GREEN AND CARBON AUDIT REPORT

(2020)

Dibrugarh University

Submitted to

Internal Quality Assurance Cell (IQAC)

Dibrugarh University, Assam

By

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Certificate

This is to certify that by following suitable procedures, methods, knowledge, and expertise in the field, the green and carbon audit report has been prepared by Dr. Shukla Acharjee and Dr. Binita Pathak, Dibrugarh University, Assam,. So far as my knowledge is concerned, they had been keenly associated with the process of assembling all kinds of data and documentation of trees, bushes, and grass cover, etc. causing carbon sequestration in addition to waste and water management within the campus.

I extend my wishes to the university fraternity for a rewarding future ahead, who can add towards environment sustainability, by implementing the methods of conservation of soil, water, plants, and energy within the campus in particular and the society in general.

(_____)

Prof. Kalyan Bhuyan

Director, IQAC

Acknowledgement

The co-ordinator and convener is appreciative of the fact that the Internal Quality Assurance Cell (IQAC), Dibrugarh University has given them the opportunity and financial assistance to do the audits for environmental sustainability in the University campus. We believe that the suggestions proposed by us would be measured by the University Authority and will be executed at the earliest.

We take this opportunity to thank Mr. Gauranga Bora, Miss Meghali Chetia, and Miss Rejina Bora for facilitating the collection of data and GIS works.

Place: Dibrugarh
Date:

(Dr. Shukla Acharjee)
Co-coordinator

(Dr. Binita Pathak)
Convener

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Introduction

An audit is a procedure of systematic identification, quantification, recording, reporting and analysis of the mechanism of the environmental multiplicity of diverse establishments. It seeks to analyze environmental practices within and outside the concerned sites which will have a brunt on the eco-friendly ambiance.

A green audit can be a constructive tool for any institution to determine how and where they are using energy, water, or resources the most; which in due course would help out the institution, in respect to bearing in mind the means to employ changes as well as to endorse additional savings. It can also be used to determine the types and volume of wastes; which yet again can be profitable for introducing a recycling project or to get a better waste minimization plan. Additionally, it can generate health awareness and endorse ecological consciousness, values, and ethics. In addition to this would aid in providing the University fraternity a better perceptive of Green impact within the campus.

Carbon audit like Green Audit is another environmental audit that will help us to understand the carbon footprints inside the university campus and to reduce the release of carbon-containing compounds into the atmosphere in this era of Anthropocene when the human race is experiencing the global climate emergency. Carbon dioxide (CO_2) contributes a maximum (60%) to global warming by capturing heat energy in the atmosphere, among the four major greenhouse gases (N_2O, CH_4, CFC, and CO_2). Therefore carbon sequestration has been considered to be the best possible solution for avoiding the disaster due to climate change. Dibrugarh University, Assam has a very good carbon pool in the form of the luxuriant growth of forest in a dedicated area of 5,66,599.84 meter square, along with the presence of tall trees within the campus. In addition to this, the soil layer covered with grasses and bushes is also far more than the areas covered by roads, buildings, and platforms. This report attempts to quantify the amount of carbon emission due to the consumption of electricity and fossil fuels, which is compared with the carbon pool observed in the university. This report also highlights the measures taken by the university and their importance in the context of externalities of climate change. Hopefully, university management would appreciate the competitive work and continue to document related activities in the future so that success stories can be built which can be followed by other educational institutes.

Carbon footprint

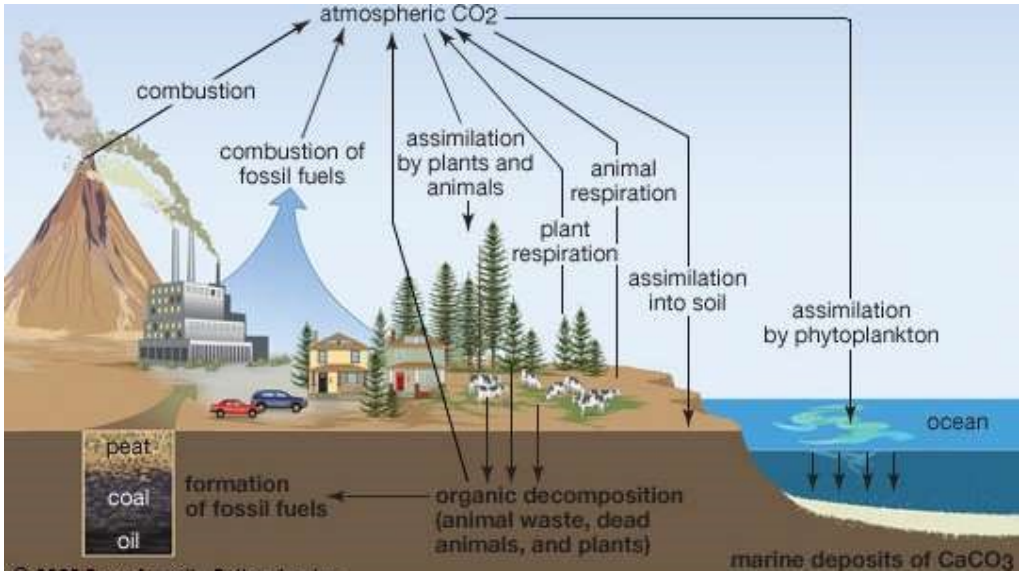
The term "carbon footprint" refers to a person or organization's carbon utilization, or the CO_2 or GHG emanated directly or indirectly throughout the life cycle of an activity or a product (Teri, 2008). For that reason, carbon footprint can be used to weigh up an object's (including a region, an organization, or a product) impact on the environment. According to the original footprint calculations, energy utilization of human activities, in general, is converted to the bio-productive area in an attempt to assess the sustainability of consumption from an ecological viewpoint.

Carbon sequestration

The term "carbon sequestration" characteristically refers to the long-term storage of carbon in plants, soils, geologic formations, and the ocean, that has the instantaneous potential to turn into carbon dioxide. The Carbon sequestration occurs both naturally and as a result of anthropogenic activities, where CO_2 is either removed from the atmosphere or diverted from emission sources to store in the forms already mentioned. In response to growing concerns about climate change due to increased CO_2 concentrations in the atmosphere, substantial attention has been drawn to the chance of increasing the rate of carbon sequestration through changes in land use and forestry and also through geoengineering techniques such as carbon capture and storage. This carbon is stored in stable solid form by direct and indirect fixation of atmospheric CO_2. Of the carbon emitted to the atmosphere by human activities, only 45% remains in the atmosphere; about 30% is taken up by the oceans, and the rest is included in terrestrial ecosystems. The amount of carbon sequestrated at a site reflects the long term balance carbon uptake and release mechanisms.The Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC, 1997) has provided a means for bearing in mind the effects of carbon sinks and sources, as well as addressing the issues related to fossil fuel emissions. High level of fossil fuel combustion and deforestation has transformed large pools of fossil carbon (coal and oil) into atmospheric CO_2. Strategies for reducing CO_2 in the atmosphere include soil carbon sequestration, tree planting etc.

Scientists are working to comprehend the impact of land use and land management on soil sequestration and ways to amplify the storage time of carbon in the soil.

Underline mechanisms controlling soil structure and storage of carbon include various chemicals, physical, biological, mineralogical, and ecological processes. They are trying to find out the relationship between biodiversity, atmospheric CO_2 level, and increased nitrogen decomposition in carbon storage.



