance of understanding waste generation and implementing effective waste management strategies to mitigate its adverse impacts on the environment and human health.

Waste refers to materials that are discarded after their primary use, being either worthless, defective, or no longer useful. By-products, on the other hand, are co-produced materials with minor economic value. Waste has the potential to transform into a by-product, joint product, or resource when innovative methods increase its value.

Pollutants are waste substances introduced into ecosystems through human activities, degrading air, water, soil, and food quality, affecting both human and non-human well-being. Some pollutants are human-made, like chemical pesticides, while others originate from the environment, such as heavy metals or fossil fuels.

The generation of waste encompasses the production of various materials and substances that are no longer useful or desired. Whether it be household waste, industrial byproducts, or agricultural residues, the sheer volume and diversity of waste pose significant challenges to communities worldwide. Moreover, the composition of waste is evolving with changing consumption patterns, technological advancements, and economic development, further complicating waste management efforts.

Effective waste management entails the systematic collection, transportation, treatment, and disposal of waste in a manner that minimizes environmental pollution, conserves resources, and protects public health. From recycling and composting to landfilling and waste-to-energy technologies, a range of approaches exists to address different types of waste streams and their associated environmental impacts.

Against the backdrop of escalating concerns over resource depletion, pollution, and climate change, the imperative for sustainable waste management has never been more pressing. This introduction sets the stage for exploring the multifaceted dimensions of waste generation and management, emphasizing the need for innovative solutions, collaborative partnerships, and proactive policies to build a more resilient and resource-efficient society. Through collective action and commitment, we can transition towards a circular economy where waste is minimized, resources are maximized, and environmental integrity is preserved for future generations.

Within the dynamic environment of a college campus, the generation of waste and its management present unique challenges and opportunities. As hubs of activity and learning, college campuses witness a myriad of waste streams ranging from food waste to paper, plastic, and electronic waste. This introduction delves into the critical importance of understanding waste generation and implementing effective waste management strategies within the college campus setting.

Waste generation on college campuses encompasses the disposal of materials that are no longer needed or usable, including items like food packaging, lecture notes, laboratory equipment, and electronic devices. The diverse nature of activities and facilities within a campus leads to the production of various types of waste, reflecting the consumption patterns and behaviors of students, faculty, and staff.

Effective waste management within college campuses involves a comprehensive approach to handling waste from its source to its disposal. This encompasses initiatives such as waste reduction, recycling, composting, proper disposal of hazardous materials, and the promotion of sustainable consumption practices. Moreover, waste management on college campuses provides a valuable opportunity for education and engagement, fostering a culture of environmental responsibility and stewardship among students and the wider campus community.

Waste management involves processes to handle waste from its origin to disposal, including collection, transportation, treatment, and regulation. It encompasses all waste types—solid, liquid, or gases—and addresses health concerns arising from waste handling and consumption of affected resources.

The generation of waste in college campuses is a notable aspect of waste management, and addressing this issue requires a comprehensive approach to reduce environmental impact and promote sustainability.

Different source of waste Generation in College Campuses:

Academic Waste: Includes paper waste, discarded textbooks, notebooks, and other educational materials.

Food Waste: Generated from dining facilities, cafes, and student activities.

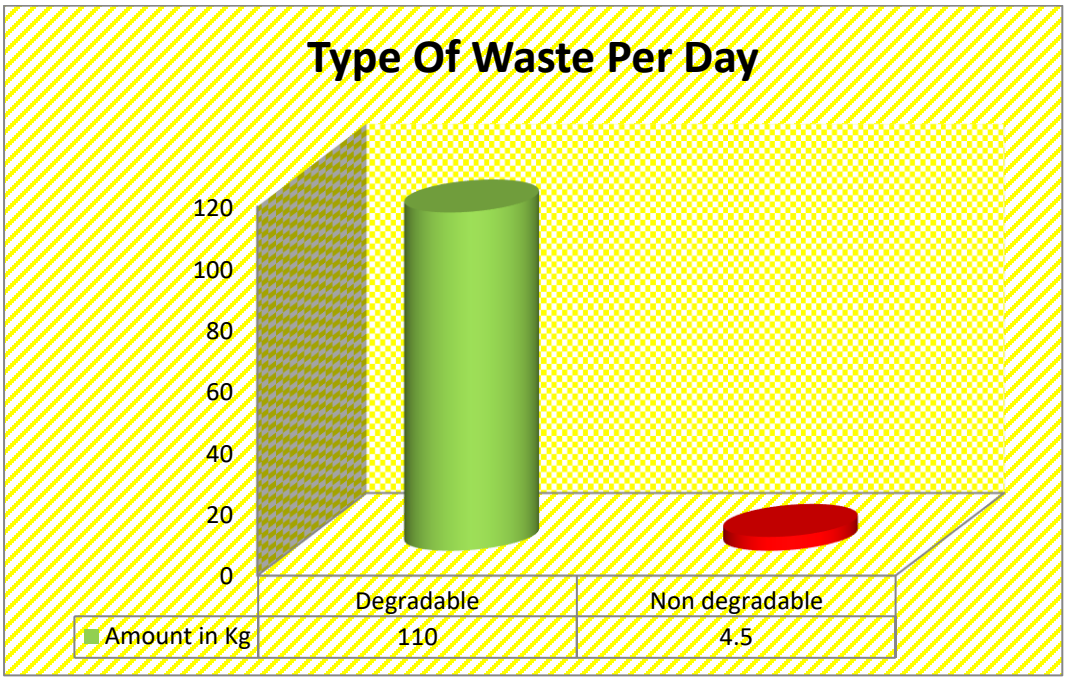
E-waste: Arises from the use and disposal of electronic devices in computer labs and personal electronics.

