



# North-Eastern Hill University

## Department of Botany

### Prof. Uma Shankar

MSc, PhD, INSA-YS, CSTUP-YS, FNIE,  
FISEB, LEAP (NIEPA & Oxford)

### Current Designation

Professor of Botany

### Career

College Topper in I.Sc. 1983  
College Topper in M.Sc. 1987  
Topper in PGD-TACP, NEHU 1989  
Ph.D. in Botany, NEHU 1991-92  
Research Associate, TERI 1992-1997  
Scientist, GBPIHED-MoEF 1997-2002  
Reader in Botany, NEHU 2002-2005  
Associate Professor, NEHU 2006-09  
Professor of Botany, NEHU 2009-...  
Head, Department of Botany 2016-19

### Awards and Honours

INSA Young Scientist Award 1999  
CSTUP Young Scientist Award 2002  
DST's BOYSCAST Fellow 2003  
Fellow of Nat. Inst. of Ecology 2006  
DBT Overseas Associate Award 2011  
EET-CRS Top List Award 2018  
INSA-CAS BEP Award 2018  
Fellow of Int. Soc. Env. Biol. 2018  
Member, RAC, BSIP, Lucknow 2018-21  
Member, AICOPTAX, MoEFCC 2018-21

### Mailing address

Department of Botany  
North-Eastern Hill University  
Mawkynroh-Umshing  
Shillong, ML 793 022, India

### Contact

Tel: +91 364 272 2221 / 2247  
Mobile: +91 94363 03990  
e-mail: [arshuma@yahoo.com](mailto:arshuma@yahoo.com)  
Website: [www.nehu.ac.in](http://www.nehu.ac.in)

### Click for

[NEHU Web Page](#)  
[Research Gate Profile](#)  
[Google Scholar Profile](#)

March 27, 2021

Ref. F.TU/FB/G-AUDIT/2020/ dated 26/03/2021

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that the first ever Green Audit Report 2019-20 of Tripura University is an original internal audit work conducted by the Green Audit Committee to monitor the environmental management practices adopted in the University which is in line with the terms of the International Standards of Internal Auditing.

After going through the report, it is obvious that adequate and appropriate audit procedures were followed for Environmental Quality Audit, Water Audit, Waste Disposal Audit, Health Audit, Energy Audit and Biodiversity Audit, and the gathered evidences support the conclusions reached and contained in this report.

The suggestions and recommendations prescribed and the conclusions derived are quite genuine and within the achievable limits, and I understand that Tripura University is competent to fulfil those to meet the Sustainable Development Goals.

I recommend and firmly believe that this report meets the requirement prescribed for development of a Green Campus.

(Uma Shankar)  
Professor of Botany





## **GREEN AUDIT REPORT- 2019-2020**



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





प्रो. गंगा प्रसाद प्रसाई  
कुलपति

**Prof. Ganga Prasad Prasain**  
Vice-Chancellor

त्रिपुरा विश्वविद्यालय  
(केन्द्रीय विश्वविद्यालय)  
सूर्यमणिनगर-799022, त्रिपुरा, भारत

**Tripura University**  
(A Central University)  
Suryamaninagar-799022, Tripura, India



### Foreword from Vice Chancellor

Presently there are many environmental problems being faced globally and it is increasingly recognized that it is leading to the situation of climate change. 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 Audit is one such step which is taken up by Tripura University in this direction to record, document, analyze and report the diverse environmental 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 am very happy to write the foreword for this Green Audit Report 2019-2020 of Tripura University, Suryamaninagar. It is my pleasure to recognize the sincere efforts of the Green Audit Committee led by Prof. Ranendu Kumar Nath, Department of Chemistry, Tripura University for their best efforts in preparing this comprehensive report. I do hope that the Green Audit Report-2019-2020 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.

  
22.03.2021

(Prof. Ganga Prasad Prasain)

## Acknowledgement

Tripura University has been working at the forefront since its inception by conducting environmental campaigns, workshops and other extension activities to bring about social change for national and international development. Tripura University is aware the needs of the green audit for the maintenance and future development of the University. In its pursuit of excellence, Tripura University has recognized itself to improve the environmental quality and maintain its unique pristine ecosystem for the future generation of students and all the inhabitants of the campus. Although we have been taking a number of steps to conserve and protect our environment but this report of 2019-2020 is the first formal effort to document the results of our investigation and interpret the information of all the required parameters of the Green audit process. Tripura University aims to take up the policy and efforts at every level to avert ecological catastrophe on a global scale by supporting the climate neutrality goals committed by the Government of India. As a part of this, efforts are taken to continuously monitor the sustainability of the academic process by constituting this Green Audit Committee consisting of faculty members working in this arena to collect basic data of the environmental parameters within the campus so that the environmental issues are resolved within the campus. The Green Audit Committee has tried to identify the current / emerging environmental issues so as to monitor the environmental management practices adopted in the University along with subsequent impact of these on the university environment.

This report is an outcome of efforts of each and every member of Tripura University Green Audit Committee who undertook this green audit to gather information on every parameters of the environment, compiled and analyzed the data to recognize the immediate and serious threats within the campus so that opportunities can be explored to bring about continuous improvement in our environmental performance and standards by our suggestions and recommendations put forth. It is hoped that this report will receive adequate attention of all the stake holders for pursuing a bottom-up approach in which we stand to face the challenges in future.

The sincere encouragement and administrative support of Prof. Ganga Prasad Prasain, Hon'ble Vice Chancellor of Tripura University during the conduct of the study has been a guiding force and I on behalf of the Green Audit Committee-2019-2020 express my heartfelt gratitude to Hon'ble Vice Chancellor for his kind gesture. I am indebted to the Registrar, Deans, HoDs, Teachers, officers, all staff members and all the campus dwellers of Tripura University for their kind support in collating data for the report. Special thanks are due to Prof. B K Agarwala, Chairman, Tripura Pollution Control Board for providing support to conduct the Air Quality assessment; Prof. Badal Kumar Datta and his research team for Floral Diversity; Prof. Priyashankar Chaudhuri and his research team for his initiate on Bio-waste management; Prof. Ajay Krishna Saha on Environmental Quality, Dr Sourabh Deb and his research team on Biodiversity and Water parameters, Er. Harjeet Nath and his research team on water quality and Er. Krishna Das, Executive Engineer and his team for basic data on the campus. At last but not the least, I would like to offer my heartfelt thanks to all the members and convener of the Tripura University Green Audit Committee -2019-20 for their untiring efforts in compiling the report.

I sincerely hope and believe that the efforts made by the present Green 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. Ranendu Kumar Nath  
Chairman

**Tripura University Green Audit Committee  
2019-2020**

**Chairman:**

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

**Members:**

Prof. B K Datta, Department of Botany, Tripura University- Member

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

Prof. Swapan Majumdar, Department of Chemistry, Tripura University- Member

Prof. P S Chaudhuri, Department of Zoology, Tripura University- Member

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

Dr Sabyasachi Dasgupta, Associate professor, Department of Forestry and Biodiversity, - Member Tripura University

Dr. Panna Das, Assistant Professor, Department of Botany, Tripura University - Member

Dr. Gobinda Gopal Khan, Assistant Professor, Department of Material Science, Tripura - Member University

Dr. S S Singh, Assistant Professor, Department of Zoology, Tripura University - Member

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

Dr. Jupiter Chakma, Medical Officer, Tripura University- Member

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

## **CONTENTS**

<b>Sl. No.</b>	<b>Title</b>	<b>Page No.</b>
<b>1</b>	<b>Foreword</b>	<b>-</b>
<b>2</b>	<b>Acknowledgement</b>	<b>-</b>
<b>3</b>	<b>Introduction</b>	<b>01</b>
<b>4</b>	<b>Methodology adopted</b>	<b>03</b>
<b>5</b>	<b>Audit stage</b>	<b>03</b>
<b>6</b>	<b>Post audit stage</b>	<b>04</b>
<b>7</b>	<b>Land use and land cover</b>	<b>04</b>
<b>8</b>	<b>Water Audit</b>	<b>06</b>
<b>9</b>	<b>Waste disposal audit</b>	<b>11</b>
<b>10</b>	<b>Health audit</b>	<b>17</b>
<b>11</b>	<b>Energy audit</b>	<b>19</b>
<b>12</b>	<b>Environmental quality audit</b>	<b>22</b>
<b>13</b>	<b>Biodiversity audit</b>	<b>28</b>
<b>14</b>	<b>Summary</b>	<b>35</b>

## Introduction

Tripura University, the offspring of the world-famous Calcutta University since its inception as a State University on 2nd October, 1987 has been engaged in its pursuit of academic excellence in this remotest and landlocked part of the country. The University was established in the erstwhile CUPGC in a green 75-acre, semi-urban setting on the National Highway at Suryamaninagar (23°45'40"N; 91°15'58"E), about 9 kms south of the capital city Agartala. It is one of the 49 Central Universities in India which has been established on 2<sup>nd</sup> July, 2007 under an Act of the Parliament to establish a teaching and affiliating university in the state of Tripura and to provide for matters connected therewith or incidental thereto. Tripura University has developed considerably and efforts were taken to strengthen the infrastructural facilities in the academic arena vis-à-vis the overall development of the University.