Carbon Sequestration Processes

Types of sequestration

a. There are a number of technologies under investigation for sequestering carbon from the atmosphere. These can be discussed under three main categories:

b. Ocean sequestration: Oceans are known to be huge heat reservoirs through the accumulation of carbon and the amount found just under the surface is roughly 920 gigatons. It stores more carbon than the atmosphere (about 760 gigatons) through direct injection or fertilization.

c. Geologic sequestration: Natural pore space in geologic formation serve as reservoirs for long term carbon dioxide storage.

d. Terrestrial sequestration: Terrestrially, carbon is stored in vegetation and in the soil, which is the natural carbon sink. Direct plant carbon sequestration occurs as plants photosynthesize atmospheric CO_2 into plant biomass for as long as they live. Once they die, the biomass becomes a part of the food chain and in due course enters the soil as soil organic carbon (SOC). Thus some of

this plant biomass is circuitously sequestrated as SOC during decomposition processes. Direct soil carbon sequestration occurs by inorganic chemical reactions that convert CO_2 into soil inorganic carbon compounds such as calcium and magnesium carbonates etc. Unlike many plants and most crops, which have short lives or release much of their carbon at the end of each season, forest biomass accumulates carbon over decades and centuries. Furthermore, carbon accumulation potential in forests is large enough that forests offer the chance of sequestering major amounts of additional carbon in relatively short periods – decades.

Soil Carbon Sequestration:

Soil carbon sequestration is the procedure of transferring CO_2 from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not instantly remitted. This transfer or "sequestering" of carbon aids in off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil and water quality and long-term agronomic productivity decreased nutrient loss, reduced soil erosion, and increased water conservation.

Major objectives of the study:

1. To measure carbon emission from power (electrical) consumption
2. To measure carbon emitted from transportation and other activities
3. To estimate organic biomass of trees
4. To analyse the waste disposal mechanism
5. Analyzing results for determination of carbon footprint analysis and carbon sequestration

Possible outcome of this study

1. Formulation of strategies for plantation and other means for carbon sequestration, waste management, soil and water conservation.
2. Creation of awareness among the stakeholders regarding carbon emission and its capturing and converting waste to wealth.

Methods for assessment of carbon emission and carbon sequestration

1. Carbon emission

Power Consumption activity

The power consumption of individuals has been studied by using secondary data on energy bills obtained during December 2019 - November 2020. The energy consumption at university is particularly for running lights, fans, and other instruments. Hence to estimate the carbon emission from electrical consumption, we have used the relation $C=\beta E$, where C is carbon dioxide emission, β (0.81 ton/MWh) is the emission factor and E is electricity consumption (Bajpai, 2012).

Consumption of fossil fuels

For the assessment of carbon emission from fossil fuels, the primary data was collected by survey method to count the number of vehicles (two-wheelers, three-wheelers, four-wheelers) entering regularly into the university campus. The numbers were found to be different for a working day and on a holiday and hence carbon emissions are calculated separately for both days.

Emission factors considered for different vehicles, based on the percentage of carbon present in the fuel used for the vehicle in India (according to Cerana Foundation), are as following:

Bus = 0.023 kg CO_2 per vehicle per km

Two wheeler = 0.054 kg CO_2 per vehicle per km

Four wheeler = 0.175 kg CO_2 per vehicle per km

Auto = 0.13 kg CO_2 per passenger per km

2. Carbon Sequestration

Above ground biomass and carbon estimation of the trees

The biomass from the surrounding areas of the university campus was estimated from the Diameter at Breast Height (DBH) and from the total height of the tree. A constant for wood density of about 690kg/m^3 is considered for measuring the total biomass of the tree. Hence the volume of dry and green biomass from the constant values has been considered in estimating the carbon sequestration by the trees.

Overview of the Institution:

Dibrugarh University, located in the District of Dibrugarh, is the second oldest University in Assam and in North-East India. It was established in 1965 under the provisions of the Dibrugarh University Act, 1965, enacted by the Assam Legislative Assembly. It is a teaching-cum-affiliating university. There are 177 affiliated colleges under Dibrugarh University and institutes spreading over the nine districts of Assam. The University is a member of the Association of Indian Universities (AIU) and the Association of Commonwealth Universities (ACU). It is accredited by the National Assessment and Accreditation Council, with an 'A' Grade in 2017.

The Dibrugarh University is located at Rajabheta, 5 km away from Dibrugarh Town (27° 29' North Latitude and 94° 55' East Longitude). The NH15 (old NH37) bisects the main campus (consisting of east and north campuses) from the other (west campus), the latter primarily comprising teacher's and officer's residence colonies. Dibrugarh University, which spreads over 20,23,428 square meters (500 acres) of the area is a lush green campus enveloped with serene beauty and environment. The total main campus area of the University is 11,04,709.69 meters squares, where the total constructed area is 1,49,471.92 meters square till December 2019 as per the planning and construction report. Moreover, the university has 5,66,599.84 meter squares of planted vegetation area and approximately 1,33,546 meter squares of forest area, including 64,749.696 meter squares land declared as Botanical garden. The university has approximately 1,21,405.68 meter squares of area for water absorption besides the forest and planted vegetation. Many departments, centres, hostels, and offices maintain their private gardens which have particularly helped to keep up the campus' greenery with flaxen biodiversity around.

Campus sites

Entrance of the East-Campus

Entrance of North Campus

Entrance of West Campus

Administrative building in Main campus

Energy Management:

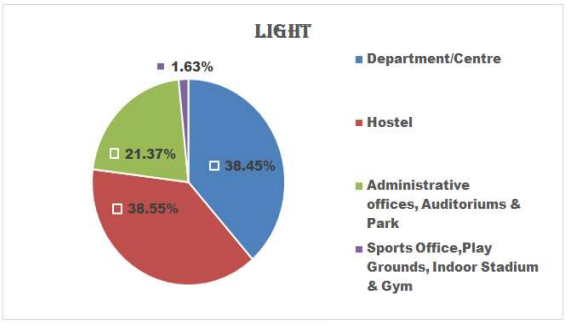
As reported, the University has used 2682.18 kilowatts of electricity from December '1, 2019 to November'30,2020 through various electrical appliances such as light, fan, AC, Refrigerator, water cooler, Computer, projectors, etc. Survey-based analysis shows that the University including all the departments, hostels, offices, etc has 11,337 numbers of bulbs with 125 Halogen bulbs, 233 numbers of AC's, 55 numbers of Refrigerators, and 106 numbers of water coolers (Table 1).

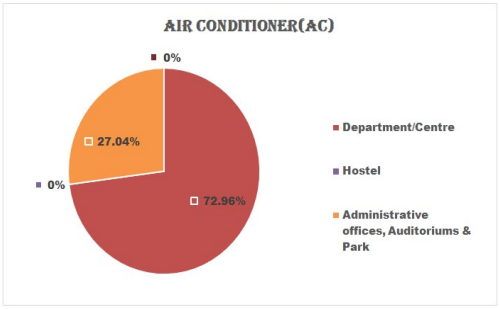
The Solar power utilization mechanism is also present within the University campus which helps in reducing greenhouse gas emission. Elements of green building implementation are reflected in all construction and renovation policies. Energy-efficient appliances usage are being substituted by conventional appliances like LED bulbs etc.