Plastic and Packaging Waste: From products, promotional materials, and campus events.

General Waste: Includes everyday waste from offices, maintenance activities, and residential areas.

Types of wastes:

Type of Wastage in Per Day	Amount in Kg
Degradable	**110**
Non degradable	**4.5**

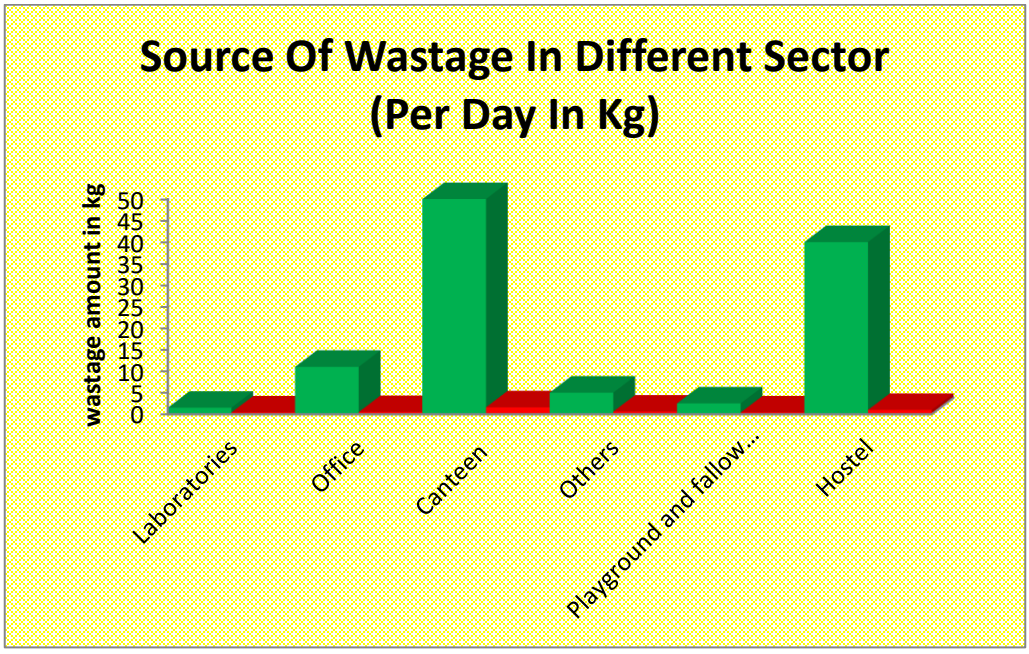


Source of Wastage in Different Sector (per day in Kg):

Source of Wastage in Different	Degradable Wastage	Non Degradable

Sector(per day in Kg)	Amount In Kg	Wastage Amount In kg
Laboratories	**1.5**	**0.4**
Office	**11**	**0.5**
Canteen	**50**	**1.6**
Others	**5**	**0.6**
Playground and fallow land	**2.5**	**0.4**
Hostel	**40**	**1**

Source of Wastage in Different Sector (per day in Kg):



Performance audit of waste issues:

Implemented wastes management		
Sl.no	Factors/Indicators	Weightage
1	Plastic and Polythene free	H
2	Re-use of papers	H
3	Hazardous effect waste management	M

4	Removal of E-Wastes	M
5	Organic & food waste	M
6	Others solid wastes	M

*** H denote- Taken management policy level above 60%**

**** M denote- Taken management policy level 40%-60%**

***** L denote-Taken management policy level below 40%**

ENERGY AUDIT

INTRODUCTION

A power review engages a methodical examination of energy utilization within an establishment, intending to save energy. It requires evaluating techniques and frameworks to decrease energy usage while maintaining operations. Suggestions for different techniques to achieve increased energy conservation are given. With traditional energy supplies like fossil fuels facing exhaustion, there's a need to explore alternatives and prioritize energy preservation. The main objective is to provide goods or services at minimal cost while reducing environmental impact. Conducting an energy evaluation helps identify potential savings, understand fuel usage patterns, pinpoint wasteful areas, and find ways for improvement. It's essential for educational sectors to adopt energy-saving methods sustainably. The evaluation process involves creating surveys, inspecting campuses, reviewing documents, conducting interviews, analysing data, taking measurements, and offering recommendations. Energy auditing considers the potential for energy conservation, management techniques, and alternative energy sources. Specific goals include assessing sustainability management systems and ensuring departmental compliance with regulations. The outcomes of the evaluation significantly impact operational costs and environmental footprint. Initiatives like the Energy Conservation Building Code and the Bureau of Energy Efficiency promote energy-efficient practices. Energy labels and ratings help consumers make informed choices. The Energy Audit acts as a standard for energy management, assisting in devising more effective strategies. It's a systematic assessment of energy supplies with the goal of conserving the environment and natural resources. At Mahishadal Raj College, affiliated with Vidyasagar University, the audit begins with identifying, measuring, recording, reporting, and analysing energy components.