The University at present runs various programs under Science, Arts & Commerce Faculty. A total number of 58 programmes are offered under this University, including Under Graduate, Post Graduate Diploma and other Post Graduate Programs. In addition to these, Ph.D programmes are also offered in 38 subjects. More than 4000 students are enrolled in the campus during the academic year pursuing different. The University also encourages cutting edge research experiences in different science and technology disciplines. Notwithstanding its marginal location and other communicational disadvantages, this university has always tried to compete with other universities of the country in terms of academic achievement, research and innovation and placement records, which have been well reflected in its NAAC Assessments and NIRF ranking.

The University has 46 Departments and every Department has state of the art classrooms, laboratories, 24-hours internet connectivity, computer centre, library, free Wi-Fi facility across the Campus, playgrounds, open theatre, health centre, bank, Cafeteria, post office, food court, hostels, guest house etc. The teaching faculties are dynamic, caring and friendly. Academic & curricular sessions are regularly complemented with sports and other socio-cultural activities like film screening, musical performances, art festivals, debates, intra-University fetes, sports tournaments, walkathons etc. Tripura University offers a vibrant campus life and one of the safest and most secure academic environments in the entire Northeast.

The Campus has a vast scenic landscape with lakes, forests, hillocks and flower and fruit gardens offering a serene and tranquil backdrop. The groves of trees, fragrance of flora, calls of flocks of birds, swarm of butterflies, reptiles etc. ease away the drudgery of academics, thereby relaxing and rejuvenating a student's mind.

## Green Audit at Tripura University

The policy of most of the Governments world over is to have a policy which can enhance labour productivity and economic growth through accumulation of human capital. The development



of the work force can largely be influenced by improving the knowledge and skills of the work force which in turn influence the future well-being of the nation with considerable gains in GDP. This has led governments to devote huge resources in improving the educational standards of its Citizens and Tripura University has also meticulously worked in on these lines to bring about a change. With the increasing cutting-edge research experiences in different science and technology disciplines there has been development and growth of Tripura University also which has led to increasing carbon footprints. The policy of the Government of India under the leadership of our Honourable PM Shri. Narendra Modi Ji has also been in this direction, by declaring the mission of 'Swachh Bharat Abhiyan', whose voice resonates with the message of "Green Campus, Clean Campus" mission launched by the University Grants Commission for all higher educational institutes. The National Assessment and Accreditation Council (NAAC), which is an autonomous body funded by the University Grants Commission of Government of India, has made 'Environmental Consciousness' mandatory criterion (Criterion VII) for grading educational institutes.

At present Tripura has been pursuing the policy of Sustainable development and at this juncture green audit becomes part and parcel of management of the campus with due scope to take up academic activities within the close circles of environmental conservation and management.

Green auditing is the process of identifying and determining whether the practices taken up at Tripura University are eco-friendly and sustainable. It is an effective ecological tool that helps to create a culture of sustainability by implementing it through regular identification, quantification, documenting, reporting and monitoring of environmentally important components. Green auditing will thus help in preserving the rich floral and faunal diversity in and around the campus; garnering interest and creating awareness among the stakeholders in future.

Tripura University is committed to responsible stewardship of resources and to demonstrate leadership in sustainable academic practices. The University supports the climate neutrality goals as outlined by the Government of India and thus will monitor the sustainability of the research and education mission through the Green Audit Committee.

The policy goals of the Tripura University Green Audit are:

- ❖ Identification and documentation of the strengths and areas of improvement within sustainable operations of administrative, academic and research laboratories via gap analysis, and outlining actions that can be implemented to further targets.
- ❖ Increase environmental awareness throughout campus and motivate all stakeholders for optimized sustainable use of available resources.
- ❖ The importance of the program is to collect baseline data of environmental parameters and resolve the environmental issue before they become a problem.



To achieve the aforementioned goals, Tripura University Green Audit Committee endeavours towards the following objectives:

- To identify current and emerging environmental issues.
- To monitor environmental management practices.
- To examine the current practices that can impact the environment.
- To create awareness among the various stakeholders of the University.
- To prepare a Green Audit Report on green practices followed by different Departments, support services and administration.

### **METHODOLOGY ADOPTED**

The methodology adopted to conduct the Green Audit of Tripura University will have the following components:

- ❖ Onsite field visits were conducted by the Green Audit Team as and when necessary.
- ❖ Enquiries were conducted amongst different stakeholders to know about the various components in connection with water use, energy consumption and waste disposal, etc.
- ❖ The water quality analysis was done using standard protocols.
- ❖ GIS tools were used to prepare the map of the campus for LULC survey.
- ❖ 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.
- ❖ Different standard protocols were followed to document and estimate the floral and faunal account.

### **AUDIT STAGE**

Tripura University started its green audit by assessing the green cover followed by looking into all the aspects which have been a part of the green audit viz. recording the land use and land cover (LULC), water availability and usage, waste generate and their management practices, recording of the environmental parameters, energy consumption and conservation strategies, etc. The members of the audit team recorded the different facilities at the Tripura University campus, determined different types of appliances and utilities (Water cooler, taps, toilets, lights, fan, ACs etc.) as well as measured the usage per item (Watts indicated on the appliance or measuring water from a tap) and identified the relevant consumption patterns (such as how often an appliance is being used) 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, biodiversity status. 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 a matter of concern that the wetland has been observed to be silted up and presently some of the area of the lake is under a thick cover of grass and aquatic weeds.

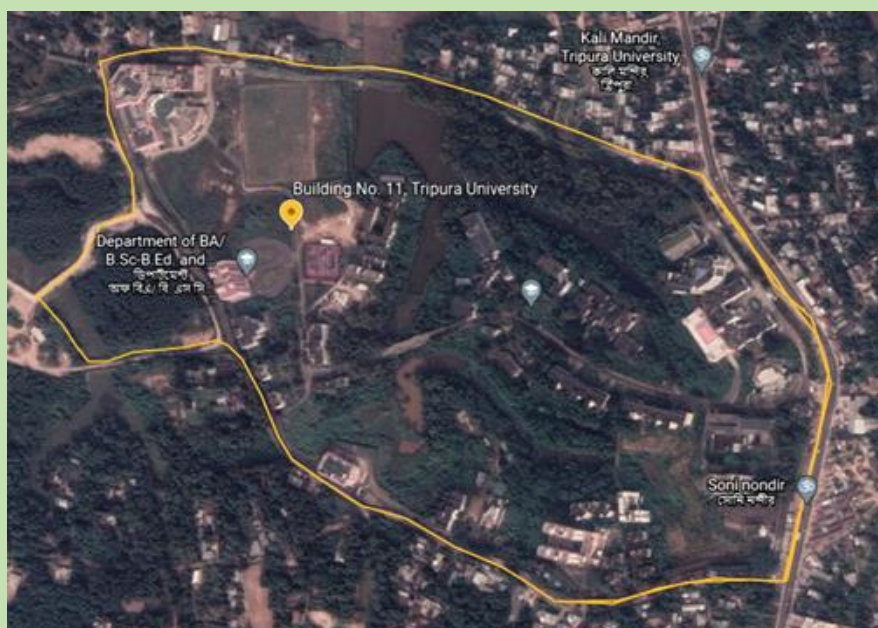


Fig 1: The Map of Tripura University campus

## GREEN AUDIT REPORT-2019-2020

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. In absence of available high ground, the wetland is being filled up for new constructions. 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.

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

### Observations

- ❖ The vegetation areas are found to be reducing over the years due to the coming up of new buildings.
- ❖ Occurrence of dense weed growth is a common feature after the rains and so the area is being cleaned every year in order to give a aesthetic look of the campus.
- ❖ Roadside avenue trees lack attention.