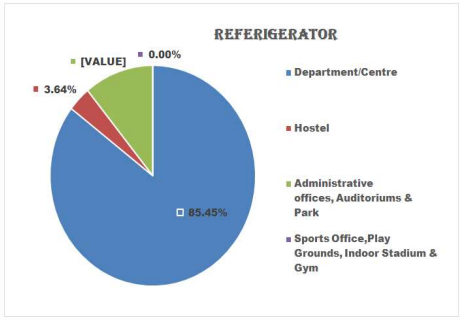
LED tubes are used as energy efficient measure

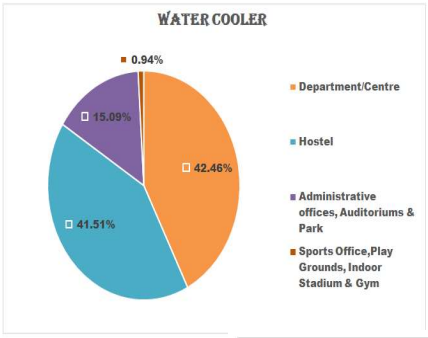
Table 1 Energy Consumption

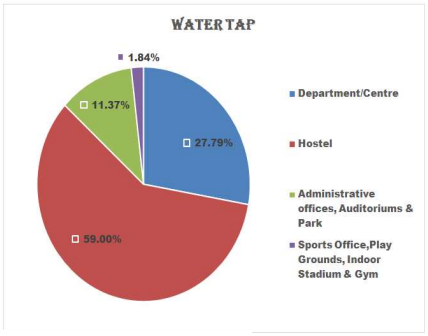
Name of Department / Centres / Offices/Hostels	No. of Lights	No. of AC	No. of Refrigerator	No. of Water Cooler
Dept. of Anthropology	94	2	4	0
Dept of Applied Geology	41	1	0	1
Dept of Assamese	75	7	0	1
Dept. of Chemistry	296	12	7	1
Dept. of Commerce	75	2	0	1
Dept. Of Economics	75	2	0	1
Dept. Of Education	250	2	1	3
Dept. Of English	65	2	0	1
Dept. Of History	75	2	0	1
Dept of Life Sciences	176	8	13	1
Dept. Of Mathematics	98	2	0	1
Dept. Of Petroleum Technology	130	7	1	1
Dept. Of Pharmaceutical Sciences	340	6	3	1
Dept. Of Physics &Centre for Studies in Atmospheric Studies	253	18	7	3
Dept. of Political Science	87	1	1	2
Dept. Of Sociology	101	3	0	1
Dept. Of Statistics	113	1	0	1
Centre for Computer Studies	110	7	0	1
Centre for Juridical Studies	175	2	0	2
Centre for Library and Information Science	36	1	0	1
Centre for Management Studies	70	11	2	3
Centre for Master in Social Works	81	2	0	1
Centre for Studies in Biotechnology	180	17	6	1
Centre for Studies in DUIET	788	36	1	7
Centre for Studies in Behavioral Sciences	47	1	0	1
Centre for Studies in Geography	51	1	0	1
Centre for Studies in Journalism and Mass Communication	42	1	0	1
Centre for Studies in Languages	29	2	0	1
Centre for Studies in Philosophy	34	1	0	0
Centre for Studies in Physical Education	65	2	0	1
Centre for Tea and Agro Studies	46	6	1	1
Centre For Women's Studies	35	1	0	1
Dr. Bhupen Hazarika Centre for Performing Arts	226	1	0	1
Administrative Offices, Directorate of Open and Distance Learning, Auditoriums and Park	2523 (Halogens = 51)	63	6	16
Sports Offices, Indoor Stadium, Gym, Playground	185 (Halogens = 74)	0	0	1
Hostels	4370	0	2	44
Rest Stop + Street Light	401	0	0	0
Total	**11347 (Halogens = 125)**	**233**	**55**	**106**

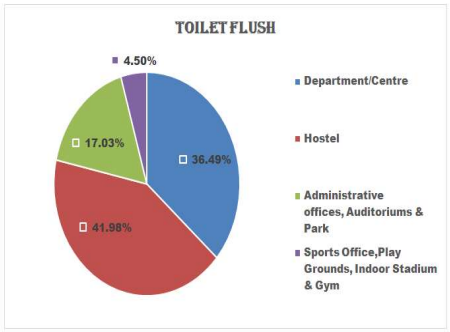












Pie diagram of number of electrical appliances owned by the university

Smart and Green Building implementation (the LNB Library)

Automatic door sensor system

Automatic lift system

Natural ventilation as a part of smart building

Renewable energy produced inside campus

Solar power plant at Engineering Workshop (solar panels)

Solar power plant at Engineering Workshop (batteries)

Biogas plant in the guest house in East Campus

Estimation of Carbon Emission

Carbon emission through power consumption activity

Carbon emission was estimated from the total power consumption in the university campus on monthly basis all through the year. The electricity consumption bills for the year i.e. December 2019 to November 2020 are considered as a bona fide source through which the total unit of electrical consumption was calculated. It can be seen that the huge campus area with two major campuses (east and west) with different building blocks in it, the total power consumption for the time period is 2682.18 KWH (Table 2) i.e., 2.68 MWH.

Based on this we can calculate the carbon emission on the campus due to electricity consumption, by considering carbon emission factor (β) for electricity to be 0.81 per MWh to be

$$C=\beta E= 0.81*2.68 = 2.17 \text{ tons/year}$$

Table 2: Electricity uses in the university campus per month

Months	Electricity Uses (in kilo watt)
December 2019	242.33
January , 2020	195.8
February , 2020	222.25
March, 2020	230.87
April, 2020	160.65
May , 2020	187.07
June , 2020	217.61
July , 2020	239.63
August , 2020	259.38
September , 2020	248
October , 2020	268.82
November , 2020	210.77
Total (in one year)	**2682.18**

Transportation in Dibrugarh University

Vehicular pollution is the preface of detrimental substances into the environment by motor vehicles. These materials, known as pollutants, have numerous bad effects on human health and the ecosystem. Examples of such pollutants include Carbon monoxide, Hydrogen, Nitrogen Oxides, particulate matter, Ammonia, Sulphur Dioxide, etc. In order to calculate the pollutant emission level in Dibrugarh University, a survey was conducted on the University Campus and the statistical data gathered as such is presented here.

The University owns 7 numbers cars including 2 ambulances and 1 bus. The bus is used for the to and fro transportation of some of the employees (a small portion only) of the University. The majority of the employees and the faculties use their private vehicles. On the other hand, the majority of the students reach the University or their respective departments by walking, by bicycle, or by local public transports; which eventually indicates lesser carbon footprint by the student community.

Parking area type

Carbon emission from transport activity

The number of vehicles visiting on a working day and on a holiday to the campus along with the mode of transport used by the students, teachers, staff, and visitors has been surveyed to estimate the amount of carbon emitted into the atmosphere. As per the survey around 1547 two-wheelers and 596 four-wheelers enter the university campus on a working day, and on a holiday were found to get reduced to 610 and 213 respectively. About 25 staff/teachers come to the university by using the university bus service. Hence for calculating the carbon emission we have considered an average of 5 km of distance traveled by each person. The emission factor suitable for Indian terrain had been used in computing the carbon emission.

Table 3:No. of vehicles entered in DU campus

No. of vehicles entered in Dibrugarh University through Jyotibatsora Gate (Working Day)			**No. of vehicles entered in Dibrugarh University through Jyotibatsora Gate (Holiday)**			**No. vehicles entered in Dibrugarh University through DUIET Gate (Working Day)**		
2W	4W	3W	2W	4W	3W	2W	4W	**3W**
661	253	8	610	213	17	886	343	**17**

In order to calculate the total pollutant emission level in Dibrugarh University, the data of vehicle pollution is collected from Auto Pollution Testing Center (Table 4). So from these data, the total pollutant emission level in Dibrugarh University is calculated for a working day (Table 5) and for a holiday (Table 6).

