

ENVIRONMENTAL AUDIT REPORT

2020-2021



TRIPURA UNIVERSITY
Suryamaninagar |
TRIPURA (W)- 799022|
TRIPURA | INDIA



प्रो. गंगा प्रसाद प्रसाई
कुलपति

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Vice-Chancellor

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(केन्द्रीय विश्वविद्यालय)
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Tripura University
(A Central University)
Suryamaninagar-799022, Tripura, India



Foreword from Vice Chancellor

Globally there are many environmental challenges being faced and it is increasingly recognized that it is leading to the situation of unwarranted climate change issues, loss of biodiversity, impact on human health and even natural disasters. For this, small concerted efforts at the local and regional levels are necessary to bring about a balance at the global level. Tripura University as an academic establishment with lots of young talents who are the future nation builders is committed to take a lead role by creating its identity in the protection and conservation of environment. It has implemented eco-friendly practices to manage the available resources. As a part of this, Green/Environmental/Energy Audit is one such step which is taken up by Tripura University in this direction for the second year to record, document, analyze and report the diverse components within our close ambit so that an eco-friendly atmosphere can be created and maintained. It will help us to identify and generate prospects to boost environmental quality, expand hygiene and health measures, improve environmental protection, and augment sustainable development practices. It will help us in management of our environment so that we can make alterations in the ongoing activities. Implementation of environmental policy provides a chance to exploit our opportunities for better performance in future and will help us to develop a sustainable campus.

I have great pleasure in writing foreword for the Green/Environmental/Energy Audit Report 2020-2021 of Tripura University, Suryamaninagar. It is my pleasure to recognize the sincere efforts of the Green/Environmental/Energy Audit Committee led by Prof. Badal Kumar Datta, Department of Botany, Tripura University for their best efforts in preparing this comprehensive report. I do hope that the Green/Environmental/Energy Audit Report-2020-2021 will guide all the stakeholders of this University to define themselves in their future activities and will motivate all to put green steps ahead in future.

(Prof. Ganga Prasad Prasain)
Vice-Chancellor

Acknowledgement

Since its establishment, Tripura University has been at the forefront of promoting social change at both national and international levels through various activities such as environmental campaigns and workshops. The university recognizes the significance of energy audits for its ongoing maintenance and future growth. In its pursuit of excellence, Tripura University is dedicated to enhancing environmental quality and preserving its unique ecosystem for the benefit of future students and campus inhabitants.

Although multiple measures have been implemented to conserve and safeguard the environment, the 2020-2021 report marks the university's second formal endeavor to document and analyze the outcomes of its investigations pertaining to energy audits. The university is committed to endorsing the climate neutrality objectives set forth by the Indian Government and is determined to prevent a global ecological crisis. This commitment is exemplified by the establishment of the Energy Audit Committee, composed of faculty members specializing in this field, tasked with gathering essential energy-related data within the campus. This information is crucial in resolving environmental concerns on the premises.

The Energy Audit Committee's primary objective is to identify prevailing and potential energy-related challenges. By doing so, it seeks to oversee the university's environmental management practices and assess their subsequent impact on the campus environment. This proactive approach aligns with Tripura University's larger goal of contributing to ecological sustainability while maintaining the integrity of its academic processes.

This report has been generated as a result of the collaborative endeavors of every participant within the Energy Audit Committee of Tripura University. The committee engaged in the energy audit with the aim of collecting information related to energy usage and energy saving parameters. Subsequently, the gathered data was compiled and scrutinized in order to identify urgent and significant challenges present within the campus environment. The intention behind this effort is to explore possibilities for ongoing enhancement in our environmental practices and standards. This is achieved through the proposals and recommendations we have presented. We anticipate that this report will garner the attention it deserves from all invested parties, promoting an approach that starts from the grassroots level. This approach will better equip us to confront forthcoming challenges.

We extend our sincere gratitude to Prof. Ganga Prasad Prasain, the esteemed Vice Chancellor of Tripura University, for his unwavering encouragement and administrative support throughout the study. As representatives of the Energy Audit Committee for the year 2020-2021, we wholeheartedly appreciate the Hon'ble Vice Chancellor's kind involvement. Our heartfelt thanks go to the Registrar, Deans, Heads of Departments, Teachers, Officers, all staff members, and the entire community of Tripura University for their invaluable assistance in gathering data for this report.

We must also express our special appreciation to Er. Krishna Das, Executive Engineer and his team for their essential contribution of campus data. Lastly, but by no means least, our profound gratitude is extended to all committee members who played a role in the creation of this report. A special mention goes to Dr. Thiru Selvan, the Convener of the Tripura University Energy Audit Committee for 2020-21, for his tireless dedication in compiling this comprehensive document.

I sincerely hope and believe that the efforts made by the present Energy Audit Committee will be helpful for Tripura University and I hope that it becomes a responsibility of all the stakeholders of this university to follow the proposed management plan suggested in the report to reduce our impact on our environment.

Prof. Badal K Datta
Chairman

Tripura University Environment Audit Committee2020-2021

Chairman:

Prof. B K Datta, Dean, Faculty of Science, Tripura University

Members:

Prof. Ranendu Kumar Nath, Department of Chemistry, Tripura University - Member

Prof. A K Saha, Department of Botany, Tripura University - Member

Dr. Y V Krishnaiah, Associate professor, Department of Geography and Disaster, - Member
Tripura University

Dr Sabyasachi Dasgupta, Associate professor, Department of Forestry and - Member
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Dr. S S Singh, Assistant Professor, Department of Zoology, Tripura University - Member

Dr Sourabh Deb, Assistant Professor, Department of Forestry and Biodiversity, - Member
Tripura University

Mr. Harjeet Nath, Assistant Professor, Tripura University - Member

Er. Krishna Das, Executive Engineer, Tripura University - Member

Mr Surajit Sarkar, Campus Incharge, Tripura University - Member

Convener:

Dr. Thiru Selvan, Assistant professor, Department of Forestry and Biodiversity,
Tripura University

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Introduction

In an era marked by escalating environmental concerns and a growing imperative for sustainable practices, the significance of conducting thorough environmental audits cannot be overstated. This environmental audit report serves as a comprehensive evaluation of the environmental parameters, operational procedures, and potential avenues for enhancement within the premises of Tripura University. With the overarching objective of advancing environmental efficiency, curbing operational expenses, and minimizing the institution's impact on the environment, this report encapsulates a meticulous evaluation undertaken in the Tripura University campus.

In the global pursuit of sustainable progress, organizations are increasingly acknowledging the pivotal role of environmental responsibility in attaining both economic and ecological goals. This environmental audit report acts as a valuable instrument for recognizing opportunities for conservation, prioritizing corrective actions, and outlining a strategic plan for the adoption of eco-conscious practices. By furnishing a detailed overview of the existing environmental landscape, prevailing operational methods, and equipment efficiency, this report empowers Tripura University with actionable insights to guide well-informed choices.

The analysis presented in this report is the culmination of collaborative endeavors between our dedicated environmental audit committee members and the personnel of Tripura University, whose invaluable contributions and access to essential data were pivotal. Employing a combination of on-site assessments and meticulous data compilation, we have endeavored to uncover a comprehensive perspective on resource usage and potential areas for refinement.

The structure of this report aims to present a lucid depiction of the present environmental scenario, succeeded by a thorough exploration of conservation measures tailored to the unique requisites and ambitions of Tripura University. Our discoveries are organized to encompass cost-effective and cost-neutral prospects, moderate investment opportunities, and strategic recommendations for the long term. These recommendations will empower Tripura University to make prudent choices in alignment with its operational objectives.

In the pursuit of a future characterized by sustainability and ecological efficiency, this environmental audit report stands as a cornerstone, offering an all-encompassing comprehension of resource consumption patterns and a roadmap for achieving tangible enhancements. By embracing the insights, it offers, Tripura University takes a significant stride towards mitigating resource wastage, optimizing resource allocation, and contributing to a greener and more prosperous tomorrow.

Environmental auditing aligns with Criterion 7 of NAAC (National Assessment and Accreditation Council), an autonomous organization in India responsible for categorizing institutions as Grade A, B, or C based on the scores assigned during the accreditation process.

About Tripura University

Emerging as an independent State University on October 2nd, 1987, Tripura University was established as an offshoot of the renowned Calcutta University. Its primary focus since inception has been to attain academic excellence in the northeastern region of India. Situated on a sprawling 75-acre semi-urban landscape along the National Highway in Suryamaninagar (23°45'40"N; 91°15'58"E), the university was founded within the premises formerly belonging to CUPGC, located approximately 9 kilometers south of the capital city Agartala.