- ❖ Drainage links were found to be missing.

**Suggestions and Recommendations**

- ❖ Future plans of construction and activities should be based on the Landscape.
- ❖ Botanical Garden and Forest Park, Wetland (Lake area), Orchards and Jungle Area needs to be conserved as carbon sink.
- ❖ The trees planted needs to be managed regularly.

**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 during 2019-2020 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

## GREEN AUDIT REPORT-2019-2020

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 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 maintain 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

## GREEN AUDIT REPORT-2019-2020

Mr. Harjeet Nath (Assistant Professor, Chemical and Polymer Engg.) has developed a water purification system operated by Solar energy. The system is estimated to provide 400 litres of pure water per day at affordable price. The department will use this energy efficient and sustainable system for purification of laboratory's waste water. A patent has been filed by Mr. Nath to patent this technology (Patent Details: "Water Purification System" IPO (Indian Patent) with Application Number TEMP/E-1/54944/2019-KOL dated 14/12/2019)



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.

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)
<b>Raw Water</b>	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
<b>Drinking water</b>	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
<b>Raw Feed Water</b>	Feed underground water	52	6.2-6.5	10-22	0.4-0.7	-	-	-
<b>Treated Water</b>	Iron Removal Plant cum oxidation and mixing chamber	59	6.3-6.6	0.8-3	-	-	-	-



### Tripura University Lake Water Quality

The seasonal water quality of the lake was studied by Ms. Khushboo Prajapati, M.Sc. student of Forestry and Biodiversity Department during her Master’s research programme in 2019. The physico-chemical parameters were compared with the standards given by the Bureau of Indian Standards (BIS) and World Health Organization (WHO) for drinking and pisciculture standard given by ICAR-RC-NEH region (Table 4). It showed that almost all the parameters were below the standard drinking water quality, but the concentration of DO and Calcium hardness was found above the desirable limits. For pisciculture purpose, the parameters like free carbon dioxide, DO, TH and ammonia was higher than the ideal value which may increase the mortality rate of the fishes.

Table 4: Seasonal Water quality of Tripura University lake

Sl. No.	Parameters	Seasons			Drinking		Fish
		Monsoon Mean ± SE	Winter Mean ± SE	Summer Mean ± SE	BIS	WHO	ICAR
1	Temp °C	31.45 ± 0.11	19.05 ± 0.45	33.4 ± 0.21	-	-	-
2	EC (mhos/cm)	1.62 ± 0.02	1.42 ± 0.01	1.16 ± 0.02	-	-	-
3	Total suspended solid	20.38 ± 1.07	27.63 ± 1.80	29.25 ± 1.66	75	≤ 30	-
4	Total Dissolved Solids	215.75 ± 1.33	304.12 ± 1.76	319.13 ± 2.43	500	500	-
5	pH	7.58 ± 0.04	7.78 ± 0.06	6.91 ± 0.01	6.5-9.2	6.5-8.5	6.7-9.5
6	Total Alkalinity (mg/l)	148.43 ± 2.50	101.67 ± 2.34	167.57 ± 3.05	200	120	50-300
7	Chloride	56.80 ± 2.37	88.75 ± 2.17	128.98 ± 2.97	250	250	-
8	Free CO <sub>2</sub>	5.68 ± 0.41	5.5 ± 0.72	7.7 ± 0.57	-	-	5
9	Total CO <sub>2</sub>	112.31 ± 0.55	218.10 ± 2.24	136.30 ± 2.35			
10	Dissolved Oxygen	15.67 ± 0.58	10.62 ± 0.84	9.32 ± 0.54	6.0	4.0-6.0	4
11	BOD	0.63 ± 0.18	2.83 ± 0.41	4.08 ± 0.39	-	20-30	<10
12	Total hardness (mg/l)	162.5 ± 2.5	165.25 ± 1.81	177 ± 1.69	300	500	30-180
13	Ca <sup>2+</sup> hardness	89.75 ± 2.01	104.5 ± 2.69	116.25 ± 2.51	75	75	75-150
14	Mg <sup>2+</sup> hardness	72.75 ± 2.41	60.75 ± 2.78	72.5 ± 2.87	30	150	-
15	Ammonia	0.98 ± 0.14	0.91 ± 0.10	1.05 ± 0.22	0.5	1.5	0.1

Note: - BIS: Bureau of Indian Standards, WHO: World Health Organization, Reference: IS 10500: 2012, WHO 2004, ICAR-RC-NEH

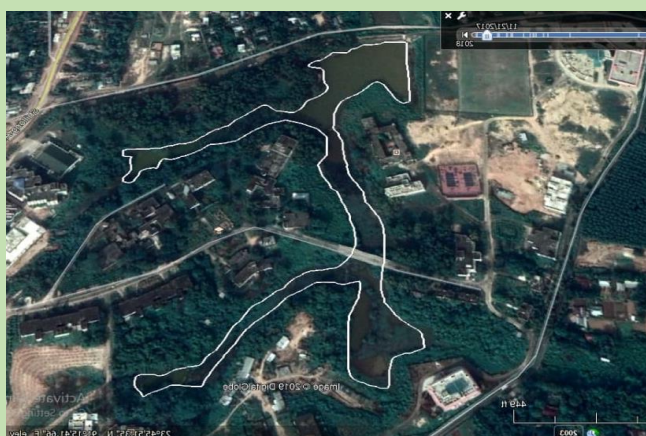


Fig. 2. Map showing the Tripura university lake

The Water Quality Index for the site was analyzed and found to be 79.95, which falls under the range from 50 to 100, which revealed good water quality. The Palmer's Algal Pollution index value of Tripura University lake is 12, which indicates moderate pollution in the lake. According to Palmer's Algal Pollution index, values between 0-10 indicate lack of organic pollution, 10-15 moderate pollution, 15-20 probable high organic pollution and 20 and above as confirmed high organic pollution. The moderate pollution of TU lake is due to more accumulation of sediments.

### 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 are 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 434 kg of different types of solid waste per week (Table 5).



Fig. 3: 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.



## GREEN AUDIT REPORT-2019-2020

Table 5: 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	Nil	
<b>TOTAL</b>			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.

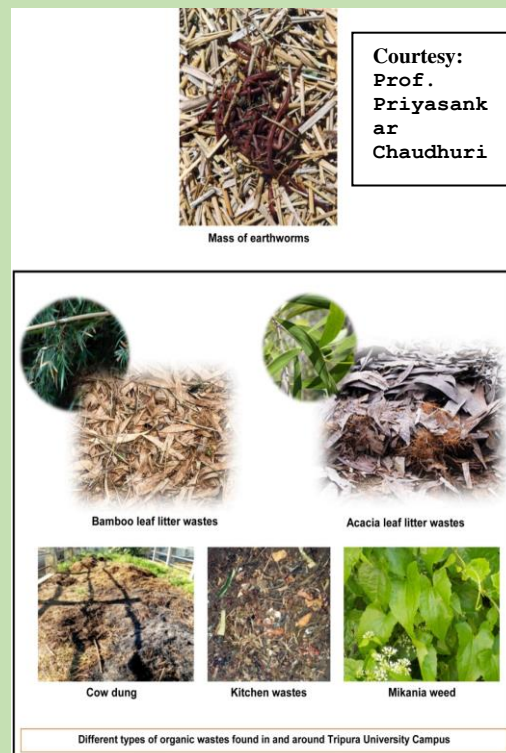
While the centralized system of solid-waste management involves timely and periodic lifting of the disposed of wastes by the Agartala Municipal Corporation, it is laudable that proper waste management including composting initiatives has been adopted. However, the need for a formal and centralized system 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 6 and Table 7.

## GREEN AUDIT REPORT-2019-2020

Table 6: 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

Table 7: 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 are stored in the -20 °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 study it was noticed among the faculty members of Tripura University by the Green 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 Green 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.

### **Health audit**

In order to encourage students to respect the environment and think about conservation, altogether Environmental Awareness/Plantation Programmes organised during 2019-2020.

## GREEN AUDIT REPORT-2019-2020

World Environment Day was celebrated by Different Academic Departments with their students.