Table 4: Vehicle pollutant emission rate (**Source:** Auto Pollution testing center)

Vehicle Type	**Percentage of CO_2**	**Hydrocarbon measured in PPM**
2 Wheeler	3.5	**6000**
3 Wheeler	3.5	**6000**
4 Wheeler	3	**1500**

Table 5: Vehicle pollutant emission in DU campus (Working day)

Vehicle Type	% of CO_2 X Total Vehicles	Hydrocarbon in PPM x Total Vehicles	Total
2 Wheeler	3.5	6000 x (661 + 886)	**9,282,000**
3 Wheeler	3.5	6000 x (8 + 17)	**150,000**
4 Wheeler	3	1500 x (253 + 343)	**894,000**
	Total Hydrocarbon Emission in PPM		**10,326,000**

Table 6: Vehicle pollutant emission in DU campus (Holiday)

Vehicle Type	% of CO_2 X Total Vehicles	Hydrocarbon in PPM x Total Vehicles	Total
2 Wheeler	3.5	6000 x 610	**3,660,000**
3 Wheeler	3.5	6000 x 17	**102,000**
4 Wheeler	3	1500 x 213	**319,500**
	Total Hydrocarbon Emission in PPM		**4,081,500**

a. Carbon Emission from 25 number of individuals using bus service on a working day is

   25 * 0.023 * 5 = 2.87 kg of CO_2 per day

b. Emission from two wheelers:

   Working day

   1547 * 0.054 * 5 = 417.69 kg of CO_2 per day

   Holiday

   610 * 0.054 * 5 =164.7 kg of CO_2 per day

c. Emission from 3 wheelers (Auto)

   Working day

   25 * 0.13 * 5 = 16.25 kg of CO_2 per day

   Holiday

   17 * 0.13 * 5 =11.05 kg of CO_2 per day

d. Emission from four wheelers

   Working day

   596 * 0.175 * 5=521.5 kg of CO_2 per day

Holiday

213 * 0.175 * 5 =186.37 kg of CO_2 per day

Total carbon emission on a Working day

a+ b+ c+d = 2.87+417.69+16.25+521.5 = 958.31 kg of CO_2 per day

Total carbon emission on a Holiday

b+ c+d = 164.7+11.05+186.37=362.12 kg of CO_2 per day

Therefore the total carbon dioxide emitted from transportation activity within and outside the university premises on a working day is 958.31 kg of CO_2 per day or **21.083 tons/month** (considering 22 working days in a month on an average) and on a holiday is 362.12 kg of CO_2 per day or **2.897 tons/month** (considering 8 holidays in a month on an average).

Total vehicular Carbon emission = 21.083 +2.897 =23.98 tons/month

or 287.76 tons /year.

Plant diversity and carbon footprint

Bio-diversity is the variety and variability of life on earth. This includes all the plants and animals that live and grow on the earth, all the habitats in which they survive, and all the natural processes of which they are a part. The earth supports an incredible array of bio- diversity. Bio-diversity is often simply defined as the number of different species in a given geographical area (MacDonald, 2003). The greater number of species present, the greater the biodiversity.

Table 7: List of identified plant species inside the Dibrugarh University campus with taxonomic details

Sl no	Local Name	English Name	Scientific Name	Family	Community
1	Norosingho	Curry tree	*Murrayakoenigii*	Rutaceae	Evergreen
2	Jobaphul	Hibiscus	*Hibiscus sp*	Malvaceae	Evergreen
3	Nemu	Lemon	*Citrus limon*	Rutaceae	Evergreen
4	Neem	Neem	*Azadhirachta indica*	Meliaceae	Evergreen
5	Aam	Mango	*Mangiferaindica*	Anacardiaceae	Evergreen

6	Nahor	Rose chestnut	*Mesuaferrea*	Calophyllaceae	Evergreen
7	Tamul	Betel nut	*Areca catechu*	Arecaceae	Evergreen
8	Korobi	Yellow oleandr	*Cascabelathevetia*	Apocynaceae	Evergreen
9	Nuni	Mulberry	*Morussp*	Moraceae	Evergreen
10	Bokul	Spanish cherry	*Mimusopselengi*	Sapotaceae	Evergreen
11	Kothal	Jackfuit	*Artocarpus heterophyllus*	Moraceae	Evergreen
12	Bottle brush	Red bottle Brush	*Calliseemonsp*	Myrtaceae	Evergreen
13	Khejur	Date plum	*Phoenix Dacactylifera*	Arecaceae	Evergreen
14	Gulap	Rose	*Rosa rubiginosa*	Rosaceae	Evergreen
15	Tejpat	Cinnamon leaf	*Cinnamonum tamala*	Lauraceae	Evergreen
16	Champaphul	Champak	*Mognolia Champaca*	Magnoliaceae	Evergreen
17	Kol	Banana	*Musa sp*	Musaceae	Evergreen
18	Togor	Jasmin	*Jasminumsp*	Oleaceae	Evergreen
19	Siris	Lebbek tree	*Albizialebbeck*	Fabaceae	Evergreen
20	Ashok	Ashoka tree	*Saracaasoca*	Fabaceae	Evergreen
21	Chandan	Sandal woods	*Santalum album*	Santalaceae	Evergreen
22	OuTenga	Elephant Apple	*Dilleniaindica*	Dilleniaceae	Evergreen
23	Vang	Canabis	*Cannabis sp*	Cannabaceae	Evergreen
24	Dhopat	Tabacco	*Nicotianatabacum*	Solanaceae	Evergreen
25	Hez	Golden Dewdrop	*Durantarepens*	Verbenaceae	Evergreen
26	Nashpati	Pear	*Pyrus*	Rosaceae	Evergreen
27	Lichu	Litchi	*Litchi chinesis*	Sapindales	Evergreen
28	Paatbahar	Garden croton	*Codiaeum Variegatum*	Euphorbiaceae	Evergreen
29	Chandan	Sandal wood	*Santalum album*	Santalaceae	Evergreen
30	Jetuka	Henna Tree	*Lawsoniainermis*	Lythraceae	Evergreen
31	SthalPodum	Cotton Rosemallow	*Hibiscus mutabilis*	Malvaceae	Evergreen

32	WollenPhool	Goldenrods	*Solidago*	Asteraceae	Evergreen
33	Borgos	Banyan	*Ficusbenghalensis*	Moraceae	Evergreen
34	Taal	Tala Palm	*Borassusflabellifer*	Arcaceae	Evergreen
35	Thekera	BorThekera	*Garcinia pedinculata*	Clusiaceae	Evergreen
36	Titaful	Nongmangkha	*Phlogacanthus thyrsiflorus*	Acanthaceae	Evergreen
37	Bohotgos	Monkey Fruit	*Artocarpuslacucha*	Moraceae	Evergreen
38	Kharikajai	Jasmine	*Jasminum auriculatum*	Oleaceae	Evergreen
39	Vekuri	Forest Bitterberry	*Solanumanguivi*	Solanaceae	Evergreen
40	Kopah	Cotton	*Gossypium*	Malvaceae	Evergreen
41	Bogijamun	White Berry	*Eugenia praecox roxb*	Rosaceae	Evergreen
42	MicPhool	Trumpet vine	*Campsisradicans*	Bignoniaceae	Evergreen
43	Alakananda	Golden Trumpet	*Allamanda Cathartica*	Apocynaceae	Evergreen
44	Kamini Phool	Jasmine orange	*Murraya Paniculata*	Rutaceae	Evergreen
45	Mosonda	Red flag bush	*Mussaenda erythrophylla*	Rubiaceae	Evergreen
46	Japanesse Ejar	Crepeflower	*Lagerstromea indica*	Lythraceae	Evergreen
47	Bah	Bamboo	*Bambusoideae*	Polaceae	Evergreen
48	Mosambi	Sweet lemon	*Citrus limetta*	Rutaceae	Evergreen
49	Kanchon	White orchid-Tree	*Bauhinia acuminate*	Fabaceae	Evergreen
50	Dhotura	Jimsonweed	*Daturastramonium*	Solanaceae	Evergreen
51	Titasopa	Champak	*Magnolia Champaca*	Magnoliaceae	Evergreen
52	Akon	Milkweed Family	*Asclepiadaceae*	Apocynaceae	Evergreen