NEED FOR AN ENERGY AUDIT

In each organization, the three primary operational costs typically consist of energy (including both electrical and thermal), personnel, and materials. Among these, energy consistently stands out as a

significant factor when considering cost management or potential savings, making energy management a vital area for cost reduction. An Energy Evaluation plays a crucial role in understanding energy and fuel usage within a sector, identifying areas prone to waste and those with potential for improvement. It offers insights that contribute to reducing energy costs, enhancing preventive maintenance, and improving quality control programs, all essential for manufacturing and utility operations. This evaluation initiative allows for a focused examination of energy cost fluctuations, energy supply reliability, decisions regarding energy sources, identification of energy conservation methods, and retrofitting for energy-efficient equipment. Essentially, the Energy Evaluation translates conservation concepts into practical solutions, providing technically feasible recommendations considering financial and organizational factors within a specified timeframe. The primary goal is to devise strategies for reducing energy usage per unit of product output or lowering operational expenses. Serving as a benchmark, the Energy Evaluation establishes a baseline for managing energy within the organization and lays the foundation for strategizing more efficient energy utilization throughout the facility. The eco-friendly campus concept emphasizes efficient energy usage and conservation, aiming for sustainable savings. Additionally, it targets reductions in carbon emissions, involves calculating carbon footprint, promotes the acquisition of energy-efficient machinery for cost-effective and safe energy supply, advocates for energy conservation in all buildings, seeks to decrease overall energy consumption, minimize waste sent to landfills, and integrates environmental considerations into contracts and facilities with significant environmental impacts. Analysing Energy Governance through audits focuses on energy savings and potential opportunities. While energy itself is intangible, its presence manifests in cables, conduits, and other materials through visible effects like heat, light, and efficiency. Energy governance assessments cover energy consumption, sources, monitoring, lighting, transportation, electrical appliances, and distribution. Energy use is a critical aspect of campus sustainability, requiring inclusion in assessments without further explanation. Despite the widespread use of energy, attention to energy-saving potential remains crucial. For instance, a traditional incandescent bulb consumes 60W to 100W, whereas an energy-efficient LED uses less than 10W, highlighting significant energy savings. Energy auditing is essential for conservation efforts and the adoption of methods to reduce consumption, thereby mitigating environmental degradation. Moreover, audits provide invaluable suggestions and recommendations for efficient energy-saving practices. Environmentally aware institutions are encouraged to review their energy practices at least once every two years, utilizing both internal and external auditors. The conduct of energy assessments, facilitated by both internal and external auditors, plays a significant role in organizational energy governance. These assessments effectively assess the energy potential within an organization, identifying more efficient approaches to reduce environmental impact.

AIMS AND OBJECTIVES OF AN ENERGY AUDIT

An energy assessment is an essential tool for formulating and implementing comprehensive energy management strategies within a company. Its main aim is to systematically pinpoint opportunities for enhancing energy efficiency, conservation, and cost savings at the assessment site. The evaluation process involves the following steps:

3.1 Assessing the energy-saving initiatives and measures in place at the assessment sites.

3.2 Identifying various opportunities for energy conservation measures and additional avenues for cost savings.

3.3 Exploring alternative energy sources to assess potential energy savings and guide decision-making in energy management.

3.4 Providing technical advice on establishing an energy balance and offering precise application-focused guidance.

3.5 Conducting a thorough examination of energy usage, reviewing recent electricity bills for the campus, and understanding the tariff structures offered by the central and State Electricity Boards.

3.6 Listing various ways in which energy is utilized, including electricity for appliances such as stoves, kettles, microwaves, as well as other sources like LPG, diesel, and more.

3.7 Evaluating the use of different devices and equipment, including incandescent (tungsten) bulbs, CFL bulbs, fans, air conditioners, cooling devices, heaters, computers, photocopiers, inverters, generators, and laboratory equipment. This assessment involves calculations based on factors such as wattage and duration of use (e.g., 60-watt bulb x 4 hours x number of bulbs = kWh).

3.8 Assessing the adoption of alternative energy sources/non-traditional energy sources within the company, such as photovoltaic cells for solar power, energy-efficient appliances, biogas, etc. Additionally, implementing initiatives to raise awareness among stakeholders regarding energy conservation and efficient use. In essence, Energy Auditing in the institutional setting is a multi-faceted approach that not only strives for efficiency in resource utilization but also emphasizes the importance of sustainable practices, cost savings, and collective responsibility for the well-being of the organization and its environment.

Mahishadal Raj College

4. Campus Area and Infrastructure:

- **Total area of the college campus: 4.14 acres.**
- **Play ground and fallow land area: 1.58 acres**
- **Number of building blocks: 08**
- **Total number of class room: 82**
- **Total number of laboratories: 26 + (workshop, Automobile)**
- **Number of common rooms: 05**
- **Number of administrative blocks/rooms: 02 Blocks and 09 rooms**
- **Total number of toilets: 38**
- **Library: 01**

- **Reading room: 03 (For students & teachers)**
- **Auditorium/seminar hall: 03**
- **Garage: 01**
- **Open stage: NIL**

METHODOLOGY AND SURVEY SCHEDULES:

To conduct an energy inspection, various methods are utilized at the inspection sites, primarily focusing on a thorough site inspection analysis. This process involves aligning overall energy inputs with total energy outputs and identifying all energy flows within a facility. Physical verification of different components such as lighting, roofs, tables, ventilation fans, air conditioning units, solar panels, heaters, generators, uninterrupted power supply units, and air circulation systems is carried out during the inspection. This includes verifying the effectiveness of installed energy-efficient systems. The inspection highlights examining the costs or potential cost savings associated with each of these components, with energy consistently emerging as a critical area for cost reduction. The task of energy management becomes essential in achieving cost-saving objectives. Additionally, the energy bill from the utility company is gathered for analysis. This assessment involves evaluating load requirements and efficient energy usage. Stakeholders are engaged during the inspection to explore opportunities for improvement in energy management. Potential areas for energy conservation and cost-saving opportunities are identified and recommended for implementation within the facility. Energy Inspection can be classified into the following types: I. Initial Energy Inspection II. Comprehensive Energy Inspection III. Scope and Scale of Energy Inspection IV. Thorough Energy Inspection

Survey and data collection:

1. List ways in which the college utilizes energy (Electricity, electronic stove, pot, microwave, LPG, wood, Gasoline, diesel, and others).
2. Total of electricity bills for the past two years.
3. Overall expenditure for LPG cylinders over the previous year.
4. Cost of gasoline/diesel/ other fuels for power generators.
5. Number of CFL bulbs installed and specify their operational duration.