As a member of the distinguished group of 49 Central Universities in India, Tripura University gained its status through a parliamentary act on July 2nd, 2007. This legislative action aimed to establish a university for teaching and affiliating purposes in the state of Tripura. Over time, the university has made significant progress, channeling its efforts into enriching academic infrastructure and nurturing overall institutional growth.

Presently, the University oversees an array of programs under its Science & Arts and Commerce Faculties. With a comprehensive array of 58 programs, including Undergraduate, Postgraduate Diploma, and other Postgraduate Programs, as well as opportunities for Ph.D. studies in 38 diverse subjects, the institution caters to over 4000 students pursuing various courses throughout the academic year. The University is deeply committed to driving pioneering research ventures across multiple fields.

Despite its geographical remoteness and inherent communication challenges, the university has consistently aspired to match the academic achievements, research breakthroughs, and placement successes of other esteemed universities in the country. This steadfast commitment is evident in the university's recognition through NAAC Assessments and its positioning in the NIRF evaluations.

Comprising 46 Departments, each equipped with modern classrooms, state-of-the-art laboratories, round-the-clock internet access, a computer center, a well-stocked library, pervasive Wi-Fi coverage across the Campus, sports facilities, an open-air theater, healthcare services, banking facilities, a cafeteria, a post office, a food court, hostels, and a guest house, the University provides a holistic learning environment. The faculty members are not only dynamic educators but also supportive mentors, fostering a holistic development approach. Alongside academic pursuits, extracurricular activities such as sports, film screenings, musical showcases, art festivals, debates, university-wide celebrations, sports competitions, and walking events are seamlessly woven into the curriculum. The campus exudes a vibrant atmosphere that nurtures an academic setting among the most secure and safest within the region.

Spanning a picturesque expanse, the Campus features lakes, woodlands, hillocks, as well as flower and fruit gardens, creating a tranquil and serene ambiance. The lush canopy of trees, fragrant blooms, the symphony of avian gatherings, the graceful dance of butterflies, and even the presence of wildlife collectively offer students a haven from academic rigor, providing a rejuvenating and calming mental sanctuary.

Environmental Audit at Tripura University

In a global context where governments emphasize policies aimed at bolstering labour productivity and economic growth through the development of human capital, Tripura University aligns itself with these goals by fostering knowledge and skill enhancement. This approach not only contributes to the nation's well-being but also generates significant contributions to GDP. In line with this, Tripura University has dedicated substantial efforts to elevate educational standards, embodying its commitment to catalyzing transformative change.

As the university advances its cutting-edge research endeavors across diverse fields, its expansion is accompanied by an inevitable rise in energy consumption and its associated environmental implications. In harmony with the vision of the Government of India, guided by the esteemed Prime Minister Shri Narendra Modi Ji, the emphasis on sustainable practices spans across sectors. This synchronization seamlessly resonates with the mission established by the University Grants Commission (UGC), which mandates an "Environmental Consciousness" criterion (Criterion VII) for assessing educational institutions.

In the contemporary era of sustainable development, Tripura University embraces the principles of responsible resource utilization and environmental stewardship, where environmental efficiency emerges as a pivotal facet of campus management. Environmental auditing entails the systematic evaluation of practices to gauge their efficiency, detect inefficiencies, and explore avenues for optimization. Through the scrutiny of consumption patterns, identification of inefficiencies, and recommendations for eco-conscious measures, the university seeks to curtail its environmental impact and contribute to broader ecological objectives.

Tripura University is unwavering in its commitment to responsible resource management and aspires to set an example in the realm of sustainable academic practices. Aligned with the sustainability mandates set forth by the Government of India, the university commits to overseeing the environmental efficiency of its research and educational endeavors through the diligent endeavors of the Environmental Audit Committee.

The policy objectives of the Tripura University Environmental Audit encompass:

Identification of Strengths and Enhancement Opportunities:

Our policy endeavors to conduct a comprehensive environmental audit, evaluating sustainable practices within administrative, academic, and research domains. Through a meticulous gap analysis, we aim to highlight strengths and areas warranting improvement. Subsequently, actionable strategies will be outlined to advance our sustainability objectives.

Cultivation of Environmental Awareness:

We are dedicated to nurturing a culture of environmental consciousness throughout our campus. By involving all stakeholders, including students, faculty, staff, and administration,

our goal is to inspire responsible and optimized utilization of available resources, thereby mitigating our ecological footprint.

Proactive Environmental Governance:

Our policy underscores the significance of proactive environmental governance. By gathering foundational data on critical environmental parameters, we aim to identify potential concerns in advance and address them preemptively. This approach ensures a sustainable and ecologically harmonious campus environment.

Through these policy objectives, Tripura University underscores its commitment to efficient resource utilization, environmental awareness, and proactive mitigation of environmental concerns through the implementation of environmental audits.

To achieve these aforementioned goals, the Environmental Audit Committee of Tripura University is dedicated to the following aims:

- ❖ Identification of prevailing and emerging environmental concerns.
- ❖ Oversight of environmental management practices.
- ❖ Evaluation of existing practices that could influence resource consumption.
- ❖ Promotion of awareness among the university's stakeholders.
- ❖ Compilation of an Environmental Audit Report detailing eco-conscious practices adopted by various departments, support services, and administrative entities.

METHODOLOGY ADOPTED

The methodology employed to conduct the Environmental Audit at Tripura University encompassed the following elements:

Preliminary Assessment:

- ❖ Gather pertinent information about environmental practices, resource consumption trends, and relevant data associated with the university's campus.
- ❖ Identify key areas with significant environmental impact, including waste management, water usage, emissions, and other relevant factors.

Onsite Data Collection:

- ❖ Conduct site visits to various buildings and facilities within the campus to assess environmental practices and resource utilization.
- ❖ The water quality analysis was done using standard protocols.
- ❖ Air quality analyses of the University campus were carried out using standard protocol.
- ❖ The noise levels were measured using a Sound Level Meter at selected sampling

stations during the day and night time within the campus.

- ❖ Collect data concerning resource specifications, operational routines, and consumption patterns for various systems.

Enquiries and Stakeholder Interviews:

- ❖ Engage in interviews and discussions with relevant stakeholders, including facility managers, maintenance staff, and occupants.
- ❖ Acquire insights into operational routines, waste management practices, and potential avenues for resource conservation.

Resource Use Analysis:

- ❖ Analyze the collected data to calculate resource consumption for different areas and systems.
- ❖ Identify trends, patterns, and any deviations in resource usage that warrant attention.

Waste Management Analysis:

- ❖ Evaluate waste management practices, including waste segregation, disposal methods, and recycling efforts.
- ❖ Propose strategies to enhance waste reduction and recycling, thereby minimizing environmental impact.

Report Compilation:

- ❖ Synthesize the findings, recommendations, and analyses into a comprehensive environmental audit report.

By adhering to this holistic environmental audit methodology, Tripura University can pinpoint opportunities to curtail resource consumption, diminish operational expenses, and contribute to a more ecologically sustainable campus environment.

AUDIT STAGE

Tripura University started its Environmental audit by recording the land use and land cover (LULC), water availability and usage, waste generate and their management practices, recording of the environmental parameters, etc. The members of the audit team recorded the different facilities at the Tripura University campus, and their impacts. The staffs, students and other stakeholders were interviewed through structured questionnaires to get details of usage, frequency or general characteristics of different appliances. Data collection was done by onsite visit and also through questionnaires in different sectors such as water, energy, waste. The ambient quality of the campus was recorded to monitor the environmental status within the University campus using standard protocols. The data obtained were collated and analyzed to prepare this audit report of Tripura University.

POST AUDIT STAGE

Land use and land cover

The topography of Tripura University campus is undulating with a wetland (lake) towards the centre that drains to the south eastern boundary. The water body is rain fed and has water almost throughout the year. The whole campus is interspersed with scattered trees at few places thus, making it a picturesque landscape suitable for a wide spectrum of flora and fauna. The Academic Departments and residential quarters/hostels have come up over the area which were highlands or in gradually filled lowlands.