53	Gudhatamul	Bottle palm	*Hyphorbe lagenicaulis*	Arcaceae	Evergreen
54	Mumaitamul	Areca palm	*Dypsislutescens*	Arcaceae	Evergreen
55	Hunali Bah	Golden Bamboo	*Bombosavulgarus*	Poaceae	Evergreen
56	BhulaGos	Sea hibiscus	*Hibiscus tiliaceus*	Malvaceae	Evergreen
57	Huwalo	Meda	*Litseamonopetata*	Lauranceae	Evergreen
58	RongGos	Achiote	*Bixaorellana*	Bixaceae	Evergreen
59	Budha bah	Budhas belly bamboo	*Bambusatuldoides*	Poaceae	Evergreen
60	Rokto Chandan	Red Sandalwood	*Ptrocarpus Samtatinus*	Fabaceae	Evergreen
61	Teteli	Tamarin	*TArmarindus indica*	Fabaceae	Evergreen
62	Cactus	Cactus	*Cactusea*	Cactaceae	Evergreen
63	Komolla	Orange	*Citrus sinensis*	Rutaceae	Evergreen
64	Tokou	Fan palms	*Livistona jenkinsiana*	Arecaceae	Evergreen
65	Kordoi	Starfruit	*Averrhoa Carambola*	Oxalidaceae	Evergreen
66	Kajinamu	Keylime	*Citrus aurantifolia*	Rutaceae	Evergreen
67	Kotonapholl	Pinwheel Flower	*Tabernaemontana divorcata*	Apocynaceae	Evergreen
68	Dhutura	Jimsonweed	*Daturastramonium*	Solanaceae	Evergreen
69	Gulnamu	Tangor	*Citrus nobilis*	Rutaceae	Evergreen
70	Brush phull	Suriname	*Calliandra surinamensis*	Fabaceae	Evergreen
71	Shum	Persia	*Perseabombycina*	Lauraceae	Evergreen
72	Robabtenga	Pomelo	*Citrus maxima*	Rutaceae	Evergreen
73	Jokolu	Macaranga	*Macaranga denticulata*	Euphorbiaceae	Evergreen
74	Acacia	Acacia	*Acacia leptocarpa*	Fabaceae	Evergreen
75	Narikol	Coconut	*Cocosnucifera*	Arecaceae	Evergreen

76	Hasi	Agarwood	*Aquilaria*	Thymelacacea E	Evergreen
77	Neel Gos	Neel Gos	*Indigofera zollingaeriana*	Fabaceae	Evergreen
78	Kola jamu	Black plum	*Syzygiumcumini*	Ericaceae	Evergreen
79	Amita	Papaya	*Carica papaya*	Caricaceae	Evergreen
80	Kodom	Burflower	*Neolamarckia cadamba*	Rubiaceae	Semi Evergreen
81	Bormedelua	Peacock flower	*Caesalpiniaceaesp*	Fabaceae	Semi Evergreen
82	Tulokhi	Holy basil	*Ocimum tenuiflorum*	Lamiaceae	Semi Evergreen
83	Hilikha	Chebulic Myrobalan	*Terminaliachebula*	Combretaceae	Semi Evergreen
84	Ahot	Peepal tree	*Ficusreligosa*	Moraceae	Semi Evergreen
85	Radhasura	Peacock flower	*Caesalpiniasp*	Fabaceae	Semi Evergreen
86	Debodaru	Debodaru	*Polyalthialogifolia*	Annouaceae	Deciduous
87	Bogori	Jujubi	*Ziziphussp*	Rhanaceae	Deciduous
88	Sotiona	Devil tree	*Alstoniasp*	Apacynaceae	Decidious
89	Hengalu	Meda	*Litseapolyanthasp*	Lauraceae	Deciduous
90	Himolu	Silk cotton tree	*Bombacaceaesp*	Bombacarica	Deciduous
91	Dimoru	Anjeer	*Ficuscarica*	Moraceae	Deciduous
92	Amlokhi	Goosebrry	*Phyllanthus*	Phyllanthacea e	Deciduous
93	Krishnasura	Flame tree	*Delonixregie*	Fabaceae	Deciduous
94	Rubber	Rubber	*Haveabrasiliensis*	Euphorbiaceae	Deciduous
95	Kanchan	White orchid Tree	*Bauhinia acuminate*	Fabaceae	Deciduous
96	Arjun	Arjuna	*Terminaliaarjuna*	Combretaceae	Deciduous
97	Dighloti	Litsea	*Litseasalicifali*	Lauraceae	Deciduous
98	Ghoranim	Chinaberry	*Meliaazedanach*	Meliaceae	Deciduous

99	Segun	Teak	*Tactonagrandis*	Lamiaceae	Deciduous
100	Nora bogori	Peach	*Prunuspersica*	Rosaceae	Deciduous
101	Lily	Lily	*Liliumsp*	Liliaceae	Deciduous
102	Shishu	Rose wood	*Dallbargiasisso*	Fabaceae	Deciduous
103	Gohora	Premna	*Premnabegalenis*	Lamiaceae	Deciduous
104	Amora	Wild mango	*Spondiusmangifera*	Anacardiaceae	Deciduous
105	Dalim	Pomegranate	*Punicagranatus*	Lythraceae	Deciduous
106	Modar	Tiger'sclaw	*Erythrinavariegata*	Fabaceae	Deciduous
107	Bel	Bael	*Aeglemarmelos*	Rutaceae	Deciduous
108	Polakh	Basted teak	*Buteamonosperma*	Fabaceae	Deciduous
109	Bual	Axlewood	*Anogeissuslatifolia*	Combretaceae	Deciduous
110	Borgos	Baniyan tree	*Ficusbengalensis*	Moraceae	Deciduous
111	Ponial	Indian pulm	*Flacouritaindica*	Salicaceae	Deciduous
112	Sonaru	Golden shower tree\golden rain Tree	*Cassia fistula*	Fabaceae	Deciduous
113	Kuhiyar	Suger cane	*Saccharum spontaneum*	Poacea	Deciduous
114	Sojina	Drumstick	*Moringaoleifera*	Moringaceae	Deciduous
115	Ajar	Pride of India	*Lagerstroemia speciosa*	Lythraceae	Deciduous
116	Gomari	Beech wood	*Gmelinaarborea*	Lamiaceae	Deciduous
117	Gulonch	Plumeria	*Plumeriarubra*	Apocynaceae	Deciduous
118	Bilatihunaru	Pink shower	*Cassia javanica*	Fabaceae	Deciduous
119	Hewali	Coral jasmine	*Nyctanthessp*	Oleaceae	Deciduous
120	Nogatenga	Nutgall tree	*Rhussemialata*	Anacardiaceae	Deciduous
121	Egyptian Starcluster	Egyptian Starcluster	*Pentaslanceolata*	Rubiaceae	Deciduous
122	Jolphai	Olive	*Oleaeuropaea*	Oleaceae	Semi Deciduous
123	Bok phul	Hummingbird Tree	*Sesbania grandiflora*	Fabaceae	Semi Deciduous