6. Energy consumed by each bulb monthly.
7. How many LED bulbs are used within college premises (with detailed operational duration)?
8. Quantity of incandescent (tungsten) bulbs installed?
9. Total number of fans in place (with detailed operational duration).
10. Number of air conditioners in place (Hours used per day, for how many days monthly).
11. Energy consumed by each electrical appliance monthly? (kWh)
12. Number of operational computers? Specify usage (Hours used per day, for how many days monthly).
13. How many photocopiers are installed?
14. Quantity of cooling devices installed?
15. Energy consumed by each inverter monthly? (kWh)
16. Number of electrical appliances used in different laboratories along with their power ratings.
17. How many heaters are used in the cafeteria? (Specify usage, hours used per day for how many days monthly)
18. Are any alternative energy source modules installed? Provide detailed specifications.
19. Are computers and additional devices set to energy-saving mode?
20. Do machines (TV, AC, Computer, weighing scale, printers, etc.) frequently operate on standby mode? If yes, specify the duration in hours.
21. What energy conservation methods does the college follow?
22. How many panels are displayed to promote energy conservation awareness?

To assess the environmental impact, carbon dioxide levels were measured at various locations across the campus using a portable CO2 analyser. This measurement aimed to evaluate the carbon footprint and identify areas with significant carbon emissions, providing valuable insights for reduction strategies. The college's energy bill was examined and analysed to understand kilowatt-hour (kWh) requirements and the efficiency of energy usage. Engaging with various stakeholders played a crucial role in familiarizing them with energy assessment procedures, ensuring a successful and results-oriented energy inspection. Opportunities for energy conservation and savings were identified during the inspection process, laying the groundwork for potential implementation steps. The assessment methodology involves gathering

information through various channels, including on-site visits, group discussions, campus surveys, inquiries, observations, perception analyses, and feedback. All these elements contribute to the comprehensive audit report.

Detailed Energy Audit Methodology:

A comprehensive analysis provides a detailed energy management plan for a facility by evaluating all significant energy-consuming systems. This kind of analysis offers the most accurate assessment of both energy efficiency and costs. It considers the combined effects of all initiatives, takes into account the energy usage of key appliances, and involves meticulous calculations for both energy cost savings and project expenses. In a thorough analysis, the energy balance is a crucial component, relying on an inventory of energy-consuming systems, assumptions about current operational conditions, and calculations of energy usage. This estimated usage is then compared with charges on utility bills. Preliminary site visits and preparations are essential stages preceding in-depth scrutiny. An initial site visit typically lasts a day, allowing the Energy Auditor/Engineer to interact with relevant personnel, familiarize themselves with the surroundings, and assess the procedures necessary for conducting the energy assessment.

Source of Energy:

Through the enquiry process it is noted that the mostly used energy source is conventional but institution has taken notable steps to develop non-conventional energy sources in terms of solar energy module.

Power house of Mahishadal Raj College

Power house of Mahishadal Raj College

Energy Cost:

Total electricity consumption(conventional)- 46199.6 U (80%)

Total electricity consumption (non-conventional)-11549.9 U (20%)

Amount paid for conventional energy used: Rs. 704997.00

Fossil fuel consumption per year-

a. Number of LPG gas cylinders used for cooking (Canteen & Hostel)-102PCs

b. Number of LPG used in Laboratories-37PCs

c. Diesel used for green Generator- 120 litter

Table 1 represents the percentage use of conventional and non-conventional uses of energy and its corresponding plot is depicted in figure 1.

Source of energy	In Percentage
Conventional	**80%**
Non -Conventional	**20%**

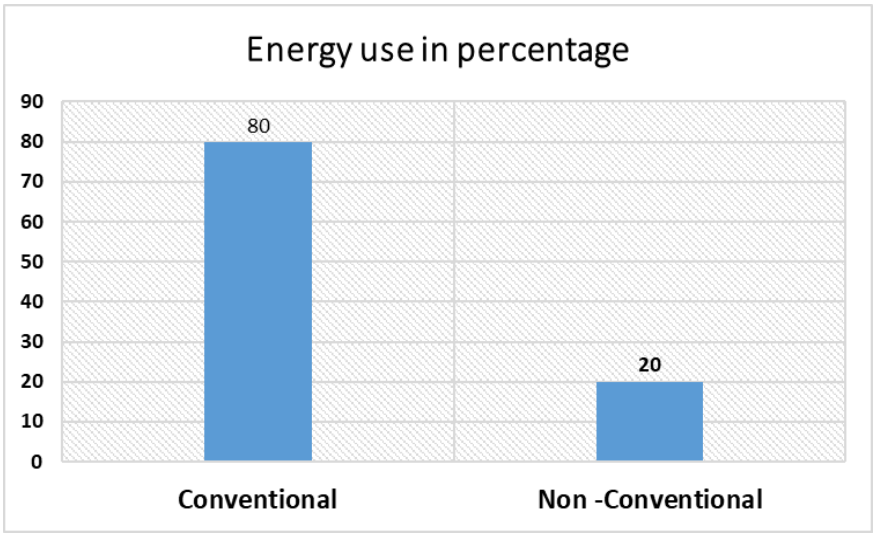


Figure:1 Mode of energy used in college campus (conventional and non-conventional)

Solar energy module at Mahishadal Raj College

During the survey different electrical appliances are recorded with its corresponding power rating. In table 2 the calculated daily consumption of electrical energy is shown below.