Tripura University took initiative for “Swachhhta Pakhwada, 2019” which was observed from 1th to 15th September, 2019 following the letter vide letter F.No.11014/01/2018-(EBSB), dated 27th August, 2019 from the Ministry of Human Resource Development, Department of Higher Education, New Delhi. Under the Banner, in Tripura University, following activities were undertaken from 5th of September to 27th of September, 2019. Renovation of traditional and other water bodies of the university, massive cleaning drive of the lake inside the Tripura University campus was carried out. It was conducted with the support of NSS Unit. Administrative and Academic staffs from different departments of Tripura University.



NSS Volunteers are in action to campaign-“Save Water” inside campus

A base line survey on water conservation was conducted in one of the adopted/ model village namely Suryamaninagar.

Notice on ban on plastics within TU campus

त्रिपुरा विश्वविद्यालय  
TRIPURA UNIVERSITY  
(केन्द्रीय विश्वविद्यालय / A Central University)  
सूर्यमणिनगर, अग्रतला / Suryamaninagar, Agartala  
त्रिपुरा(प.)/Tripura(W.), पिन/PIN – 799022, भारत/INDIA



दूरभाष / Phone : (0381) 237 9003  
237 4803

फैक्स / Fax : (0381) 237 4802/3

ई-मेल / E-Mail: registrar@tripurauniv.in  
वेबसाइट / Website : www.tripurauniv.in

**\*MOST URGENT\***

Ref. No. F.TU/REG/CAMPUS/7/2016

Date : 04.06.2018

**NOTICE**

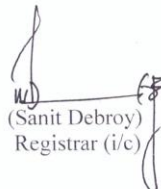
This is for information of all concerned that the University will celebrate **World Environment Day and Vanamahotsav 2018 on 5<sup>th</sup> June, 2018 (Tuesday) at Auditorium-II of Academic Building XI.**

In this regard, a pledge to abandon use of plastic in the campus will be organized. HOD, Forestry & Biodiversity will also deliver a lecture on the theme 'Beat Plastic Pollution'.

All Heads/In charge of Dept. and Programme Officer, NSS are hereby requested to inspire all students to join the programme and assemble in front of the Academic Building XI of the University on **5<sup>th</sup> June, 2018 at 11.00 AM.**

Prof. A.K. Ghosh, Hon'ble Vice Chancellor, Tripura University will attend the programme.

All Faculty members, Officers, Non-teaching staff, Research Scholars and students of the Tripura University are cordially invited to be present in the University Programme.

  
(Sanit Debroy)  
Registrar (i/c) 4.6.18

Copy for information and wide circulation to:

1. The Pro-Vice-Chancellor, Tripura University.
2. The Dean, Faculty of Science, Tripura University.
3. The Dean, Faculty of Arts & Commerce, Tripura University.
4. The Dean of Students' Welfare, Tripura University.
5. All Heads/In-charge/Coordinators, Department of ..... with a request to circulate among all Faculty members, Students and Research Scholars.
6. Dr. R. Chatterjee, Programme Officer, NSS, Tripura University.
7. All Officers/Branches/Section, Tripura University.....
8. The Campus In-charge, Tripura University.
9. P.S. to the Hon'ble Vice Chancellor, Tripura University.
10. Notice Board/Website for wide circulation.

As a part of the initiative Tripura University conducted National Workshop on "River and Water Management for sustainable development with policy perspectives" in collaboration with Aviral Ganga Mission and Govt. of Tripura on 3<sup>rd</sup> and 4<sup>th</sup> July, 2019 with the theme water conservation, Waste water treatment, recycle and reuse, solid waste management etc.





### **Energy audit**

According to Energy Conservation Act, 2001, Energy Audit is the verification, monitoring, and analysis of the use of energy including submission of a technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption.

The Energy and electricity audit aimed to cover the aggregate consumption of Electrical and Natural gas energy within the Tripura University campus including academic and administrative blocks. In different hostels, LPG cylinders are primarily used for cooking purposes and the number of uses was also counted. Domestic LPG connections were not included in the present study. Within the campus, no other fossil fuel like coal-fire or firewood, etc based energy is used.

All the buildings of the University are designed and constructed in such a way that during day time no electricity is consumed for lighting of tube lights and other electric lights. Proper day light and ventilation facilities are available for every building.

Moreover, Tripura University is taking its initiative to utilize renewable energy has installed roof top solar panels of capacity 600 KWp in 14 buildings to compensate for the necessity of electrical energy within the campus. This has resulted tremendous curtailment in the electricity consumption. Tripura University has saved a substantial amount Rs. 62,57,087/- for the period of almost 2 years i.e., from January, 2019 to November, 2020. In addition to that, all the High Pressure Sodium Vapour lamps (HP-SV) and High Pressure Metal Halide (HP-MH) street lights have been replaced by the energy efficient LED street lights and mushroom head LED lights are installed to reduce the consumption of the electricity under the green initiatives schemes. The total number of energy efficient LED lights is 258 and total savings is Rs. 61,78,791.00 for the period of 3 years 6 months i.e., from May, 2017 to November, 2020. At present, TU has 500 numbers of LED bulbs and LED panels, LED outdoor streetlight as

## GREEN AUDIT REPORT-2019-2020

compared to 220 numbers CFL and 280 numbers Halogen bulbs in various academic and administrative blocks. There were 500 numbers of AC (Air Conditioner) and 3500 numbers of Fan installed in the different academic and administrative blocks. On the other hand, on an average 45 worth of natural gas (LPG cylinders) per month has been utilized in the different hostels and guest house within the campus.



Fig 4: Use of solar power panels in TU Campus

On average, 110000 units per month of electricity were consumed by the University in the year 2019-20 including the residential quarters. In the previous year 2018-19, the average power consumption was 220000 units per month. It has also been observed that there is a slight increase of around 46% in the monthly average electricity consumption during the current year which could be attributed to the installation of solar panels in some specific zones.

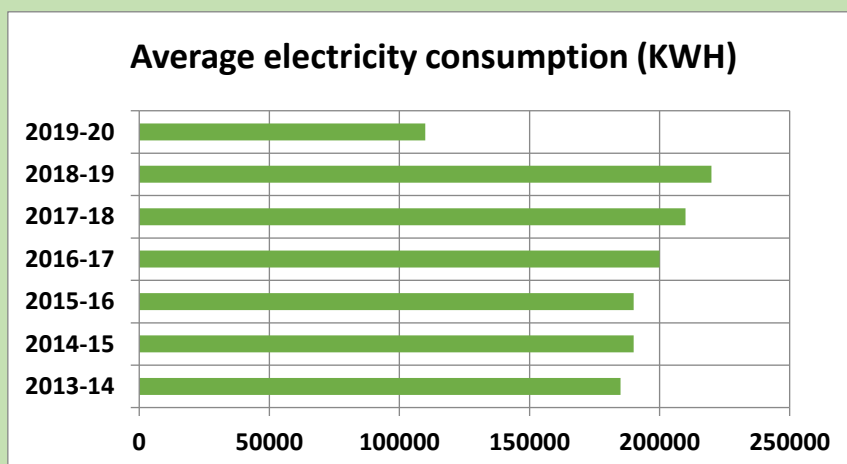


Fig. 5: Average electricity consumption in TU campus from 2013-14 to 2019-20

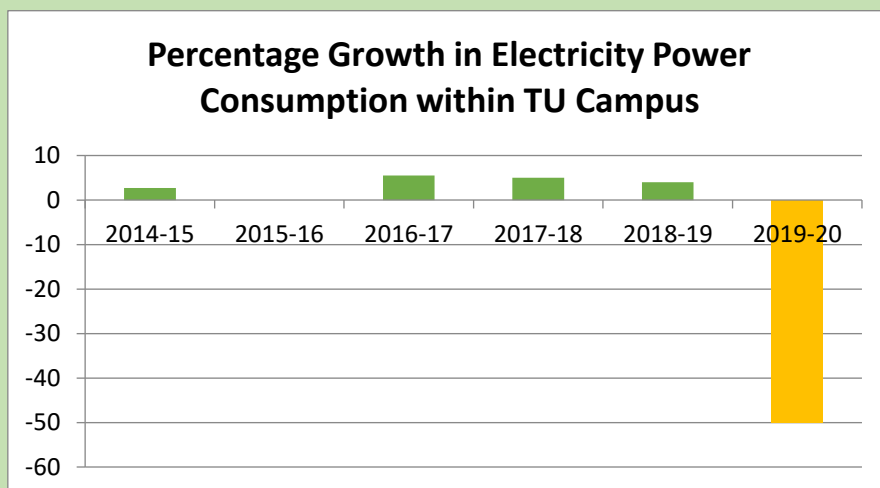


Fig. 6: Percentage growth in Electric Power consumption in TU campus from 2014-15 to 2019-20