The present study revealed that the TU campus has a total of 97 acres of land of which 75 acres existed as a part of the main campus and an additional area of 22 acres was added to the total area during 2015. The TU campus occupy an area of 10.94 acres under orchards, 7.95 acres under wetland (Lake area), 3.75 acres under Botanical Garden and Forest Park, 6.43 acres of playground which together constitutes 29.07 acres (29.97%; Fig: 1). Organized plantations in the campus are mainly along the internal roads, around guest House/hostel, residential quarters and in the Botanical Garden and Forest Park. The large wetland is a home to a wide diversity of aquatic flora and fauna.

It is found that a total of about 38.74 acres (~39.94% of total) are under the built-up category, of which residential quarters, hostels, academic departments and administrative units form a significant part. The buildings which are coming up in the last few years are multistoried as a part of the initiative of the TU administration for vertical expansion. The campus is dispersed with roads connecting each building and along the boundary of the main area which covered an estimated area of approximately 2.82 Acres and the playgrounds covering an area of nearly 6.43 acres of land.

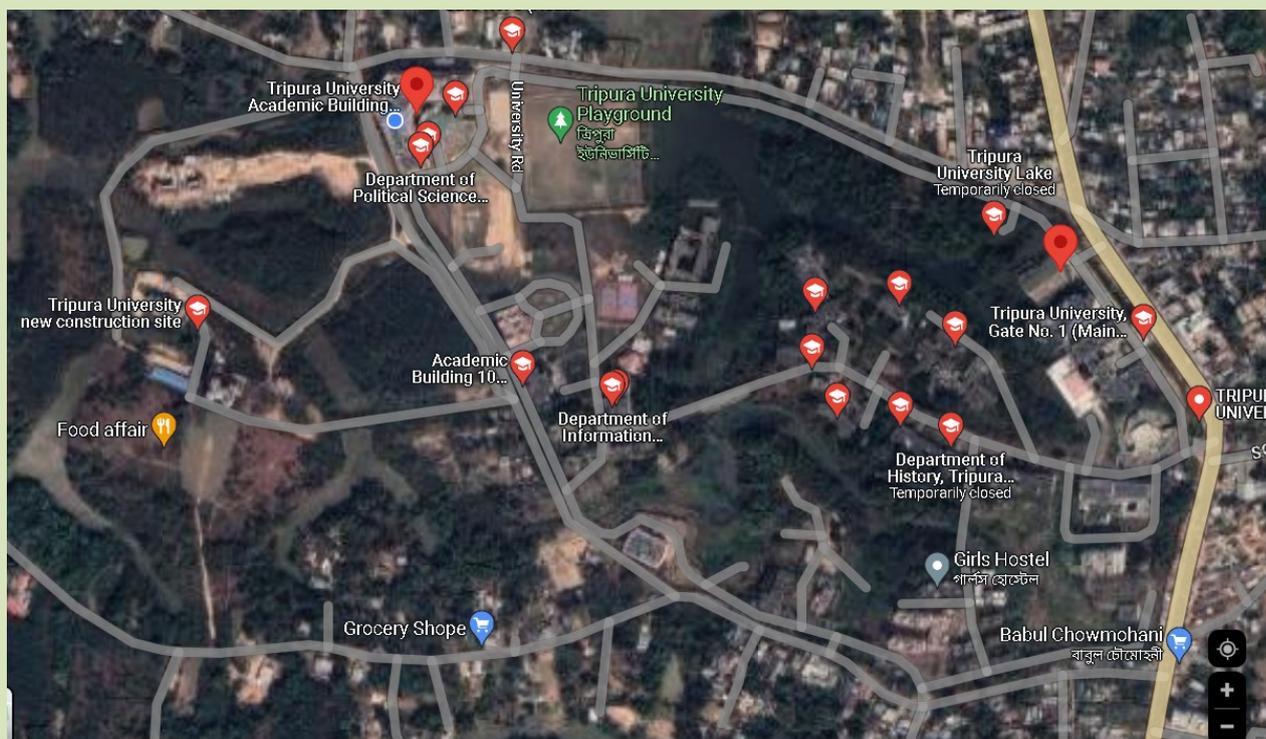


Fig 1: The Map of Tripura University campus

Table 1: Land use categories in Tripura University Campus

Sl. No.	Land Use Category	Area (in approx. Acres)
1	Botanical Garden and Forest Park	3.75
2	Wetland (Lake area)	7.95
3	Play ground	6.43
4	Orchards	10.94
5	Road	2.82
6	Foot Path	0.21
7	Pump Station	0.20
8	Protection Wall	0.02
9	Drain	0.46
10	Retaining Wall	0.02
11	Culvert	0.02
12	Building Under Construction	1.03
13	Overhead Tank	0.009
14	Car Parking	1.48
15	Garage	0.15
16	Building	29.17
17	Transformer	0.104
18	Generator	0.05
19	Security House	0.012
20	Water Pump	0.04
21	Septic Tank	0.88
22	Jungle Area	5.51
23	Tin Shed	0.06
24	Power Sub Station	0.25
25	Toilet	0.49
26	Garden	0.25
27	Statue	0.001

Water Audit

Water is an important natural resource and is available naturally depending on the climate and topographic features. All organisms are dependent on water for their living. Although water is available in nature, portable water is not available freely for human consumption. There have been many practices to conserve water so that it can be readily available for human use. It has been noticed that due to unsustainable use of water resources there is contamination and depletion of the ground water and also water which is available in various reservoirs like lakes, ponds, streams etc. which is becoming more alarming. Therefore, it becomes increasingly important to conserve protect and manage the water resources availability and usage so that it is sustainably used within the university campus. Water auditing is conducted to evaluate the quality, availability and usage of water; the facilities available and methods adopted to revitalize and use it so that the resources are intact without leading to deterioration.

Uses and management

A total of 431000 L of water is pumped every day for the university dwellers as well to meet the daily demands of the academic and administrative Departments (Table 2). The daily use of the water was approx. 431000 L per day.

Table 2: Source and uses of water in the TU campus

Source of water		
Sl. No	Parameters	Information
1	No of Wells	2
2	No of the motors used	2
3	Horsepower- motor	20 HP x 2
4	Depth of well- Total	76 m x 2
5	Capacity of Tank (Total)	150000 L
Quantity of water used in different sections of the Campus		
6	Sections	Water use (L/day)
7	Hostel	135000
8	Resident quarter	54000
9	Administrative block	8000
10	Construction work	Self-Arrangement
11	Canteen	4000
12	Urinals and Toilets	80000
13	Departments	63000
14	Gardens	50000
15	Laboratories	20000
16	Drinking	12000
17	Leakage	5000
18	Main purposes of water use in the campus	Drinking and cooking purpose Toilets and wash areas Laboratory use Gardening Construction
19	Nos. of water tap excluding households/ residential quarters)	1250 nos
20	Water cooler and drinking water filtration facility (excluding households/ residential quarters)	68 nos
21	Nos. of urinal and toilets (excluding households/ residential quarters)	113
22	Nos. of waterless /bio-toilets	Nil
23	Any water wastage/why?	Yes, leakage from pipes and tanks, leaving of taps open at times
24	Water usage for gardening	50000 Ltr
25	Wastewater sources	leakage from pipes and

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		tanks, Overflowing of tanks from residential qtrs., Toilets, laboratories, hostels
26	Use of wastewater	Nil
27	The fate of wastewater from labs	Discharged into soak pit in case of contamination and natural discharge
28	Any wastewater treatment for lab water	No
29	Whether any green chemistry method practiced in Labs	No
30	Rainwater harvesting	Rain water harvesting is maintained by the water body within the premises which also helps in maintaining the ground water level and there is no reusable rain water which is harvested

The stake holders of the residential quarters of Tripura University specially re-use the grey water which is obtained from the various domestic activities and they re-use the same water for gardening and vegetable fields etc. Also, water recycling is done as per the direction of the competent authority in broader scale as and when required. Tripura University is blessed with a natural large water body (lake) inside its premises. Naturally, this large lake serves the main purpose of rain water harvesting. During the rainy season water from the roof tops of the buildings directly fall into the lake through rain water outlets, RCC drains and recharges the ground water table throughout the year. To maintain the water level throughout the year a sluice gate is installed and on the rear side of it a semi-permanent structure is recently constructed. This sluice gate and the semi-permanent structure have resulted the constant water level in the lake. This lake recharges ground water and supplies adequate supply of water through the pumps of the University.