124	Atlas	Sugar apple	*Annonasquamosa*	Annonaceae	Semi Deciduous
125	Modhuri	Guava	*Psidiumguajava*	Myrtaceae	Semi Deciduous
126	Omari	Omari	*Amoorawallichii*	Amooraceae	-
127	Siju	Spurge tree	*Euphorbia Neriifolia*	Euphorbiaceae	-
128	Begena	Brinjal	*Solanum Melongena*	Solanaceae	-
129	KitabPhool	White cedar	*Thujaorientsalis*	cupressaceae	Coniferous
130	Araucaria	Norfolk Island Pine	*Araucaria heterophylla*	Araucariaceae	Alpine

Table 8: Number of species found from the major plant community

Sl no	Community	Total Number of species
1	Evergreen	79
2	Semi Evergreen	6
3	Deciduous	35
4	Semi Deciduous	4
5	Coniferous/Alpine/others	5
Total		130

The Dibrugarh university campus is located at tri-junction of three prominent vegetation zones viz. i) monsoon deciduous type by Indian climatic condition, ii) evergreen type (Indo-Myanmar bio-diversity), and iii) evergreen and coniferous (East-Himalayan biodiversity); which makes the area a rich bio-diversity region, and thus the maximum number of prominent types of evergreen species are found here. However, the area is also covered by monsoon deciduous types of species including *Litseapolyantha, Tactonagrandis, Erythrina variegateetc.* In all 133 species, some species are naturally grown but some are planted in a specific thematic manner for e.g. Nahor (*Mesuaferrea)* which belongs from the evergreen community. A few other species of exotic variety were planted in the campus by making a significant presence here, that include *Polyalthialogifolia, Thujaorientsalis and Araucaria heterophylla*

belonging to deciduous, coniferous, and alpine community respectively.

Biomass and carbon estimation from trees

Estimation of above-ground biomass (AGB) is a crucial part of carbon stocks. Estimated C pools in different forest types can be used in making decisions about C management within forests. Generally, in the estimation of biomass from trees, allometric equations are used. Allometric equations explain the correlation of one part of a plant to another part of a plant. Usually, some parts of the plant are easier to measure than other parts. Usually, it is easy to gauge and foretell the hard parts i.e. tree trunk or girth and height (eg. Use diameter to predict tree height for a given

species). In the present study, we had first measured the aboveground biomass for trees. It was calculated using the tree girth at breast height and the total height of the tree, similarly, the constant variables based on tree species are taken into account for estimating total biomass. This is further used for measuring carbon C stored in the tree species.

In this project, the Tree survey reveals that there are 21,037 trees on the university campus. A large tree inhales 20.3 kg of CO_2 in a year and exhales enough oxygen for a family of four for a year. As there are 21,037 numbers of trees on the University campus, so in total, the trees within the campus inhale (20.3X 21037) **427,051.1 kg of** carbon per year. Again, with the aid of an online calculator of the U.S., it has been found that a single student on average produces 7.47 metric tons or 74700 kilograms of carbon per year. By considering 4631 present students in the university (for academic batch 2020-2021), it is found that the total carbon that the university produces per year is (4631 x 74700 kg) = 345,935,700 kg (being the major fraction, only the student group is considered here for the calculations). From this, it can be clearly assumed that every year (345,935,700- 427051.1) **345,508,649.9 kgs** of carbon remains on the university campus. As such, in order to reach a balanced environmental condition, the number of trees must be increased.

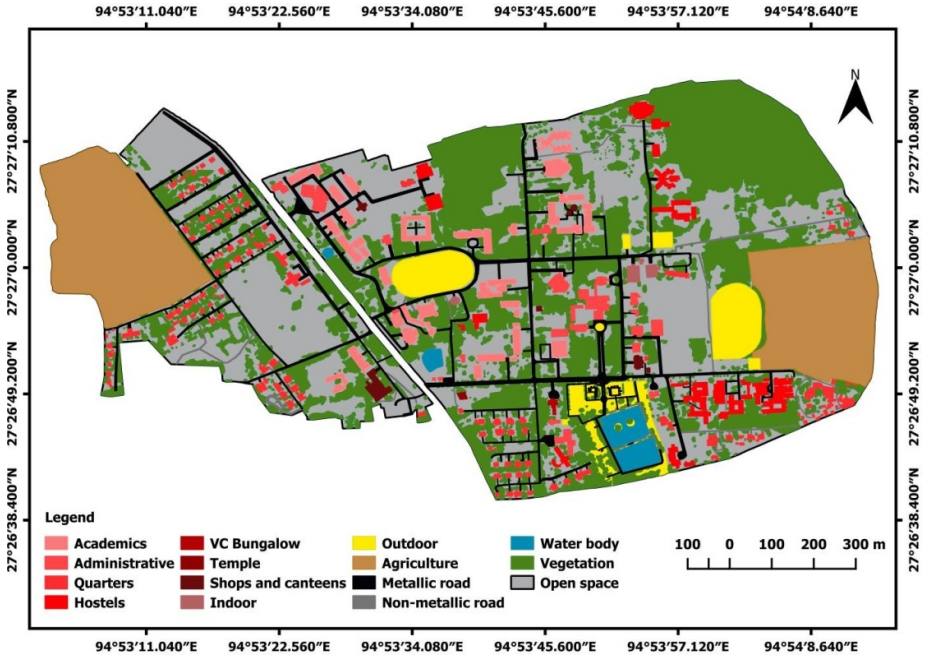
Land Use Dynamics of the campus:

Land use dynamics are very imperative in the identification of the most favorable land utilization of a given area. The land-use dynamics in the Dibrugarh University campus are studied through the digitization of different land-use classes. For better convenience of the study and availability of data, Google earth image is considered as

the base for the analysis, and a total of 15 classes were considered to delineate the geographical objects inside the campus. The Table 7 summarizes the total land area and percentage of area occupied by each LU/LC class across the study area.

Table 9: The total land area and percentage of area occupied by each LU/LC classes

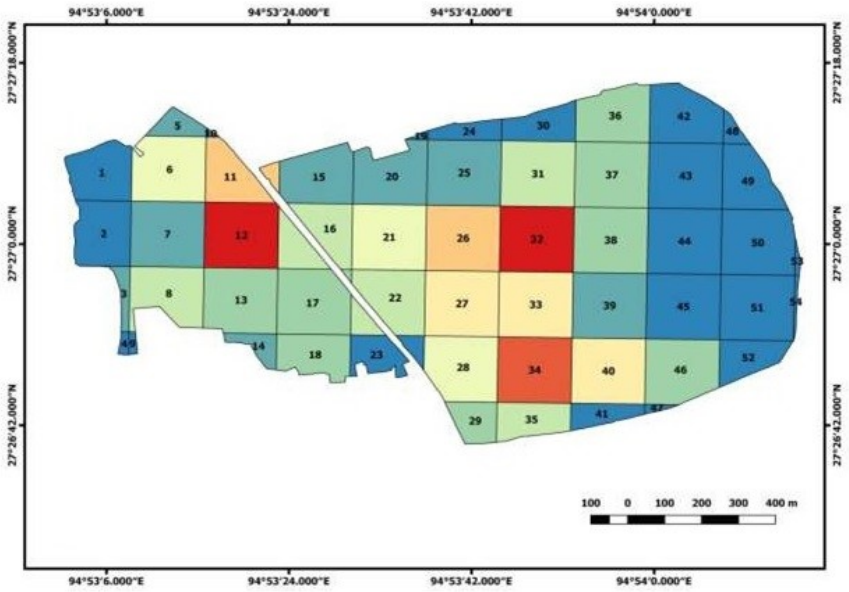
Sl. No.	LU/LC class	Total area (sq. m)	Area in Percent (%)
1	Academics	39225.75	**2.65**
2	Administrative	17449.81	**1.18**
3	Hostel	24440.31	**1.65**
4	Quarter	25728.17	**1.74**
5	VC Bungalow	513.37	**0.035**
6	Indoor	2659.40	**0.18**
7	Outdoor	77386.35	**5.25**
8	Shops and canteens	4018.69	**0.27**
9	Temple	329.54	**0.022**
10	Agriculture	205020.72	**13.90**
11	Metallic road	78412.17	**5.32**
12	Non metallic road	7689.35	**0.52**
13	Water body	16600.89	**1.13**
14	Vegetation	452488	**30.67**
15	Open space	523216.70	**35.47**
	LU/LC	**951962.5162**	