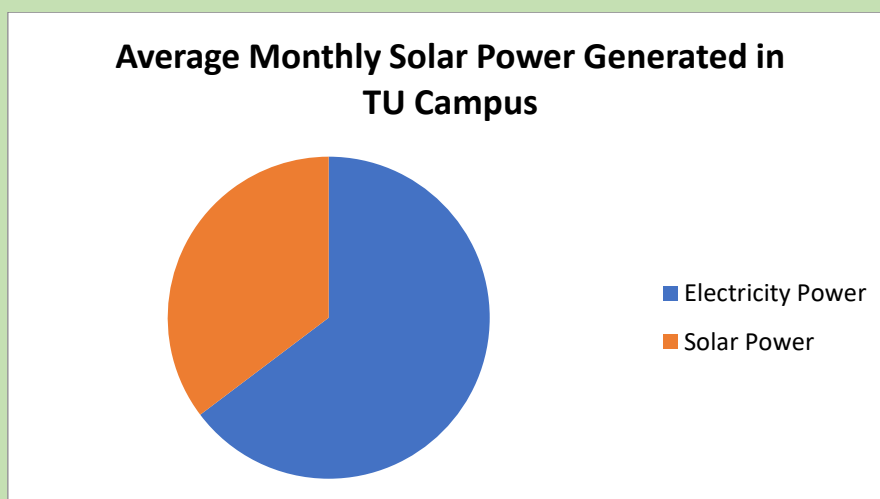


Fig. 7: Monthly Solar power generated within TU campus

**Observations**

- ❖ Separate Electricity meters were not found in the Hostels, Academic, and Administrative blocks.

**Suggestions and Recommendations**

- ❖ There should be facility to record energy consumption in every building.
- ❖ Solar power generated roadside poles can be installed.
- ❖ Solar power can be augmented in coming years.
- ❖ Regular Campaigns should be done to switch off of lights and other electric appliances after use.

## Environmental quality audit

### Air quality assessment

For air quality monitoring three parameters namely Particulate Matter (PM 10), Sulphur dioxide (SO<sub>2</sub>), and nitrogen dioxide (NO<sub>2</sub>) were considered for measurement in the University campus. PM<sub>10</sub> 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. 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<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> were made according to the internationally accepted standard technique through use of Respirable Dust Sampler (RDS) with gaseous sampling attachments and PM<sub>2.5</sub> Sampler manufactured by M/s Environtech Instruments PVT. LTD., New Delhi.

The Particulate matter PM<sub>10</sub> was observed to be 58.7 µg/m<sup>3</sup> and PM<sub>2.5</sub> was observed to be 48.93 µg/m<sup>3</sup> Table 8, in the Tripura university campus which is lower than the permissible limits of CPCB Ambient Air Quality Standards of 100 µg/m<sup>3</sup> and 60 µg/m<sup>3</sup>, respectively. In the University Campus, the major source of PM<sub>10</sub> and PM<sub>2.5</sub> might be the dust from Vehicular traffic, construction, and burning.

SO<sub>2</sub> is the component of greatest concern and is used as the indicator for the larger group of gaseous sulphur oxides (SO<sub>x</sub>). In the University Campus, the SO<sub>2</sub> concentration was observed to be 1.14 µg/m<sup>3</sup> Table 8. This is much below the CPCB permissible limit of 80 µg/m<sup>3</sup>. So, the University campus can be called a zone which does not have SO<sub>2</sub> pollution. Moreover, the good luxuriant vegetation which is present in the university campus also contributes a lot to the absorption of SO<sub>2</sub> by plants.

NO<sub>2</sub> is the most prevalent form of NO<sub>x</sub> in the atmosphere which is generated from different anthropogenic (human) activities. NO<sub>2</sub> is not only an important air pollutant by itself but also reacts in the atmosphere to form ozone (O<sub>3</sub>) and acid rain. In the University campus, the NO<sub>2</sub> was observed to be 5.08 µg/m<sup>3</sup> Table 8. This is much below the CPCB ambient air Quality permissible limit of 80 µg/m<sup>3</sup>.

From the result in Table 8 it was observed that the value of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> of air inside the Tripura University campus are within the prescribed standard limit of CPCB (Central Pollution Control Board, 2009).



## GREEN AUDIT REPORT-2019-2020

Table 8: 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 <sub>10</sub> ) µg/m <sup>3</sup>	24 Hours	58.7	100	Gravimetric
Particulate Matter (PM <sub>2.5</sub> ) µg/m <sup>3</sup>	24 Hours	48.93	60	Gravimetric
Sulphur Dioxide (SO <sub>2</sub> ) µg/m <sup>3</sup>	24 Hours	1.14	80	Improved West and Geake
Nitrogen Dioxide (NO <sub>2</sub> ) µg/m <sup>3</sup>	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 9) 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 isolate was maximum in outdoor (68) compare than indoor (64) in Table 9. *Aspergillus* sp., *Penicillium* sp., *Alternaria* sp.,

## GREEN AUDIT REPORT-2019-2020

*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 9. 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
<b>Total Isolates</b>	<b>17</b>	<b>24</b>	<b>13</b>	<b>13</b>	<b>15</b>	<b>14</b>	<b>19</b>	<b>17</b>	<b>64</b>	<b>-</b>	<b>68</b>	<b>-</b>	<b>132</b>	<b>-</b>

**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.

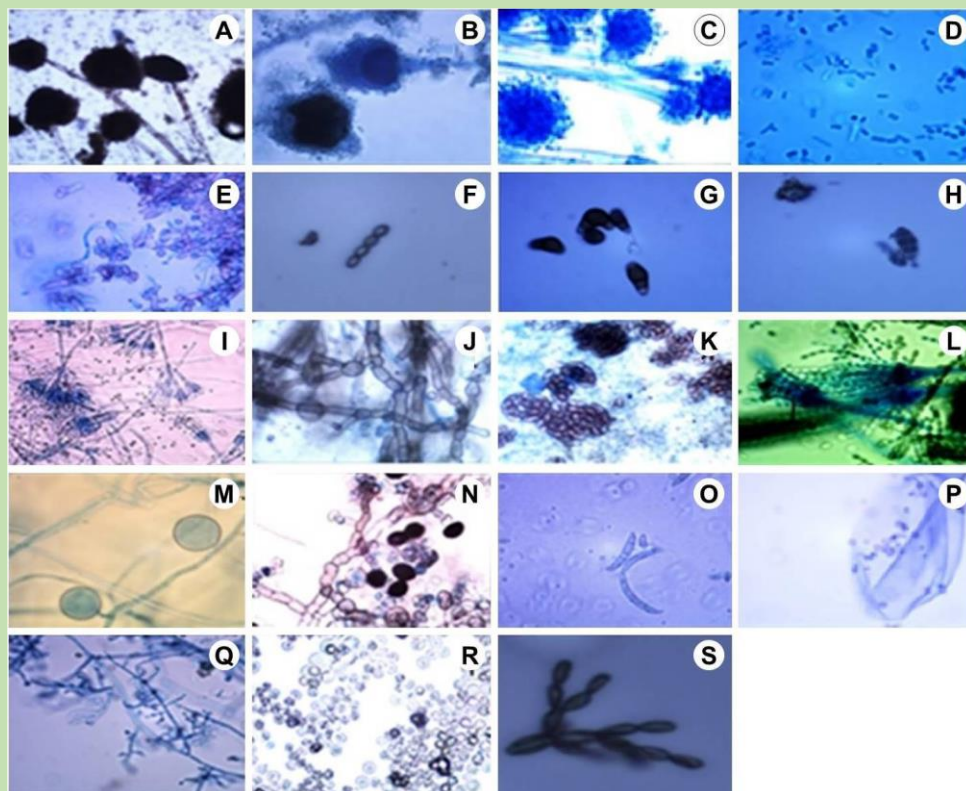


Fig 8. Air-fungal species from outdoor and indoor environments of Tripura: A–C, *Aspergillus* sp.; D, *Geotrichum* sp.; E, *Cladosporium* sp.; F, *Torula* sp.; G, *Curvularia* sp.; H, *Alternaria* sp.; I, *Penicillium* sp.; J, *Phoma* sp.; K, *Acremonium* sp.; L, Unidentified sp. 1; M, *Pythium* sp.; N, *Nigrospora* sp.; O, *Fusarium* sp.; P, *Rhizopus* sp.; Q, *Trichoderma* sp.; R, Unidentified sp. 2; S, *Monilia* sp.