Water Quality assessment

The water requirements of Tripura University are met from two underground tube wells. The water recovered from the wells using motors are treated in an iron removal plant cum oxidation and mixing chamber so that it is portable for consumption. Without treatment there is huge sediment and the water is not portable. Water samples from different sources were collected and analysed for its quality parameters and the results are presented in Table 3.

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Table 3: Water quality analysis report of the water samples obtained from different sources within TU campus

Type of Sample	Water Source/ point of use purifier used	TDS (ppm)	pH Range	Turbidity (NTU)	Iron (ppm)	Calcium (ppm)	Magnesium (ppm)	COD (ppm)
Raw Water	Tap water	50-96	6.5-9	1.2-5.3	0.05-4.5	6.2-8.1	1.2-1.9	55-65
Drinking water	Resin cum RO-UV purifier (Model Kent Mineral RO)	25-30	6.8-7	0.8-1.2	0.01-0.2	2.9869	0.8096	35-44
Raw Feed Water	Feed underground water	52	6.2-6.5	10-22	0.4-0.7	-	-	-
Treated Water	Iron Removal Plant cum oxidation and mixing chamber	59	6.3-6.6	0.8-3	-	-	-	-

Observations

- ❖ TU does not have a reusable water treatment facility for wastewater generated from Academic buildings, administrative buildings, library, residential quarters, guest houses, hostels, laboratories, canteen, etc.
- ❖ At times there is overflowing of overhead water tanks.
- ❖ Water consumption is not properly monitored within the campus as there are no systems to record it.
- ❖ There is accumulation of sediments in the TU lake area especially during the rains.
- ❖ Water from the buildings is discharged into the lake.

Suggestions and Recommendations

- ❖ Rainwater harvesting systems could be improved so that there is a facility available in every building for reusing of water.
- ❖ A water conservation drives should be initiated by involving all the stake holders.
- ❖ Automated sensors can be installed to prevent the overflow from water tanks.
- ❖ Automated taps could be used so that usage of water can be reduced.

Waste disposal audit

Pollution from waste is aesthetically displeasing and results in large amounts of litter in our communities which can cause health problems. Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and public health.

Solid waste can be categorized into three types: biodegradable, non-biodegradable and hazardous waste. Bio-degradable wastes include food wastes, canteen waste, wastes from toilets etc. Non-biodegradable wastes include what is usually thrown away in homes and

schools such as plastic, tins and glass bottles etc. Hazardous waste is waste that is likely to be a threat to health or the environment like cleaning chemicals, acids and petrol. Unscientific management of these wastes such as dumping in pits or burning them may cause the harmful discharge of contaminants into soil and water supplies, and produce greenhouse gases contributing to global climate change respectively. Special attention should be given to the handling and management of hazardous waste generated in the campus. Bio-degradable waste can be effectively utilized for energy generation purposes through anaerobic digestion or can be converted to fertilizer by composting technology. Non-biodegradable waste can be utilized through recycling and reuse. Thus, the minimization of solid waste is essential to a sustainable University. The auditor diagnoses the prevailing waste disposal policies and suggests the best way to combat the problems.

Status of Solid Waste Generation in the campus

Each and every department of Tripura University as well as administrative offices create some waste and dumped in small waste bin located in the department. Each building several dust bins are placed from where housekeeping staffs take the wastes. From the small bin wastes are dumped in big bin by the housekeeping staffs regularly. From the big waste bins the car from Agartala Municipal Corporation took the solid wastes. As tabulated below, on an average, the hostels and teacher flats/quarters account for the highest amount of solid waste generated on the campus. On average, various stakeholders generate about 500 kg of different types of solid waste per week (Table 4).



Fig. 2: Waste bins and the collection of waste by the AMC in TU campus

Solid Waste Management

Management of solid waste is one area where all stakeholders are more-or-less aware of the issues involved. Each of these sections/ stakeholders has appropriated their own set of solid-waste management practices as per their convenience, requirements, and availability of resources. Investigations revealed that 45 Academic Departments of the University have a total of 180 numbers of indoor dustbins installed for solid-waste disposals. On an average, each of these departments has a provision of about 5 dustbins. At present none of the Departments had facility of segregating the waste.

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Table 4: Solid waste generated on the campus per Week

Sl. No.	Stakeholders	Types of solid waste	Average waste generated /week (Kg)	% of waste
1	ACADEMIC DEPARTMENT	Paper waste	40	9.22
2		Plastic waste	12	2.76
3		Organic Waste	35	8.06
4		E-waste	1.0	0.23
5	ADMINISTRATIVE OFFICE	Paper waste	20	4.61
6		Plastic waste	5	1.15
7		Organic Waste	10	2.30
8		E-waste	1.0	0.23
9	RESIDENTIAL QUARTER/HOSTELS/GUEST HOUSE	Paper waste	60	13.82
10		Plastic waste	30	6.91
11		Organic Waste	200	46.08
12		E-waste	1.0	0.23
13	CANTEENS	Paper waste	3.0	0.69
14		Plastic waste	1.0	0.23
15		Organic Waste	15	3.46
16		E-waste	NII	
TOTAL			434 Kg /week	

The teacher's quarters maintain on an average one personal dustbin for solid-wastes disposals and a pit for the dumping of organic wastes. 40% of the Academic Departments and 50% of residential quarters maintain separate disposal systems for dry and wet waste.

The practice of separating bio-degradable waste from non-biodegradable ones is prevalent in the teacher's quarters, Guest House and 20% of Academic Departments but is absent in hostels.

For all the academic departments, administrative office, residential quarter/hostels/guest house and canteens 90 % of the accumulated solid waste excluding the ones which are dumped in the pits is lifted by Agartala Municipal Corporation (AMC) every two days, which is then segregated and land filled while for the rest is composted.

While the centralized system of solid-waste management involves timely and periodic lifting of the disposed of wastes by the Agartala Municipal Corporation, it is laudable that proper waste management including composting initiatives has been adopted. However, the need for a formal and centralized system for segregating the waste generated ought to be adopted in the University which will then followed by composting. Solid-waste recycling is not practiced in the campus. Moreover, the practice of recycling is another avenue that requires immediate operationalization.

The organic wastes filled in the pits are subjected to composting which forms a best practice in the campus. In addition to the organic waste generated from different units, large sources of organic wastes other than kitchen wastes (University canteen, house hold) like leave litter, terrestrial weeds etc that are generated from maintain and cleaning the campus are collected during different periods of the year. These organic wastes are hard to degrade in the soil due to high content of lignin.



Fig. 3: Different organic wastes used for vermi-composting



Vermicomposting is the technology where with the use of locally available appropriate species of composting earthworms (*Perionyx excavatus*), huge amount of plant biomass produced in the University campus is reduced into available plant nutrient rich organic manure within a short time span. Thanks to Prof. Priyasankar Chaudhuri, Department of Zoology who has expertise and has been working in this field since many years.

Following collection of wastes from in and around the Tripura University Campus, the waste resources are dumped near the vermicomposting unit (basement of car parking area). The organic wastes to be processed by earthworms are chemically analysed to know their nutrient values. All the different types of wastes are mixed thoroughly and precomposted for 2-3 weeks. After precomposting precomposted substrates are loaded in the cemented vermicomposting tanks (15' × 1' × 0.75'). Locally available earthworms, *Perionyx excavatus* are then introduced in the composting tanks.

Following inoculation, the earthworms (*Perionyx excavatus*) through their feeding, burrowing and casting activities convert the organic wastes into manure called vermicompost within 45 days. Nutrient contents of original wastes and earthworm worked vermicompost are given in Table 5 and Table 6.

Table 5: Nutrient characteristics of different organic wastes

Parameters	C	BC	AC	MC	KW
pH	7.42	6.75	6.3	7.63	10.0
Electrical conductivity ($\mu\text{Mho cm}^{-1}$)	580.66	720.00	570.00	990.00	-
Organic Carbon (%)	17.14	19.52	19.83	20.37	36.8
Total Nitrogen (%)	1.26	1.52	1.82	3.08	3.49
Av. Phosphorus ($\text{mg } 100\text{g}^{-1}$)	147.39	48.97	26.15	163.71	0.89 % (Total P)
Av. Potassium ($\text{mg } 100\text{g}^{-1}$)	1000.00	937.33	1087.00	5962.00	2.18 % (Total K)

*C = Cow dung, BC = Bamboo - cow dung, AC = Acacia - cow dung, MC = Mikania - cow dung, KW = Kitchen waste

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Table 6: Plant nutrients in vermicompost (after 45 days) derived from organic wastes of University Campus

Parameters	C	BC	AC	MC	KW
pH	6.85	7.06	6.9	6.71	7.59
Electrical conductivity ($\mu\text{Mho cm}^{-1}$)	594.33	870.00	680.66	1387.00	-
Organic Carbon (%)	11.20	17.90	14.92	17.49	10.48
Total Nitrogen (%)	1.96	2.23	2.16	3.83	1.67
Av. Phosphorus ($\text{mg } 100\text{g}^{-1}$)	275.04	130.96	86.88	300.96	1.09% (Total P)
Av. Potassium ($\text{mg } 100\text{g}^{-1}$)	1175.00	1420.00	1589.00	7321.33	0.85% (Total K)

*C = Cow dung, BC = Bamboo - cow dung, AC = Acacia - cow dung, MC = Mikania - cow dung, KW = Kitchen waste

Out of the four cemented tanks, two tanks run at a time that generate 1500kg vermicompost (i.e. 750kg vermicompost/tank).