Table 2: The detail calculation of energy consumption.

Sl. No	Description	Total	Watt	Total Watt
1	LED tube	710	20W	14200W
2	LED lamp	237	9 W	2133W
3	Halogen Lamp LED	3	80W	240W
4	Street light LED	3	24 W	72 W
5	Spot light LED	21	15W	315W
6	Roof lights LED	65	18W	1170W
7	LED	34	12W	408W
8	LED	28	40W	1120W
9	LED	4	45W	180W
10	LED	4	52W	208W
11	LED	6	60W	360W
12	LED	3	80W	240W
A	TOTAL		**20646W**	
13	Fluorescent tube	259	40W	6120W
14	Halogen lamp.	1	500W	500W
B	TOTAL		***6620W***	
X	A + B		**27266 W**	
FANS				
OLD FANS	334	60 W	**20040W**	
4	70 W		280W	

1	100W	100W	
12	120 W	1440W	
1	145 W	145W	
1	150 W	150W	
2	160 W	320W	
2	180 W	360W	
C	**22835W**		
NEW FANS			
175	60 W	10500W	
4	140 W	560W	
2	145 W	290W	
D	**11359W**		
Y	C + D	**34185W**	
AIR CONDITIONER			
SINGLE PHASE	12	1200W	14400W
2	1500W	3000W	
3	1800W	5400W	
THREE PHASES	15	2500W	37500W
WATER COOLERS	3	1000W	3000W
Refrigerator	2	250W	500W
Z	***63800 watts***		
XEROX MACHINES	3	2000W	***6000 watts***
LIFT 10 passenger	2	15000W	30000W
PUMPS	1 X 2 HP	1481W	1491W
4 X 1 HP	746W	2984W	

Computers	126	60W	7560W
Printers	23	40W	920W
Projectors	9	200W	1800W
Audiovisual equipment	25 cc camera, 12 sound box, 2 Boofer, 2 mixtures,4 no TV, 2 Amplifier	20,2000,2000,1000 2000,50W	32700W
Aqua guard	11	25 w	275W
Lab instruments	16542 w 25% use	4135W	
Grand Total	**(208KW)**	**208685W**	

Photo of a sample room during data collection at Mahishadal Raj College

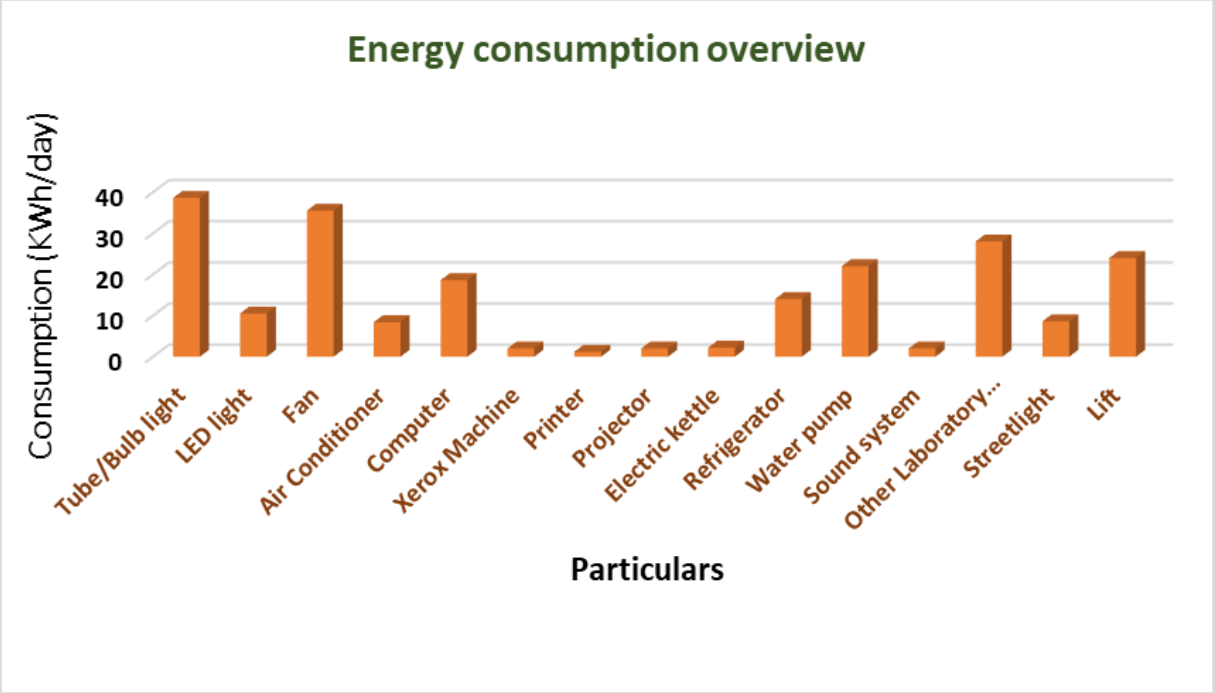
For precaution, a maximum Demand Controller (DC) can be installed at the main LT panel to avoid the maximum demand penalty. In case the running maximum demand increases, the demand controller will switch off some non-essential load like Air-conditioning load etc. and simultaneously it will also give alarm for further action.

Table 3: The detail calculation of energy consumption.