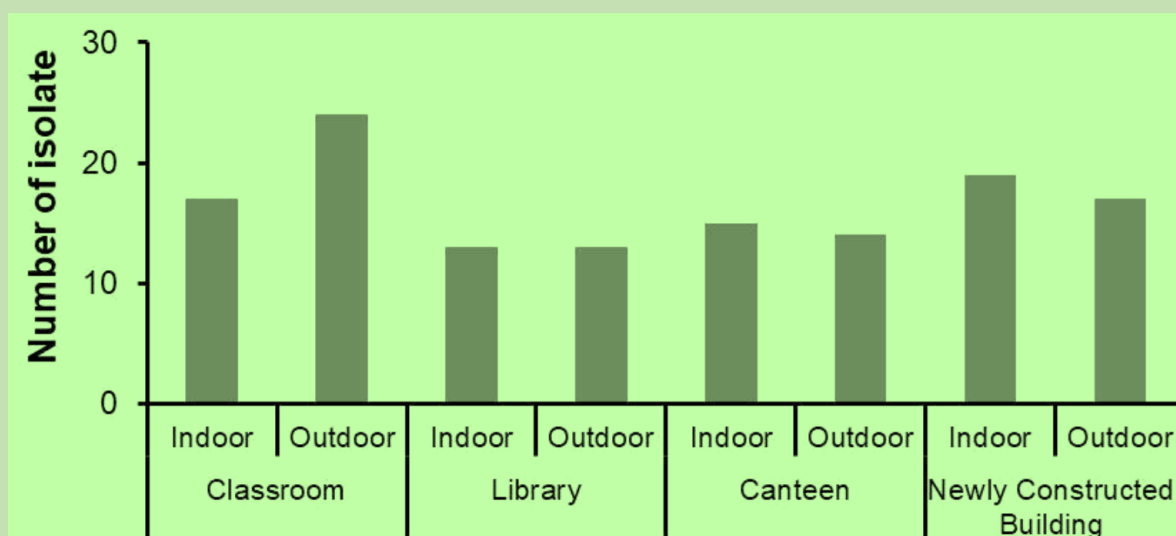


Fig 9. Number of isolated fungal genera from four selected sites.

**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 during 2019-20 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 10: 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



## GREEN AUDIT REPORT-2019-2020

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 10, 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.

**Biodiversity audit**

Biodiversity audit of Tripura University is a continuous process and efforts of the faculty members, researchers, and the students to assess the living biota and its conservation have been going on for many years. Regularly many conservation practices are taken up by the University so that anthropogenic impact on the biodiversity components and ecosystems are minimized. The scientific information and existing database are based on various studies as well as research work done by Botany, Zoology and Forestry and Biodiversity departments of Tripura University. Despite various limitations, data have been compiled to prepare authentic documentation that provides an insight into the status of the biodiversity and natural ecosystem in the campus. Different conservation practices also have been applied for a better and sustainable campus ecosystem.

The main objective of biodiversity audit is to provide documentation of biodiversity components within the institutional area, to observe ecosystem structures and functions along with regular biodiversity monitoring of the different components of biodiversity.

A lake is located within the campus and maintained by Tripura University to enrich the beauty of the campus. Earlier the lake was a small unutilized waterbody, which was later extended for irrigation purposes and a small barrage was constructed to maintain the water level of the area. Many migratory birds are often observed and some of the fishes are available during the rainy seasons. It is also used for irrigation purposes in the nearby agriculture field and cultural services like scenic beauty.

Spread over approximately 97 acres of land, the Tripura University campus is home to different varieties of fauna as well as flora.

The present audit started from July 2019 and continued till June 2020 and the study documented altogether the biodiversity in Tripura University Campus.

**Faunal diversity**

The faunal diversity under different species groups are listed in Table 11.

Table 11: Faunal diversity in the TU campus

<b>Butterfly Diversity</b>		
<b>1.</b>	Common Mormon	<i>Papilio polytes</i>
<b>2.</b>	Great Mormon	<i>Papilio memnon</i>
<b>3.</b>	Common Birdwing	<i>Troides helena</i>
<b>4.</b>	Chocolate Pansy	<i>Junonia iphita</i>
<b>5.</b>	Lemon Pansy	<i>Junonia lemonias</i>
<b>6.</b>	Common Sailor	<i>Neptis hylas</i>
<b>7.</b>	Common pierrot	<i>Talicauda nyseus</i>

## GREEN AUDIT REPORT-2019-2020

8.	Lemon emigrant	<i>Catopsilia pomona</i>
9.	Common seargent	<i>Athyma perius</i>
10.	Common lescar	<i>Pantoporia hordonia</i>
11.	Jezelbel	<i>Delias eucharis</i>
12.	Limeblue	<i>Chilades lajus</i>
13.	Tiny Grass Blue	<i>Zizula hylax</i>

### Skimmers and Dragonflies

1.	Scarlett Skimmer	<i>Crcothermis servilia</i>
2.	Fulvous Forest Skimmer	<i>Neurothemis fulvia</i>
3.	Chalky Percher	<i>Diplacodes trivialis</i>
4.	Ditch Jewel	<i>Brachythemis contaminate</i>
5.	Slender Skimmer	<i>Orthetrum sabina</i>
6.	Common Picture Wing	<i>Rhyothemis variegata</i>

### Herpetofauna Diversity

#### Snakes

1.	Painted Bronzeback Tree Snake	<i>Dendrelaphis pictus</i>
2.	Chckered Keelback	<i>Xenochropis piscator</i>
3.	Common Wolf Snake	<i>Lycodon aulicus</i>
4.	Buff Striped Keelback	<i>Amphiesma stolatum</i>

#### Geckos And Lizards

1.	Oriental Garden Lizard	<i>Calotes versicolor</i>
2.	Common Sun Skink	<i>Eutropis multifasciculata</i>
3.	Keeled Skink	<i>Eutropis carinata</i>
4.	Flat Tailed House Gecko	<i>Hemidactylus platyurus</i>

#### Toads and Frogs

1.	Common Toad	<i>Duttaphyrnus melanosticus</i>
2.	Common Tree Frog	<i>Polypedates teraiensis</i>
3.	Pygmy Toad	<i>Microhyla berdmorei</i>
4..	Tokay Gecko	<i>Cryptodactylus tripuraensis</i>
5.	Indian Bull Frog	<i>Rana tigrina</i>

#### Fishes

1.	Tilapia	<i>Tilapia spp.</i>
2.	Grass Carp	<i>Ctenopharyngodon idella</i>

#### Tree Shrews, moles and squirrels

1.	Northern Tree Shrew	<i>Tupaia belangeri</i>
2.	House Shrew	<i>Suncus murinus</i>
3.	White Toothed Shrew	<i>Suncus etruscus</i>
4.	Hairy Belied Squirrel	<i>Callosciurus pygerythrus</i>
5.	Indian Long Tailed Field Mouse	<i>Apodemus sylvaticus</i>

#### Avifauna

Sl. No.	Common Name	Scientific Name
1.	Lesser Whistling Teal	<i>Dendrocygna javanica</i>
2.	Asian Openbill Stork	<i>Anastomus oscitans</i>
3.	Indian Pond Heron	<i>Ardeola grayii</i>
4.	Little Egret	<i>Egretta garzetta</i>
5.	Little Cormorant	<i>Phalacrocorax niger</i>
6.	Black Kite	<i>Milvus migrans</i>
7.	Common Moorhen	<i>Gallinula chloropus</i>