Vermicompost generated in the composting unit is applied to flower garden and Musambi garden of the University for sustainable agriculture.

Liquid waste management:

Liquid waste is generated from Science laboratories, Hostels, Residential quarters and canteen. Liquid wastes generated by the University are of two types:

1. Sewage waste
2. Laboratory, residential washing and canteen effluent.

The laboratory liquid is sent to soak pit and other liquid wastes are mainly drained to improve the ground level of water. University do not have any sewage treatment plant yet.

Biomedical waste management:

In Tripura University only few faculties use animal for their research purpose from where some biomedical waste is produced. Though the amount of waste is very negligible amount still the carcass of the animals is stored in the $-20\text{ }^{\circ}\text{C}$ for the time being. After sufficient amount of carcass stored university hand over to Agartala Municipal Corporation for Biomedical waste management.

E-waste management

Tripura University has very efficient mechanism to dispose E wastes generated from various sources. E-wastes are generated from computer laboratories, electronic labs, Physics Labs, Chemistry Lab, Biotech Labs, Academic and Administrative Offices.

The e-waste includes out of order equipments or obsolete items like lab instruments, circuits, desktops, laptops and accessories, printer, charging and network cables, Wi-fi devices, cartridges, sound systems, display units, UPS, Biometric Machine, scientific instruments etc. All these wastes are put to optimal use. All such equipment's which cannot be reused or

recycled is being disposed off through authorized vendors. Instead of a new procurement Buy-Back option is preferred for technology upgradation.

Hazardous Waste

In India, the Ministry of Environment, Forest and Climate Change, Government of India; is the agency to promulgate the Hazardous Waste (Management and Handling) Rules, 1989, under the provision of the Environment Protection Act, 1986. These rules were amended and new rules entitled “Hazardous waste (Management, Handling, and Trans-boundary Movement) Rules, 2008” were promulgated, which was further amended in the years 2009 & 2010 for proper management and handling of hazardous waste in the country (CPCB, 2010-2011). These regulations sometimes require detailed knowledge of the constituents and properties of waste streams so they can be managed properly.

Tripura University, like other entities that generate and manage hazardous wastes, is faced with a range of problems. The following features create hazardous waste management problems unique to the University:

- ❖ Most departments do not generate large quantities of hazardous waste and can be classified as conditionally exempt small quantity generators (generators of less than 100 grams of hazardous waste per month)
- ❖ Stakeholders are not adequately aware of the regulations that may apply to them, or they may have chosen to ignore the regulations, believing they do not have to comply.

During the audit it was noticed among the faculty members of Tripura University by the Environment Audit Committee, that majority of the stakeholders (> 90%) were confident about their understanding of hazardous waste and their obligation in disposing of materials.

Ideally, Handling, collection, and transportation and proper handling of chemicals begin with understanding the potential hazards related to their use. All stakeholders, especially from Academic Departments and laboratories should be responsible for disseminating information on hazardous materials being used in the facility. The dissemination of information can involve discussions on reactivity and possible health effects.

The survey carried out by Tripura University Environment Audit Committee revealed that despite having an understanding of hazardous waste; a majority of the respondents were uncertain of disposal of hazardous waste. Many respondents were not aware of the green initiatives which can be taken to manage hazardous waste.

It is evident that hazardous wastes which though is generated in very small quantity requires transportation off the university property, to an approved treatment facility. It is evident that there is no collection and management of waste across the campus, but improvements in the overall liquid waste is required to manage the handling and transportation of the generated waste to a treatment facility off the campus.

The university faces several obstacles to ensuring the disposal of hazardous wastes in an appropriate manner. These include the need for funds to pay for an outside handler and on-site coordinator to manage the waste management program. The large variety and small

quantities of wastes produced by the Academic Departments and the residential is also a manner of concern. Data from the survey indicates that household batteries such as alkaline batteries were most frequently disposed of as compared to household and office cleaners such as tiles and floor cleaners, pesticides, wood preservatives such as varnishes and paint products which are disposed in very low quantity. Caution must be taken while moving hazardous waste materials through campuses along public streets.

Observations

- ❖ Disposal of biomedical waste generated in the TU laboratories is not streamlined.
- ❖ The liquid hazardous waste generated in the laboratories required transportation to off campus disposal facility.

Suggestions and Recommendation

- ❖ The TU campus is to be declared as a plastic-free campus.
- ❖ The practice of using biodegradable materials should be encouraged as alternatives.
- ❖ Vermi-composting facilities could be expanded.
- ❖ A centralized system of recycling paper could be adopted.
- ❖ The incinerator can be installed in the campus.

Environmental quality audit

Air quality assessment

For air quality monitoring three parameters namely Particulate Matter (PM₁₀), Sulphur dioxide (SO₂), and nitrogen dioxide (NO₂) were considered for measurement in the University campus. PM₁₀ is suspended particulate matter, either solid or liquid, with a diameter of 10 micrometers or less, including smoke, dust, soot, salts, acids, and metals. Particulate matter can also be formed indirectly when gases emitted from motor vehicles and industries undergo chemical reactions in the atmosphere.

The air quality monitoring station was set up on the roof of the Laboratory of Chemistry building at the University premises using the services of Tripura State Pollution Control Board (TSPCB) (Fig. 4). Logistic considerations as easy accessibility, security, availability of reliable power supply etc. were examined before finalizing the locations. The air quality monitoring was conducted for 24 hour schedule in three shifts (8 hourly duration) at the monitoring station. The sampling procedures for measurement of PM_{2.5}, PM₁₀, NO₂ and SO₂ were made according to the internationally accepted standard technique through use of Respirable Dust Sampler (RDS) with gaseous sampling attachments and PM_{2.5} Sampler manufactured by M/s Environtech Instruments PVT. LTD., New Delhi.

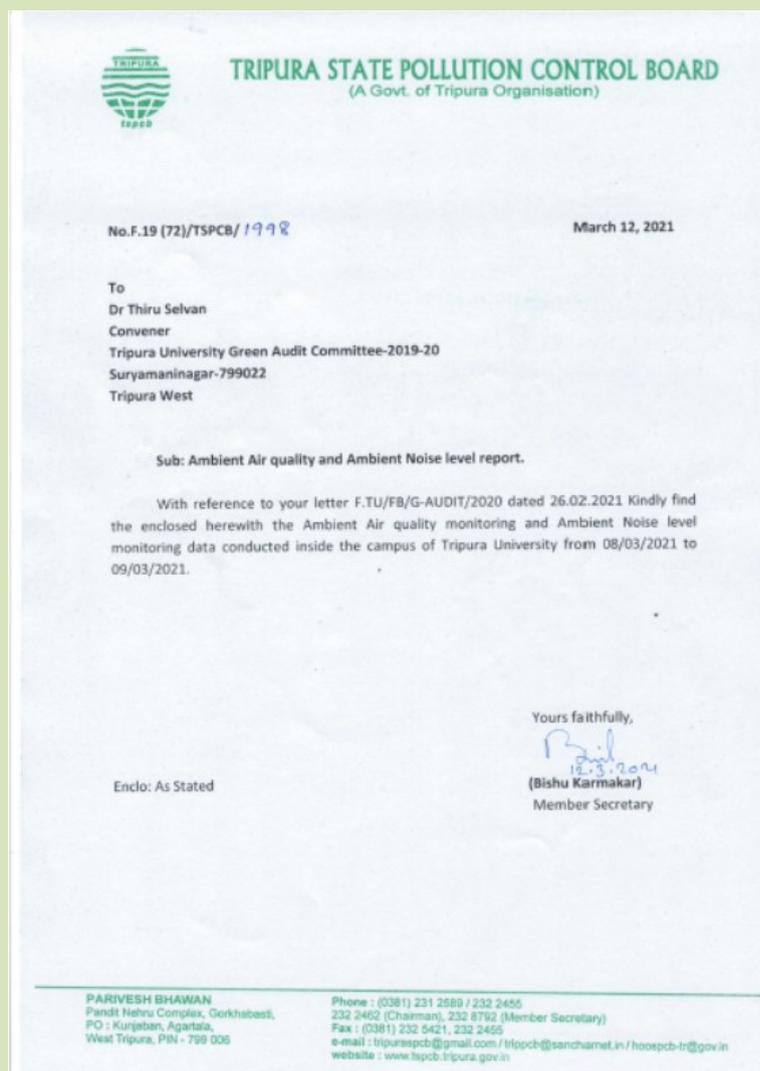


Fig. 4. Letter of Air quality and Noise level data recorded by TSPCB.