Month	Present Sanction Load (S.L.) kW	Monthly Power Factor (P.F.)	Sanction Demand (S.D.) (kVA)	Running Max. Demand kVA	Recommended S.D. (kVA)
July, 22	99.47	.9849	101	43.4	80
Aug22	98.63	.9766	101	40.48	80
Sept22	97.59	.9663	101	73.28	80
Oct 22	96.29	.9534	101	17.44	80
Nov 22	96.68	.9573	101	36.32	80
Dec 22	95.07	.9413	101	20.00	80
Jan.23	94.12	.9319	101	18.00	80
Feb 23	93.90	.9298	101	28.16	80
Mar 23	97.10	.9614	101	35.84	80
April 23	97.68	.9672	101	40.64	80
May 23	97.61	.9665	101	68.08	80
June 23	96.78	.9583	101	51.52	80

The corresponding plot of energy consumption from calculation is depicted in figure 2.

Figure 2: Bar diagram to represent the energy consumption rate.



Alternative energy module at Mahishadal Raj College

Figure 3: Unit consumption overview

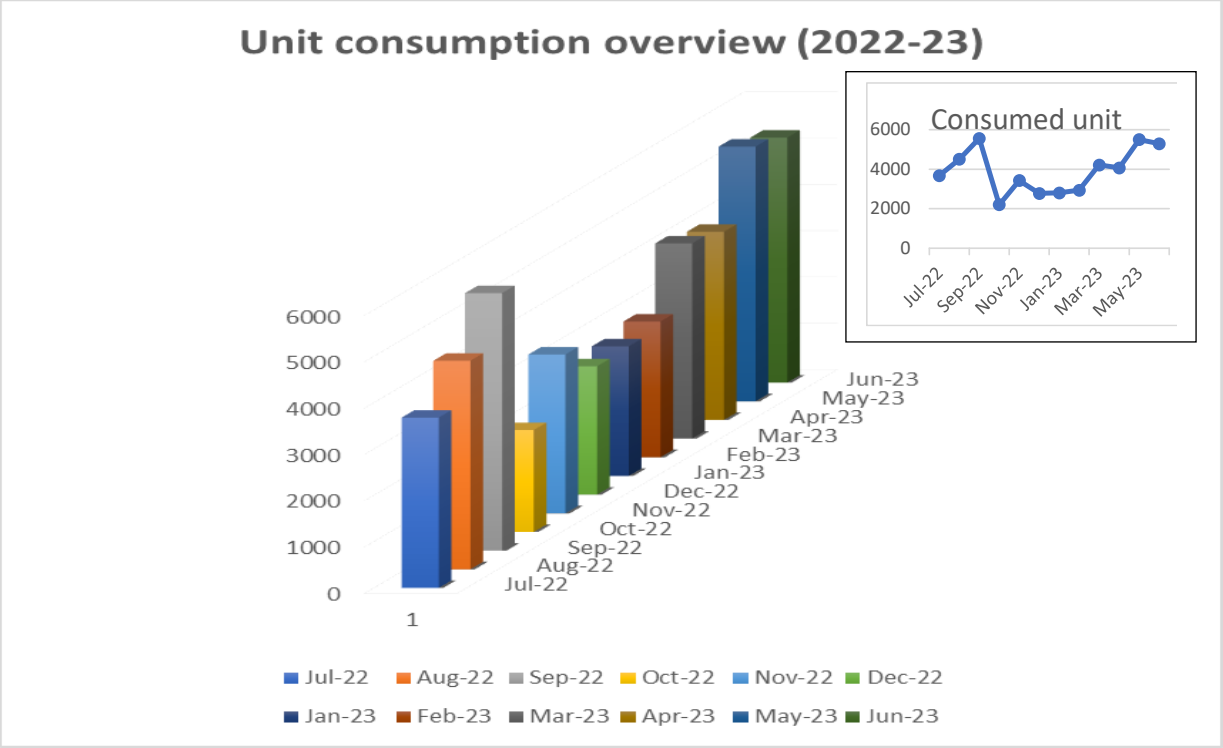
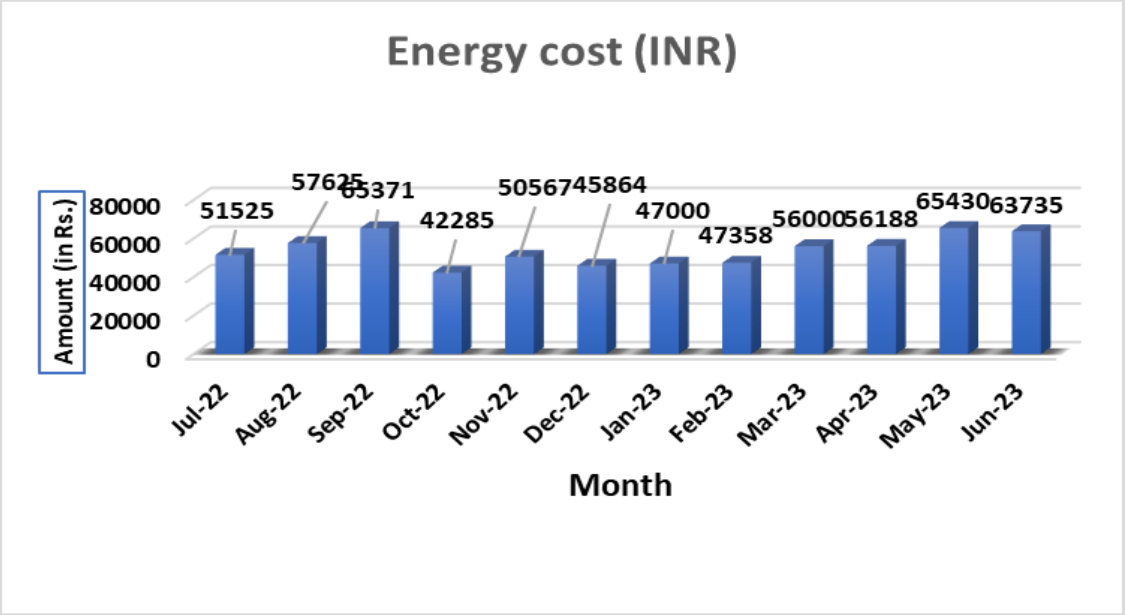


Figure 4: Energy cost profile



The amount of CO_2 (ppm) in different places is depicted in table 4 and its corresponding pie diagram is shown in figure 3.