Land use land cover of Dibrugarh University

Grid wise analysis of LU/LC:

In order to have a critical study of the vegetation cover within the university campus we have used a density grid analysis, which is a way to envision and analyze (polygon) data by transforming the polygon into a regular grid. For the present study, each resulting grid cell is assigned a value that is determined by the density of nearby polygon three main LU/LC classes have been selected for grid-wise density analysis for vegetation, built-up, and roads.

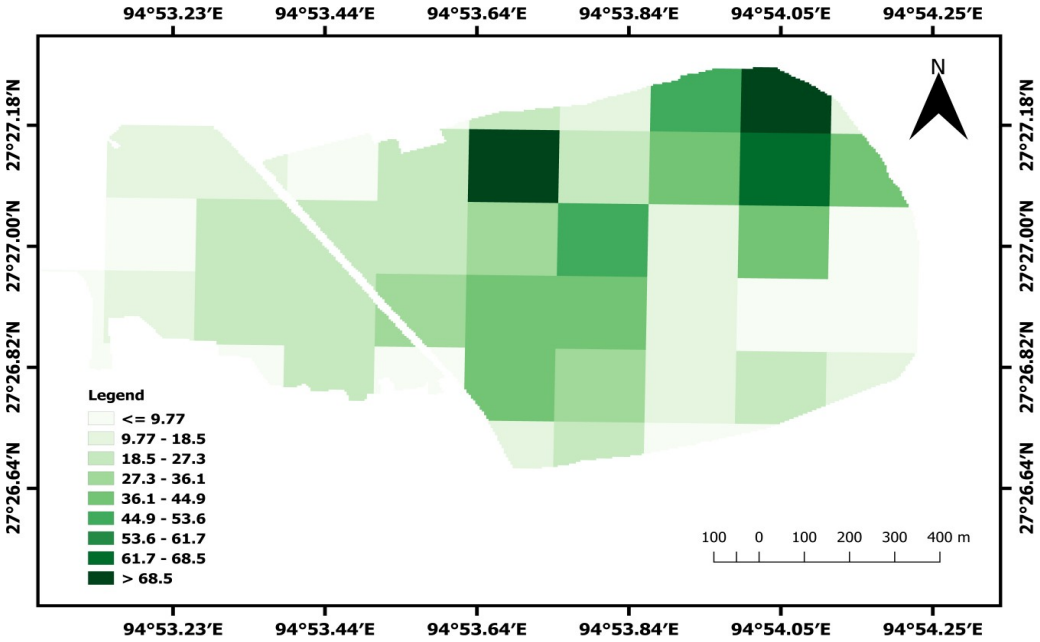


Grid no. reference map

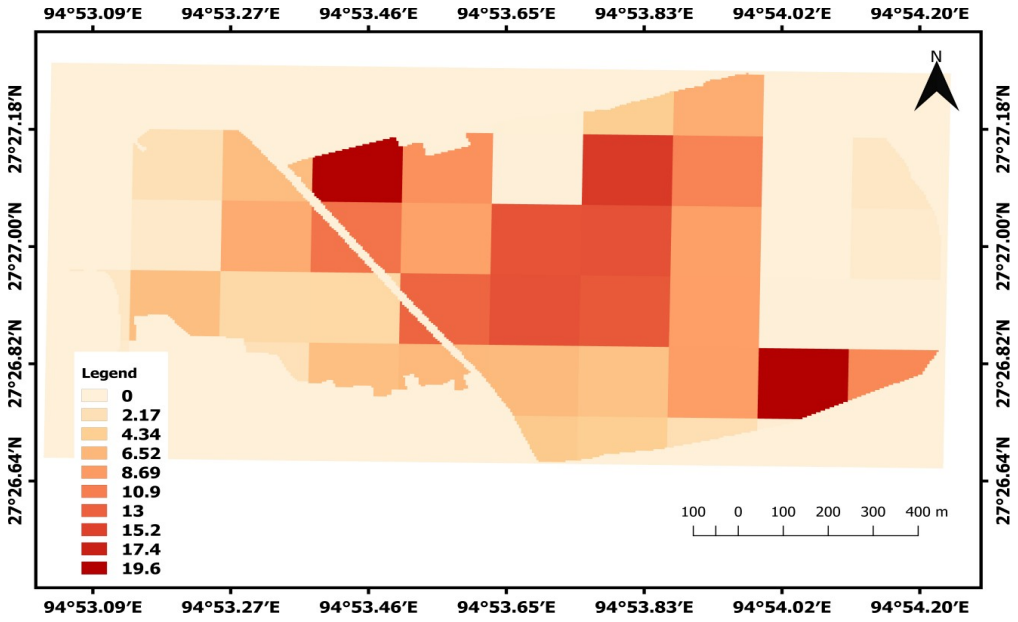
Table 10: Grid wise density analysis that is vegetation, built-up and roads

Grid Number	Vegetation density (percent)	Buildup density (percent)	Road (percent)
1	0	0	**0**
2	0	0	**0**
3	2	1	**0.28**
4	2	1	**0.03**
5	0	0	**2.29**
6	15	2	**5.74**
7	5	1	**2.044**
8	18	6	**4.37**
9	2	0	**0.68**
10	0	0	**0.41**
11	13	6	**10.32**
12	23	7	**8.12**
13	23	3	**5.08**
14	4	2	**2.52**
15	3	20	**12.89**
16	27	12	**9.4**
17	23	3	**5.78**
18	21	6	**1.57**
19	2	0	**0**
20	20	9	**3.74**
21	26	8	**7.024**
22	34	13	**8.41**
23	9	6	**4.78**
24	19	0	**1.095**
25	72	0	**4.97**
26	34	14	**11.96**
27	37	14	**6.18**
28	42	6	**8.47**
29	16	5	**2.65**
30	13	4	**0.30**