## GREEN AUDIT REPORT-2019-2020

8.	Bronze Winged Jacana	<i>Metopidius indicus</i>
9.	Common Kingfisher	<i>Alcedo atthis</i>
10.	White-throated Kingfisher	<i>Halcyon smyrnensis</i>
11.	Common Pigeon	<i>Columba livia</i>
12.	Green bee-eater	<i>Merops orientalis</i>
13.	Common Myna	<i>Acridotheres tristis</i>
14.	Red vented Bulbul	<i>Pycnonotus cafer</i>
15.	Oriental Magpie Robin	<i>Copsychus saularis</i>
16.	Black Drongo	<i>Dicrurus macrocercus</i>
17.	Asian Pied Myna	<i>Gracupica contra</i>
18.	House Sparrow	<i>Passer domesticus</i>
19.	Eurasian Tree Sparrow	<i>Passer montanus</i>
20.	Spotted Dove	<i>Spilopelia chinensis</i>
21.	Green-billed Malkoha	<i>Phaenicophaeus tristis</i>
22.	Eastern Jungle Crow	<i>Corvus leuillanti</i>
23.	Greater Flameback	<i>Chrysocolaptes guttacristatus</i>
24.	Black-hooded Oriole	<i>Oriolus xanthornus</i>
25.	Asian Palm Swift	<i>Cypsiurus balasiensis</i>
26.	Lineated Barbet	<i>Megalaima lineata</i>
27.	Common Goldenback	<i>Dinopium javanense</i>
28.	Stork-billed kingfisher	<i>Pelargopsis capensis</i>
29.	Grey-headed fish eagle	<i>Haliaeetus ichthyaetus</i>
30.	Rufous-necked laughingthrush	<i>Pterorhinus ruficollis</i>
31.	Chestnut-tailed starling	<i>Sturnia malabarica</i>
32.	Purple sunbird	<i>Cinnyris asiaticus</i>
33.	Rose-ringed parakeet	<i>Psittacula krameri</i>
34.	Barn owl	<i>Tyto alba</i>
35.	Spotted owl	<i>Athene brama</i>
36.	Oriental White Eye	<i>Zosterops palpebrosus</i>
37.	Red Wattled Lapwing	<i>Vanellus indicus</i>
38.	Spotted Dove	<i>Spilopelia chinensis</i>

### Floral diversity

The floral diversity under different species groups are listed in Table 12. The list is based on the studies carried out by Prof. Badal K Datta and Dr Sourabh Deb and his team of scholars.

Table 12 Summary of some recorded Flora in Tripura University campus

Sl. No.	Scientific Name	Local name	Family
1	<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	Akashmoni	Mimosaceae
2	<i>Ageratum conyzoides</i>		
3	<i>Ageratum houstonianum</i>		
4	<i>Ailanthus integrifolia</i>		
5	<i>Albizia lebeck</i> (L.) Benth.	Koroi	Mimosaceae
6	<i>Alstonia scholaris</i> (L.) R.Br.	Chatim	Apocynaceae
7	<i>Alternanthera sessilis</i>		
8	<i>Anacardium occidentale</i> L.	Kaju	Anacardiaceae



## GREEN AUDIT REPORT-2019-2020

9	<i>Annona reticulata</i> Sieber ex A.DC.	Ataphal	Annonaceae
10	<i>Anthocephalus chinensis</i> Hassk.	Kadam	Rubiaceae
11	<i>Antidesma ghaesmbilla</i>		
12	<i>Aquilaria malaccensis</i> Roxb.	Agor	Thymelaeaceae
13	<i>Araucaria columnaris</i> Hook.		Araucariaceae
14	<i>Artocarpus heterophyllus</i> Lam.	Kathal	Moraceae
15	<i>Averrhoa carambola</i> L.	Kamranga	Oxalidaceae
16	<i>Azadirachta indica</i> A. Juss.	Neem	Meliaceae
17	<i>Bauhinia variegata</i>		
18	<i>Bombax insigne</i>		
19	<i>Borassus flabellifer</i> L.	Tal	Arecaceae
20	<i>Caesalpinia bonduc</i> (L.) Roxb.	Ghagragota	Caesalpinaceae
21	<i>Caesalpinia pulcherrima</i> (L.) Sw.	Radhacura	Caesalpinaceae
22	<i>Callistemon lanceolatus</i> (Sm.) Sweet	Bottle-brush	Myrtaceae
23	<i>Careya arborea</i> Roxb.	Kumvira	Lecythidaceae
24	<i>Carica papaya</i> L.	Pepe	Caricaceae
25	<i>Cassia fistula</i> L.	Bandor lathi	Mimosaceae
26	<i>Cassia siamea</i>		
27	<i>Cassia siamea</i> Lam.	Cassia	Mimosaceae
28	<i>Chenopodium Sp.</i>		
29	<i>Citrus limon</i> (L.) Osbeck	Lebu	Rutaceae
30	<i>Citrus maxima</i> (Burm.) Merr.	Jambura	Rutaceae
31	<i>Citrus reticulata</i> Blanco	Komala	Rutaceae
32	<i>Clausena heptaphylla</i>		
33	<i>Cocos nucifera</i> L.	Narikal	Arecaceae
34	<i>Dalbergia lanceolaria</i> L.f.	Koroi	Papilionaceae
35	<i>Delonix regia</i> (Bojer) Raf.	Krishna chura	Caesalpinaceae
36	<i>Dendrothe falcata</i>		
37	<i>Dillenia pentagyna</i> Roxb.	Chalita	Dilleniaceae
38	<i>Diospyros montana</i>		
39	<i>Elaeocarpus floribundus</i>		
40	<i>Elaeocarpus floribundus</i> Blume	Jolpai	Elaeocarpaceae
41	<i>Engelhardia spicata</i>		
42	<i>Eucalyptus citriodora</i> Hook.	Eucalyptus	Myrtaceae
43	<i>Eucalyptus globosus</i>		
44	<i>Euphorbia tirucalli</i> Thunb.	Sitla	Euphorbiaceae
45	<i>Ficus benghalensis</i> L.	Bot gach	Moraceae
46	<i>Ficus hispida</i> L.f.	Dumur	Moraceae
47	<i>Ficus religiosa</i> Forssk.	Ashot	Moraceae
48	<i>Flacourtia jangomus</i>		
49	<i>Glochidian lanceolarium</i> (Roxb.) Voigt.		Euphorbiaceae
50	<i>Gmelina arborea</i> Roxb.	Gamai	Verbenaceae
51	<i>Hymenodictyon excelsum</i>		
52	<i>Hyptis suaveolens</i>		

## GREEN AUDIT REPORT-2019-2020

53	<i>Lagerstroemia speciosa (L.) Pers.</i>	Jarul	Lythraceae
54	<i>Lannea coromendalica</i>		
55	<i>Lantana camara</i>		
56	<i>Mallotus phillipensis H. Karst</i>	Kamela	Euphorbiaceae
57	<i>Mallotus tetragona</i>		
58	<i>Mangifera indica Linn.</i>	Aam	Anacardiaceae
59	<i>Melastoma malabathricum</i>		
60	<i>Melia azedarach Blanco</i>	Bon neem	Meliaceae
61	<i>Michelia champaca L.</i>	Champa	Magnoliaceae
62	<i>Microcos panicula</i>		
63	<i>Millettia pinnata (L.) Panigrahi</i>	Karach	Papilionaceae
64	<i>Mimusops elengi Bojer</i>	Bokul	Sapotaceae
65	<i>Moringa oleifera Lam.</i>	Sajna	Moringaceae
66	<i>Murraya koenigii (L.) Spreng.</i>	Curry patta	Rutaceae
67	<i>Musa paradisiaca L.</i>	Kola gach	Musaceae
68	<i>Nyctanthes arbor-tristis L.</i>	Sheoli	Oleaceae
69	<i>Oldenlandia sp,</i>		
70	<i>Parkia roxburghii G.Don</i>	Wakre	Mimosaceae
71	<i>Peltophorum pterocarpum (DC.) Backer ex K.Heyne</i>	Radhachura	Caesalpiniaceae
72	<i>Phyllanthus emblica L.</i>	Amla	Euphorbiaceae
73	<i>Polyalthia longifolia (Sonn.) Hook.f. &amp; Thomson</i>	Devdaru	Annonaceae
74	<i>Psidium guajava L.</i>	Goyam	Myrtaceae
75	<i>Samanea saman (Jacq.) Merr.</i>	Rain tree	Mimosaceae
76	<i>Sapindus mukorossi Gaertn.</i>	Ritha	Papilionaceae
77	<i>Schima wallichii Choisy</i>	Kanak	Theaceae
78	<i>Sesbania grandiflora Linn.</i>	Bokful	Papilionaceae
79	<i>Streblus asper Lour.</i>	Saruwa	Moraceae
80	<i>Suregada multiflora</i>		
81	<i>Swietenia mahagoni (L.) Jacq.</i>	Mahogany	Meliaceae
82	<i>Syzygium cumini (L.) Skeels</i>	Jam	Myrtaceae
83	<i>Syzygium fruticosum DC.</i>	Jam	Myrtaceae
84	<i>Syzygium jambos</i>		
85	<i>Tectona grandis L.f.</i>	Segun	Lamiaceae
86	<i>Terminalia bellirica (Gaertn.) Roxb.</i>	Bahera	Combretaceae
87	<i>Terminalia arjuna (Roxb. ex DC.) Wight &amp; Arn.</i>	Arjun	Combretaceae
88	<i>Toona ciliata M.Roem.</i>	Rangeen	Meliaceae
89	<i>Trema orientalis Blume</i>	Naircha	Ulmaceae
90	<i>Trewia nudiflora</i>		
91	<i>Xanthoxylum lintonella</i>		
92	<i>Ziziphus oenoplia (L.) Mill.</i>	Ban boroi	Rhamnaceae
93	<i>Ziziphus mauritiana Lam.</i>	Boroi	Rhamnaceae