Table 4. Amount of CO2 (ppm) in different places

Locations inside college campus	CO2 (ppm) in air	Remarks
Class room (Block 1)	450	CO_2 level is low
Class room (Block 2)	550	CO_2 level is low
Class room (Block 3)	405	CO_2 level is low
Staff Room 1	450	CO_2 level is low
Staff Room 2	420	CO_2 level is low
Library	400	CO_2 level is low
Office	544	CO_2 level is low
Laboratories	407	CO_2 level is low
Conference Hall	417	CO_2 level is low
Canteen	680	CO_2 level is low
Parking	498	CO_2 level is low

Thermometer

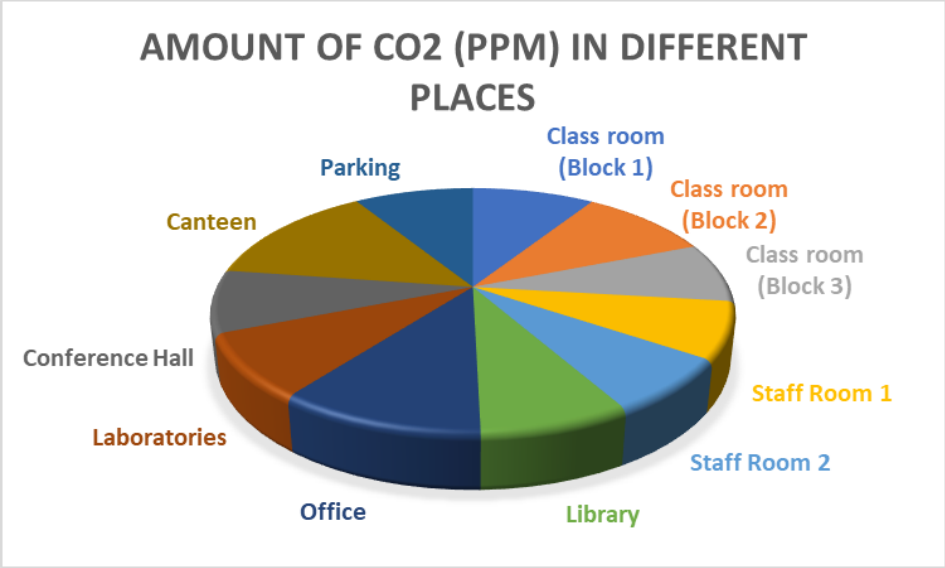
Solar radiation measuring unit

CO2 Level Reference Ranges:

- 350-1000 ppm: Typical levels found in occupied spaces with efficient air exchange and clean air.
- 1000-2000 ppm: Moderate levels associated with reports of drowsiness and diminished air quality.
- 2000-5000 ppm: Critical levels linked to symptoms such as headaches, sleepiness, and a sensation of stagnant, stale air. Additionally, reduced concentration, attention span, elevated heart rate, and mild nausea may occur

Different instruments to measure CO2 (ppm) in different places

Figure 3. Amount of CO_2 (ppm) of the Air in Different location of the college Premises.



The calculation of carbon footprint can be carried out according to the method outlined on www.carbonfootprint.com, which involves summing the annual electricity usage. The CO_2 emissions from electricity are calculated using the formula:

CO_2 emission from electricity = (electricity usage per year in kWh / 1000) x 0.84

Substituting the given values: = (46199.6 kWh / 1000) x 0.84 = 38.08 metric tons

Note:

- Annual electricity usage: 46199.6 kWh
- 0.84 is the conversion coefficient from kWh to metric ton

9. Major audit observation:

SL. No.	Sectors	Weightage
1	Applied to NCE	L
2	Tendency to use LED and CFL bulb	M
3	Reduce of AC Uses	H
4	Awareness	L
5	Management of CHG_s	H

 # H denotes management policy level > 25%

 # M denotes management policy level > 15%--25%

 # L denotes management policy level< 15%

10. Best Practices followed in the Organization

- Transformers, generators, and UPS systems are securely fenced and accompanied by awareness boards indicating 'Dangers' and 'Warnings'.

- 'Switch ON' and 'Switch OFF' signs are strategically placed throughout most areas to promote energy-saving practices among stakeholders.
- Electrical wires, switch boxes and stabilizers are adequately protected to prevent any potential hazards to staff and students.
- LED lights and solar street lights are employed.
- Power factor is maintained close to unity with Automatic Power factor Correction (APFC)
- Variable Frequency Drives (VFDs) are used for lifts and air conditioners.
- Old generation monitor and T. Vs have been replaced with LED monitors.
- E-Vehicles are available within the campus.
- Star rated equipment's are used where applicable.