The Particulate matter PM_{10} was observed to be $58.7 \mu\text{g}/\text{m}^3$ and $PM_{2.5}$ was observed to be $48.93 \mu\text{g}/\text{m}^3$ Table 7, in the Tripura university campus which is lower than the permissible limits of CPCB Ambient Air Quality Standards of $100 \mu\text{g}/\text{m}^3$ and $60 \mu\text{g}/\text{m}^3$, respectively. In the University Campus, the major source of PM_{10} and $PM_{2.5}$ might be the dust from Vehicular traffic, construction, and burning.

SO_2 is the component of greatest concern and is used as the indicator for the larger group of gaseous sulphur oxides (SO_x). In the University Campus, the SO_2 concentration was observed to be $1.14 \mu\text{g}/\text{m}^3$ Table 7. This is much below the CPCB permissible limit of $80 \mu\text{g}/\text{m}^3$. So, the University campus can be called a zone which does not have SO_2 pollution. Moreover, the good luxuriant vegetation which is present in the university campus also contributes a lot to the absorption of SO_2 by plants.

NO_2 is the most prevalent form of NO_x in the atmosphere which is generated from different anthropogenic (human) activities. NO_2 is not only an important air pollutant by itself but also reacts in the atmosphere to form ozone (O_3) and acid rain. In the University campus, the

NO₂ was observed to be 5.08 µg/m³ Table 7. This is much below the CPCB ambient air Quality permissible limit of 80 µg/m³.

From the result in Table 7 it was observed that the value of PM_{2.5}, PM₁₀, NO₂ and SO₂ of air inside the Tripura University campus are within the prescribed standard limit of CPCB (Central Pollution Control Board, 2009).

Table 7: Status of ambient air quality in the campus of Tripura University

Pollutants	Time weighted Average	S-1	Standards (CPCB, 2009)	Method Used
Particulate matter (PM ₁₀) µg/m ³	24 Hours	58.7	100	Gravimetric
Particulate Matter (PM _{2.5}) µg/m ³	24 Hours	48.93	60	Gravimetric
Sulphur Dioxide (SO ₂) µg/m ³	24 Hours	1.14	80	Improved West and Geake
Nitrogen Dioxide (NO ₂) µg/m ³	24 Hours	5.08	80	Jacob & Hochheiser

In indoor environments people require fresh air because people spent most of the time inside the dwelling (Lingnel 2008, Ayanbimpe et al. 2010). According to Chadeganipour et al. (2010), all atmospheric air, whether indoor or outdoor, contains certain varieties of some fungal spores. Generally, outdoor air is the dominant source of indoor fungi (Shelton et al. 2002). Fungal spore concentration in outdoor environments consistently differs from indoor environments. Many aerobiological studies have been conducted for airborne fungal spores (Khandelwal 2008) but mainly from outdoor environments (Almina et al. 2019) but indoor environments are equally important because people spend most of their time indoor, punctuated by physicians (Portnoy et al. 2005). Nowadays fungal allergy is very common to people mainly those who spend most of the time indoor but it is difficult for diagnosis from the other type allergy due to fungi which are many and antigenically variable than the other allergens. The assessment of airborne fungal concentration was performed by Prof. Ajay Krishna Saha and his team of Scholars (Karmakar et al 2020) using sedimentation plate technique. Saboraud Dextrose Agar (SDA), Czapek-Dox Agar (CDA), Potato Dextrose Agar (PDA) and Malt Extract Agar (MEA) was prepared. The plates were exposed in indoor and outdoor environments of the Library, Canteen, Newly Constructed Building and Class Room. These plates were exposed for 5 minutes during the time in between hour 11 am to 5 pm after which they are sealed, labeled and transported to the laboratory. The culture plates were incubated at room temperatures (25°C) until growth appeared. Isolates were identified based on the standard texts and keys (Ellis 1971, Domsch et al. 1980, Watanabe 2002).

A total of 132 colonies (Table 8) were found comprising of 18 genera. The dominant fungal genera were *Alternaria* sp. (9.85%), *Aspergillus* sp (43.18%), *Cladosporium* sp (7.58%), *Curvularia* sp (3.03%), *Fusarium* sp (6.06%), *Penicillium* sp (18.18%) and *Trichoderma* sp (3.79%).

In this present study it was found that the number of fungal isolates was maximum in outdoor (68) compare than indoor (64) in Table 8. *Aspergillus* sp., *Penicillium* sp.,

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Alternaria sp., *Cladosporium sp.*, *Fusarium sp.* Were isolated both from indoor and outdoor environments. *Phoma sp.*, *Torula sp.*, *Nigrospora sp.*, *Geotrichum sp.* and Unidentified sp. (1) were isolated from indoor-environments. *Monilia sp.*, *Rhizopus sp.*, *Pythium sp.*, *Acremonium sp.*, Unidentified sp. (2), Unidentified sp. (3) and *Trichoderma sp.* were isolated from outdoor environments. The no. of isolated fungal genera highest in M.Sc. classroom (indoor-outdoor=41) and lowest in Library (indoor-outdoor=26). The highest concentration of fungi observed in July and August.

Table 8. Percentage of fungal isolate from indoor and outside environment in TU Campus

Fungal genera	CR		L		C		NCB		I		O		Total Isolate	Grand Total %
	I	O	I	O	I	O	I	O	Total Isolate	Total %	Total Isolate	Total %		
<i>Acremonium sp</i>	0	0	0	0	0	0	0	1	0	0.00	1	1.47	1	0.76
<i>Alternaria sp</i>	3	4	3	3	0	0	0	0	6	9.38	7	10.29	13	9.85
<i>Aspergillus sp</i>	5	5	7	6	10	5	12	7	34	53.13	23	33.82	57	43.18
<i>Cladosporium sp</i>	0	0	0	0	1	4	2	3	3	4.69	7	10.29	10	7.58
<i>Curvularia sp</i>	3	0	1	0	0	0	0	0	4	6.25	0	0.00	4	3.03
<i>Fusarium sp</i>	4	1	0	0	1	2	0	0	5	7.81	3	4.41	8	6.06
<i>Monilia sp</i>	0	1	0	0	0	0	0	0	0	0.00	1	1.47	1	0.76
<i>Nigrospora sp</i>	0	0	0	0	0	0	1	0	1	1.56	0	0.00	1	0.76
<i>Geotrichum sp</i>	0	0	0	0	1	0	0	0	1	1.56	0	0.00	1	0.76
<i>Penicillium sp</i>	1	9	2	4	0	0	4	4	7	10.94	17	25.00	24	18.18
<i>Phoma sp</i>	0	0	0	0	1	0	0	0	1	1.56	0	0.00	1	0.76
<i>Pythium sp</i>	0	1	0	0	0	0	0	0	0	0.00	1	1.47	1	0.76
<i>Rhizopus sp</i>	0	1	0	0	0	0	0	0	0	0.00	1	1.47	1	0.76
<i>Torula sp</i>	1	0	0	0	0	0	0	0	1	1.56	0	0.00	1	0.76
<i>Trichoderma sp</i>	0	2	0	0	0	3	0	0	0	0.00	5	7.35	5	3.79
Unidentified sp. 1	0	0	0	0	1	0	0	0	1	1.56	0	0.00	1	0.76
Unidentified sp. 2	0	0	0	0	0	0	0	1	0	0.00	1	1.47	1	0.76
Unidentified sp. 3	0	0	0	0	0	0	0	1	0	0.00	1	1.47	1	0.76
Total Isolates	17	24	13	13	15	14	19	17	64	-	68	-	132	-

Note: I= Indoor; O= Outdoor; CR- Classroom; L- Library; C- Canteen; NCB- Newly Constructed Building.