### **Snag trees in TU campus and their use by different various fauna**

Snags mean dead trees found in natural habitat, which is also known as a wildlife tree. It has great importance as it is the home for various wild animal species. Dying trees, standing dead trees (snags) and downed woody material have numerous ecological functions and contribute to structural complexity and biodiversity within forests (Harm et al., 1986; Franklin, 1988).

An extensive survey in Tripura University campus found altogether 32 Snags. All these available snags are a home of different animal species like Squirrel, Owlet, dove, myna, parakeet, barbet, Woodpecker, Gecko, House lizard, different species of Snakes, spiders, scorpions, ants, termites, moths, beetles' caterpillars etc.

### ***Tree diversity and Carbon Stock in Tripura University Campus***

Trees are the prevalent component of a terrestrial ecosystem. They provide benefiting function by accumulating atmospheric carbon. The potential of tree species richness in our Tripura University campus was explored by Dr Sourabh Deb (Dept. of Forestry and Biodiversity) and his team. The study constitutes an assessment of tree species richness, standing biomass and carbon stock of trees in the campus. A total of 66 tree species with 1301 individuals (40.69 individual ha<sup>-1</sup>) belonging to 56 genera from 32 families were identified from Tripura University campus. The dominant family was Mimosaceae and species was *Acacia auriculiformis* (n=524), followed by *Cassia siamea* (n=31) and *Cassia fistula* (n=25). The compositional pattern shows that number of individual with the lower DBH was higher and only 47 individuals were found in > 45 cm DBH class. The total biomass (AGB and BGB) was 377.76 T in the entire area, with 11.82 T ha<sup>-1</sup> and carbon as 5.91 T ha<sup>-1</sup>. *Acacia auriculiformis* emerged as the highest biomass contributor due to its higher number of individuals. The study shows that the tree species found in the campus make an important contribution in conserving diversity and helps to maintain the carbon stock in the University Campus.

The study concluded that tree species richness of the campus is important as it is playing vital role in carbon management. Trees like *Anacardium occidentale*, *Artocarpus heterophyllus*, *Cassia siamea*, *Mangifera indica* and *Sapindus mukorossi* possess interesting qualities like large size, high sequestration potential and better aesthetical values, making them good candidates for landscape designing. Overall, tree planting has helped to transform the area into a verdant green campus. The largest collection of trees in the campus may help to reduce the ambient temperature and keep the environment clean. The campus is enriched with various plants of different habitat. Therefore, development activities like building construction could be restricted to some places. It is an urgent need to implement sustainable conservation measures from old matured trees to new emergent one. The young trees are yet to be matured and further there will be an addition to standing biomass leading to increasing carbon storage. The present work will also upheld the importance of tree species and build up the base line information of biodiversity as an inputs as well as the general welfare of trees in the Tripura University Campus.

### Observations

- ❖ Fascinating characteristic of the Tripura University Campus is its lush green environment with rich floral and faunal diversity.
- ❖ The trees existing are not managed properly and even are axed at times for construction activity.
- ❖ Growth of weeds and other invasive species is a cause of concern after the rains.

### Suggestions and Recommendations

- ❖ The ecosystem of the campus should be managed properly for a better environment.
- ❖ The lake which forms the wetland of the campus should be conserved and maintained.
- ❖ Proper landscape and long-term plan of the vegetational distribution/area is required for sustainable management of the trees and other vegetation in TU campus.



### Summary

Green auditing is the process of identifying and determining whether the practices of the Institution are eco-friendly and sustainable for which Tripura University, conducted the first “Green Audit” for the year 2019-2020 with a primary objective to prepare a statement on the green practices followed by the university and to conduct a well-formulated audit report.

Green auditing began with the assessment of the status of vegetative cover, waste management practices, water use and efficiency and energy conservation strategies etc. The audit team monitored different facilities at the University campus, determined different types of appliances and utilities (Water cooler, taps, toilets, lights, fan, ACs etc.) as well as measuring the usage per item (Watts indicated on the appliance or measuring water from a tap) and identifying the relevant consumption patterns (such as how often an appliance is being used) and their impacts. The staff and learners were enquired to get details of usage, frequency, of general characteristics of different appliances. Data collection was done by onsite visit and by direct accounting in different sectors such as water, energy, waste, biodiversity status. The environmental monitoring in the University campus to ascertain the status of the ambient quality of the campus was done through standard protocols. The data were collated and analyzed to prepare this audit report of 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. 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. It is a matter of concern that a few of the wetland is getting silted up and presently under a thick cover of grass and aquatic weeds in some of the portions. The Vegetational area including the trees are also found to be reducing due to development and expansion of campus limited with its landholding.

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 2019-2020 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 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 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 434 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 study it was noticed among the faculty members of Tripura University by the Green 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.

All the buildings of the University are designed and constructed in such a way that during day time no electricity is consumed for lighting of tube lights and other electric lights. Proper day light and ventilation facilities are available for every building. Tripura University is taking its initiative to utilize renewable energy has installed roof top solar panels of capacity 600 KWp in 14 buildings to compensate for the necessity of electrical energy within the campus. This has resulted tremendous curtailment in the electricity consumption. Tripura University has saved a substantial amount Rs. 62,57,087/- for the period of almost 2 years i.e., from January, 2019 to November, 2020. On average, 110000 units per month of electricity were consumed

by the University in the year 2019-20 including the residential quarters. Separate Electricity meters were not found in the Hostels, Academic, and Administrative blocks. There should be facility to record energy consumption in every building.

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<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> were made according to the internationally accepted standard technique. The Particulate matter PM<sub>10</sub> was observed to be 58.7 µg/m<sup>3</sup> and PM<sub>2.5</sub> was observed to be 48.93 µg/m<sup>3</sup> in the Tripura university campus which is lower than the permissible limits of CPCB Ambient Air Quality Standards of 100 µg/m<sup>3</sup> and 60 µg/m<sup>3</sup>, respectively. In the University Campus, the major source of PM<sub>10</sub> and PM<sub>2.5</sub> might be the dust from Vehicular traffic, construction, and burning. In the University Campus, the SO<sub>2</sub> concentration was observed to be 1.14 µg/m<sup>3</sup>. This is much below the CPCB permissible limit of 80 µg/m<sup>3</sup>. Moreover, the good luxuriant vegetation which is present in the university campus also contributes a lot to the absorption of SO<sub>2</sub> by plants. In the University campus, the NO<sub>2</sub> was observed to be 5.08 µg/m<sup>3</sup> Table 8. This is much below the CPCB ambient air Quality permissible limit of 80 µg/m<sup>3</sup>. 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 during 2019-20 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.

Biodiversity audit of Tripura University is a continuous process and efforts of the faculty members, researchers, and the students to assess the living biota and its conservation have been going on for many years. Spread over approximately 97 acres of land, the Tripura University campus is home to different varieties of fauna as well as flora. Although best effort was made to record the fauna of the campus but the list has not been exhaustive. A total of 66 tree species with 1301 individuals (40.69 individual ha<sup>-1</sup>) belonging to 56 genera from 32 families were identified from Tripura University campus. The dominant family was Mimosaceae and species was *Acacia auriculiformis* (n=524), followed by *Cassia siamea* (n=31) and *Cassia fistula* (n=25).

Finally, it can be concluded that the Green Audit Report-2019-20 will help in assisting the process of an ecofriendly approach to the sustainable development of the Tripura University

## **GREEN AUDIT REPORT-2019-2020**

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.