Energy Conservation Proposals:

The energy assessment offered suggestions for decreasing energy expenses, instituting precautionary maintenance measures, and improving quality assurance activities, all essential for the effective operation of utilities at the assessment locations. • Consider investing in energy-efficient equipment (4-5 star rated) when replacing. • Install sub-meters in all buildings to monitor energy usage and consumption per building. • Implement efficient water usage and temperature settings through automated processes to achieve energy savings. • Establish continuous monitoring and analysis of energy usage with a dedicated campus team. • Regularly conduct energy conservation awareness campaigns (ECON) among stakeholders through associations, clubs, forums, and chapters. • Promote the practice of switching off electrical equipment when not in use. • Ensure maintenance and replacement of outdated appliances in all laboratories. • Activate power-saving mode on computers and electronic devices. • Install a Biogas plant for the hostel kitchen and canteen. • Deploy automatic switches with occupancy sensors in common areas. • Significantly reduce high monthly electricity consumption in the college through frequent energy assessments. • Upgrade outdated and inefficient fans with new energy-efficient models. • Monitor equipment in all laboratories regularly and promptly address any issues. • Offer value-added, non-formal, certificate, or diploma courses on 'Energy and Environment Management Audits' to benefit students and research scholars seeking certification as Lead Auditors.

Introducing Energy-Saving Circuits for Air Conditioners:

These systems cleverly minimize compressor runtime using timing or temperature variance logic, while ensuring human comfort remains unchanged. This advancement can lead to electricity savings ranging from 15% to 30%, depending on weather conditions and temperature preferences. With a total of 7 split-type air conditioners, it is recommended to gradually swap out older units with new, energy-efficient models labelled with 5 Stars by the Bureau of Energy Efficiency (BEE). Given an average compressor ON time of 5 hours per day, this shift ensures notable energy preservation.

Recommendations on Carbon Footprint in the Organization:

- Enhance the cooking setup in the hostel kitchen and cafeteria to conserve gas.
- Promote restraint in the regular utilization of generators, inverters, and UPS systems.
- Mandate the habit of powering down lights, fans, air conditioners, devices, and tools when not in operation.
- Implement sufficient airflow and emission systems in theatres, lecture halls, and meeting venues to diminish carbon dioxide levels among students, academics, and personnel.

Conclusions:

Considering the organization's well-established renown and endurance, there is a notable chance to enhance energy preservation initiatives and advance the campus towards self-reliance. The institution has already taken admirable strides in this direction by incorporating energy-saving lighting, raising awareness among stakeholders, and ensuring dependable power backups. Moreover, the organization upholds top-tier standards in energy assessment, which encompass appropriately securing transformers, generators, and UPS systems with fencing and awareness signage indicating potential dangers. Prominent signs promoting energy-conserving behaviours, coupled with thorough maintenance of electrical infrastructure, further reinforce energy preservation endeavors and ensure the well-being of faculty and students. The implementation of sprinkler irrigation on campus to curtail energy usage is commendable. Nonetheless, there are additional suggestions that could enhance the organization's capacity for energy conservation. These measures hold the potential for a brighter future, marked by an energy-efficient campus and sustainable environmental and community progress for stakeholders in the years ahead.

RECCOMMANDATION

To reduce energy consumption and management

- Given the organization's established reputation and longevity, there is ample opportunity to enhance energy conservation efforts and transition the campus towards self-sustainability. The institution has already made significant strides in this direction through initiatives such as implementing energy-efficient lighting, raising awareness among stakeholders, and ensuring essential power backups. Additionally, the organization follows best practices in energy auditing, including properly protecting transformers, generators, and UPS systems with fencing and awareness boards highlighting potential hazards. Prominent signage promoting energy-saving practices,

as well as the careful maintenance of electrical infrastructure, further contribute to energy conservation efforts and ensure the safety of staff and students.

- The adoption of sprinkler irrigation on campus to minimize energy usage is commendable. However, there are further recommendations that could enhance the organization's energy savings potential. These measures can lead to a more prosperous future, characterized by an energy-efficient campus and sustainable environmental and community development for stakeholders in the years ahead.

Potential areas for environment management and green development.

- Increase more two units of rain water harvesting and use of the same for irrigation in garden along with the wash room use and clinging purpose may be done through developing some green project mode which reduce the consumption of ground water to some extent.
- Auto regulating device should be attached with the submersible bump so that overflow of the roof top tank may be checked especially at the Rabindra Bhaban.
- Auto regulating sprinkler may be installed for adequate irrigation in the garden even in the summer period.
- The Mahishadal Raj College has a considerable area of building blocks so, during rainy season huge amount of water from the roof top may be transfer to Ground water recharge system which may be taken into account by the college authority in anspecific environment project mode.
- Some waste water was directly found to be admixed in the natural water bodies through some drainage system which should be carried on after passing through the water treatment plant.
- In each and every floor of all building more separate degradable and non degradable waste been should be installed for proper management of the waste and the degradable waste may be transfer in the plant through which organic fertilizer can be produced and applied as green manure in the garden.
- As the college is situated at lower Bengal and the chance of hitting of cyclone to that area is very high, A natural disaster management committee and a center should be formed in the college campus to overcome the locals from the adverse situation if arise in near future.

- In the e-waste management center proper documentation the e waste with proper measurement is essential for the proper management of e waste.

For better conservation of Biodiversity

- Some wild habitat in the campus of the college were recorded which may be conserved and can be denoted "Keep wildness in wild"
- A wild indigenous fish rescue center may be develop in the Fishery campus where wild aquatic plants along with different aquatic wild life like soft skin turtle may be conserved
- Some portion beside the Pond may be allotted for aboriginal tree re library which can be used both for study and conservation of some locally threatened tree species
- A medicinal plant library may be established at the garden area of the main campus along with a butterfly garden where a number of host and nectar plants for different species of butterfly may be conserved.
- Name plate of all existing MTS should be done and install for education purpose.