It was concluded that proper and periodic maintenance of working environments involving frequent cleaning, disposal of accumulated wastes, setting up of modern infrastructure facilities, application of fumigants/fungicides and use of dust masks while working can certainly help to improve the air quality and reduce the allergic incidence to people who work in such environments.

The knowledge of the atmospheric pollen presence found in different regions is of great interest for clinicians and allergic patients (Kobzar, 1999). Although the atmosphere consists of a large number of pollen grains, only a few of them are responsible for allergic manifestations (Singh and Kumar, 2004). The composition of airborne pollen in a specific region depends on its characteristic vegetation and meteorological conditions (Gracia-Mozo et al 2006; Latorre, 1999). A study was carried out by Prof. Badal K Datta and his team, from the Department of Botany revealed that the pollen grains of 43 types belonging to 29 families were identified from the atmosphere of Tripura University Campus of which 10 are well known allergens. On the basis of pollen concentration in the air, it was noticed that maximum number of pollen grains was found in March-April (184 and 218) and minimum in July and September. Cyperaceae, Poaceae, *Eucalyptus globulus* and *Lantana camara* pollens were recorded almost throughout the year. Pollen of *Acacia auriculiformis*, *Coccinia grandis*, *Flacourtia jangomus*, *Tectona grandis*, and *Oldenlandia sp.* were present only in

spring in very low concentration. Pollen of *Amaranthus/ Chenopodium* was trapped in very lower amounts throughout the year.

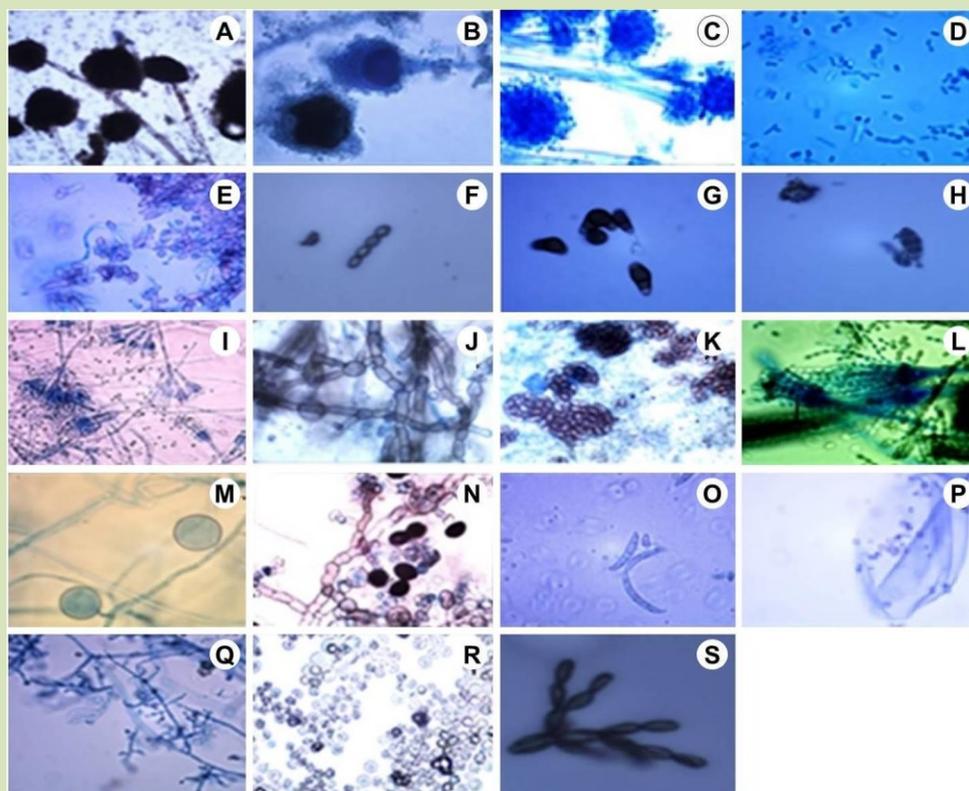


Fig 5. Air-fungal species from outdoor and indoor environments of Tripura: A–C, *Aspergillus* sp.; D, *Geotrichum* sp.; E, *Cladosporium* sp.; F, *Torula* sp.; G, *Curvularia* sp.; H, *Alternaria* sp.; I, *Penicillium* sp.; J, *Phoma* sp.; K, *Acremonium* sp.; L, Unidentified sp. 1; M, *Pythium* sp.; N, *Nigrospora* sp.; O, *Fusarium* sp.; P, *Rhizopus* sp.; Q, *Trichoderma* sp.; R, Unidentified sp. 2; S, *Monilia* sp.

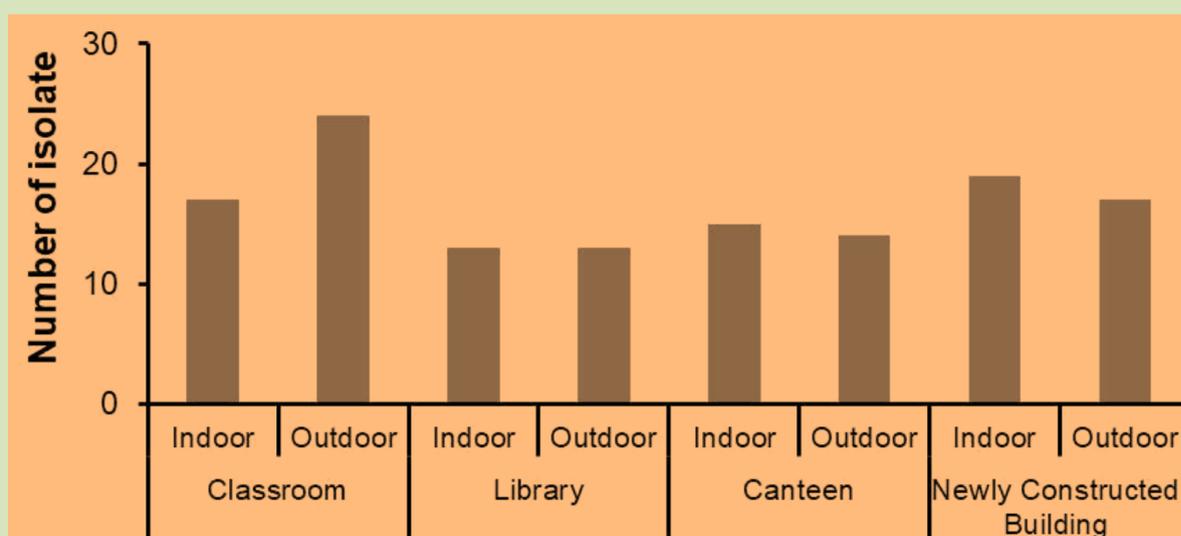


Fig 6. Number of isolated fungal genera from four selected sites.

Vehicular movements

It was estimated that on an average around 400 nos. of two wheelers and 110 nos of four-wheeler vehicles (including vehicles coming to Bank & Post Office) visited TU Campus in general days per month excluding the vehicles of campus dwellers. The University has two designated parking places. Except 30 percent of the vehicles, rest are visiting for a while.

Ambient Noise Levels

Under the Air (Prevention and Control of Pollution) Act, 1981, noise is regarded as a pollutant. There are two major settings where noise mostly occurs; these are - community noise and industrial noise. Community noise is also called environmental noise and is defined as the noise emitted from all the sources except the noise from the industrial sources. As far as community noise is concerned the WHO guidelines recommend less than 30 dB(A) in bedrooms during the night which is essential for good quality sleep. Again, it should be less than 35 dB(A) in classrooms which is important for good teaching and learning conditions.

The noise level monitoring was carried out to assess the equivalent noise level (Leq) around the Tripura University campus both in the day time and night time. Sound Level Meters CR: 1710 (Class-1) was used for monitoring of noise levels. The noise levels were monitored at least for 20 minutes at each location. The noise monitoring was carried out at the 8 (Eight) locations inside the University campus.

Table 9: Ambient Noise Levels within T.U. Campus

Sl. No.	Location	Measured Noise Level at Day Time Leq dB(A)	Standard at Day Time for Sensitive Zone Leq dB(A)	Measured Noise level at Day Time Leq dB(A)	Standard at Night Time for Sensitive Zone Leq dB(A)
1	Residential Complex	48.3	50	39.7	40
2	PG Gent's Hostel	49.3	50	38.7	40
3	In Front of Geography Department	48.5	50	33.7	40
4	Near Administrative Building-1	51.3	50	41.7	40
5	Near Administrative Building-2	62.5		31.3	
6	PG Girl's Hostel	40.9	50	41.6	40
7	In Front of Library	55.5	50	44.6	40
8	In Front of Bank	59.6	50	51.2	40

From the data obtained Table 9, it was observed that the ambient noise levels in four locations viz. near administrative building -1, administrative building- 2, in front of library building and in front of bank of Tripura University is faintly beyond the prescribed standard limit during the peak hours. Ambient noise levels for rest of the four locations are well within the prescribed standard limit during day and night time. The exceeding of maximum permissible limits in these areas can be attributed to the noise emerging from vehicular movements and traffic-related noises along the National Highway/other roads along with the University campus. The noise levels were high in the administrative areas because of obvious reasons of the congregation of a large number of stakeholders for official works along with large no. of vehicular movement in and out of the building area. In most of the other sampling stations, the Leq levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the permissible levels.

However, it is important to note that the average noise level, considering all sampling stations within the campus, was higher than the maximum permissible limit of 50db(A) as recommended by the CPCB for all the location nearing the boundary. Although the Leq levels are high outside the atmosphere of the classrooms are quite calm and should be below the WHO recommended value of 35 dB(A) which is suitable for classroom teaching-learning environment.

Observations

- ❖ It is estimated that > 60 percent of campus dwellers walk within the campus.
- ❖ Noise is a disturbing factor on campus, particularly along the national highway, and within the campus during all India Examinations and Admission periods.

Suggestions and Recommendations

- ❖ Students and staff should be encouraged to use bicycle.
- ❖ The vehicular account should be maintained for the campus dwellers and staff members.
- ❖ Noise attenuation has to be done by planting vegetation around buildings and along Highway.
- ❖ Govt. authorities are requested to monitor the use of loudspeaker and noise producing sources within the 100m radius outside the University campus in compliance with prescribed rules.

Summary

Environmental auditing is the process of assessing and determining the extent to which the practices of an institution align with eco-friendly and sustainable principles. In this context, Tripura University conducted its Environmental Audit for the year 2020-2021 with the central objective of evaluating the institution's environmentally conscious practices and producing a comprehensive audit report.

The process of environmental auditing commenced by evaluating the institution's waste management protocols, water consumption practices, among others. The audit team systematically assessed various facilities within the university campus, measuring elements like water usage and identifying associated consumption patterns and their environmental impacts. Inputs from staff and students were gathered through inquiries to gain insights into usage habits. Data collection was achieved through on-site visits and direct measurements in different sectors such as water and waste. To gauge the ambient quality of the campus environment, standard protocols for environmental monitoring were employed. The amassed data were meticulously collated and analyzed to formulate this comprehensive environmental audit report for Tripura University.

The present survey revealed a total of 97 acres of land of which of which 75 acres existed as a part of the main campus and an additional area of 22 acres was added to the total area during 2015.

Water auditing was conducted for the evaluation of facilities of raw water intake and determining the facilities for water treatment and reuse. The potable water quality is within the standard limits. The daily use of the water during 2020-2021 was approx. 431000 L per day. TU does not have a reusable water treatment facility for wastewater generated from Academic buildings, administrative buildings, library, residential quarters, guest houses, hostels, laboratories, canteen, etc. and thus require attention. The stake holders of the residential quarters of Tripura University specially re-use the grey water which is obtained from the various domestic activities for gardening and vegetable fields etc. Also, water recycling is done as per the direction of the competent authority in broader scale as and when required. Tripura University is blessed with a natural large water body measuring inside its premises. Naturally, this large lake serves the main purpose of rain water harvesting. Rainwater harvesting systems could be improved so that there is a facility available in every building for reusing of water.

The waste collection and disposal were reviewed and the best way to combat the problems was suggested. On an average, various stakeholders generate about 500 Kg of different types of solid waste per week respectively. Investigations revealed that 45 Academic Departments of the University have a total of 180 numbers of indoor dustbins installed for solid-waste disposals. On an average, each of these departments has a provision of about 5 dustbins. The teacher's quarters maintain on an average one personal dustbin for solid-wastes disposals and a pit for the dumping of organic wastes. 40% of the Academic Departments and 50% of residential quarters maintain separate disposal systems for dry and wet waste. For all the academic departments, administrative office, residential quarter/hostels/guest house and canteens 90 % of the accumulated solid waste excluding the ones which are dumped in the pits is lifted by Agartala Municipal Corporation (AMC) every two days, which is then segregated and land filled while for the rest is composted. While the centralized system of

solid-waste management involves timely and periodic lifting of the disposed of wastes by the Agartala Municipal Corporation, it is laudable that proper waste management including composting initiatives has been adopted. The organic wastes filled in the pits are subjected to composting which forms a best practice in the campus.

During the audit it was noticed among the faculty members of Tripura University by the Audit Committee, that majority of the stakeholders (> 90%) were confident about their understanding of hazardous waste and their obligation in disposing of materials. It is evident that hazardous wastes which though is generated in very small quantity requires transportation off the university property, to an approved treatment facility. It is evident that there is no collection and management of waste across the campus, but improvements in the overall liquid waste is required to manage the handling and transportation of the generated waste to a treatment facility off the campus. The laboratory liquid is sent to soak pit and other liquid wastes are mainly drained to improve the ground level of water. University do not have any sewage treatment plant yet. Tripura University has very efficient mechanism to dispose E wastes generated from various sources. All these wastes are put to optimal use. All such equipment's which cannot be reused or recycled is being disposed off through authorized vendors. Instead of a new procurement Buy-Back option is preferred for technology upgradation. Most departments do not generate large quantities of hazardous waste and can be classified as conditionally exempt small quantity generators (generators of less than 100 grams of hazardous waste per month). It is evident that hazardous wastes which though is generated in very small quantity requires transportation off the university property, to an approved treatment facility.

The air quality monitoring was conducted for 24-hour schedule in three shifts (8 hourly duration) at the monitoring station. The sampling procedures for measurement of PM_{2.5}, PM₁₀, NO₂ and SO₂ were made according to the internationally accepted standard technique. The Particulate matter PM₁₀ was observed to be 58.7 µg/m³ and PM_{2.5} was observed to be 48.93 µg/m³ in the Tripura university campus which is lower than the permissible limits of CPCB Ambient Air Quality Standards of 100 µg/m³ and 60 µg/m³, respectively. In the University Campus, the major source of PM₁₀ and PM_{2.5} might be the dust from Vehicular traffic, construction, and burning. In the University Campus, the SO₂ concentration was observed to be 1.14 µg/m³. This is much below the CPCB permissible limit of 80 µg/m³. Moreover, the good luxuriant vegetation which is present in the university campus also contributes a lot to the absorption of SO₂ by plants. In the University campus, the NO₂ was observed to be 5.08 µg/m³. This is much below the CPCB ambient air Quality permissible limit of 80 µg/m³. It was estimated that on an average around 400 nos. of two wheelers and 110 nos of four-wheeler vehicles (including vehicles coming to Bank & Post Office) visited TU Campus in general days per month excluding the vehicles of campus dwellers. The noise level monitoring was carried out to assess the equivalent noise level (Leq) around the Tripura University campus both in the day time and night time.

It was observed that the ambient noise levels in four locations viz. near administrative building -1, administrative building- 2, in front of library building and in front of bank of Tripura University is faintly beyond the prescribed standard limit during the peak hours. Ambient noise levels for rest of the four locations are well within the prescribed standard limit during day and night time. The noise levels were high in the administrative areas because of obvious reasons of the congregation of a large number of stakeholders for official works along with large no. of vehicular movement in and out of the building area. In most of

the other sampling stations, the Leq levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the permissible levels.

Finally, it can be concluded that the Environment Audit Report-2020-21 will help in assisting the process of an ecofriendly approach to the sustainable development of the Tripura University Campus. The observation, suggestions and recommendations specified at every section will guide the university authority in formulating suitable policy for the university so as to improve the quality of environment within the Tripura university campus by defining its goal such that the concerted efforts can bring about an impact at the global level.



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