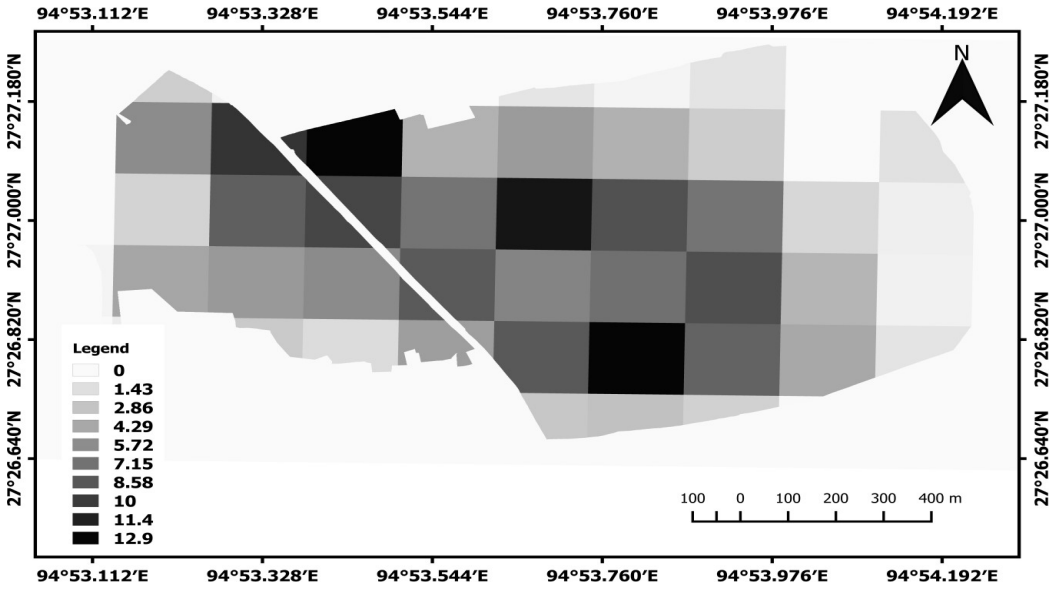
31	25	16	**3.80**
32	48	14	**8.85**
33	44	13	**7.229**
34	33	5	**16.99**
35	25	4	**2.97**
36	53	7	**1.16**
37	42	10	**2.36**
38	18	8	**7.03**
39	17	8	**8.94**
40	18	8	**7.92**
41	6	2	**2.12**
42	77	0	**0**
43	67	0	**0**
44	38	0	**1.85**
45	8	0	**3.61**
46	27	26	**4.26**
47	1	0	**0.003**
48	10	0	**0**
49	38	1	**1.28**
50	8	1	**0.57**
51	1	0	**0.45**
52	16	10	**1.145**
53	0	0	**0**
54	0	0	**0**



Grid wise density of prominent tree species in Dibrugarh University Campus



Grid wise density of built up areas inside Dibrugarh University Campus



Grid wise map of road density in Dibrugarh University Campus

From the Table 10, it is seen that Grid numbers 1, 2, 5, 10, 53, and 54 show no vegetation due to the presence of agricultural land and open field. Whereas the highest vegetation cover is found in grid number 42 (77%) followed by 25, 28, 32, 33, 36 and 43 (72%, 42%, 48%, 44%, 53%, 67% respectively). Lowest vegetation (only 1%) is found in grid numbers 47 and 53. The grid numbers 3, 4, 7, 9, 14, 15, 19, 23, 45 exhibits less than 10%, while the remaining grids retain medium vegetation cover.

There is no built-up area present in the grid numbers 1, 2, 5, 9, 10, 19, 24, 25, 42, 43, 44, 45, 47, 48, 51, 53, 54. Highest density built-up is there in the grid number 46 (26%) followed by 15, 31, 32, 26, 27, 33 and 22 with density of 20%, 16%, 14%, 14%, 14%, 13% and 13% respectively. 1- 5% built-up density is found in the grids 3, 4, 6, 7, 13, 14, 17, 29, 30, 34, 35, 41, 49 and 50. Remaining grids exhibit 5- 12% built-up density.

The the high density of road is found in the grid numbers 11 (10.3%), 15 (13%), 26 (12%) and 34 (17%) whereas the grid numbers 3, 4, 10, 30, and 47 preserve the lowest density of road (0.003-0.41%). 1-4% of the road density is found in the grids 5, 6, 7, 14, 18, 20, 24, 29, 31, 35, 36, 37, 41, 44, 45, 49, 52. The present retains of the remaining grids is 4-10% of roads.

The present analysis reveals that, the area cover by vegetation and water bodies are 30.67 % and 1.13 % respectively, whereas, the built-up and roads are covered with 20.14 % area.

Water Management in Dibrugarh University

Wise use of water is a general practice in the departments, centres, hostels, and offices of the University. In this regard, the arrangement of piped water is the primary sources of water consumption within the University campus. Water tap, toilet flush, shower are the basic water-efficient appliances used in the University campus. The University owns 2990 numbers of water taps, 1110 numbers of toilet flushes in general.

There are sufficient water outlets for the students. But, during the survey, it was observed that some water coolers are not functional. Hence, for the proper functioning of the appliances, it should be one of the vital responsibilities of the University to keep a regular check on the running of these apparatus.

Besides that, it is found that Rainwater harvesting is not a practice in the University yet as of now.

Water Conservation Program Implementation

Natural water preservation in ponds

Water Efficient Appliances (water tape, toilet flash etc.)

Waste management in Dibrugarh University:

Waste management techniques are helpful for minimizing or reduction of waste in the environment and this help out to keep the environment unpolluted.

> "*Waste management or Waste disposal is all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment, and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling etc.*"(Wikipedia)

- There are several waste management techniques that are being adopted in the Dibrugarh University campus. Some of the initiatives being taken up are as follows:

- A numbers of source, segregation dustbins are installed within the ➢ University campus for the purpose of cleanliness. These are helping in selecting the wastes to be recycled and to be disposed off completely.
- Most of the organic and inorganic wastes are taken away by NGO-Prayash for disposal, mainly from the provided dust bins and hostels.
- The University has its own project of Vermi-Compost, where the organic wastes are (can be) used for compost. The produced compost can be used for promoting organic farming activities within the campus. The hostels and canteens can be motivated as well to use the product with a plan to ensure the availability of organic foods in the canteens and hostels for the future; which is the main purpose of this project.
- It must be noted that most of the departments and centres of the University have taken initiatives to cut down the use of paper and plastics.

Some practices requiring reformation:

- The daily generated wastes of the two busiest canteens of Dibrugarh University, Juti and Jo-Sag are disposed off to Dibrugarh District Municipality at regular intervals. However, the rest of the canteens dispose their wastes in their respective backyards.

- The various departments/centres, administrative offices of the university dump their generated wastes in a particular place and later on they burn it.

- University as of yet has not initiated any paper on the recycling program in addition to biogas project. In its place, most of the waste paper and toxic waste on an auction basis are put up for sale.

Awareness program related to environment and sustainability

Campaign to convert Waste to Wealth to Reduce the Use of Paper and Plastic

Events related to environment and sustainability

Recycling Program for University Waste

Vermicompost unit functional in the university campus

Table 11: Waste generated by the different food joints inside DU campus

Sl. No.	CANTEEN	Bio-degradable (in kg/day)	Bio-degradable (in kg /year)	Non–Bio-degradable (in kg/day)	Non–Bio-degradable (in kg /year)
1	Juti Canteen	30	**10950**	10	**3650**
2	Duiet Cafeteria	10	**3650**	2	**730**
3	Risha (DUDOL)	2	**730**	½	**182.5**
4	New Library Canteen	2	**730**	½	**182.5**
5	Jo-sag	15	**5475**	7	**2555**

Table 12: Waste generated by the International Hostels

Sl. No.	International hostel	BioDegradable (in kg/day)	Biodegradable (in kg /year)	Non–Bio-degradable (in kg/day)	Non–Bio-degradable (in kg /year)
1	International	5	**1825**	1	**365**
2	International	6	**2190**	1	**365**

Table 13: Waste generated by different boys' hostels

Sl. No.	Boys' Hostels	Bio- Degradable (in kg/day)	Bio-degradable (in kg/year)	Non–Bio-degradable (in kg/day)	Non–Bio-degradable (in kg/year)
1	Padmanath Gohain Baruah Chatra Nivas	29	**10585**	0.250	**91.25**
2	Maffijuddin Ahmed Hazarika Chatra Nivas	20	**7300**	0.150	**54.75**
3	Boys Hostel For Professional Courses	21	**7665**	0.100	**36.5**
4	LeelaGogoi Memorial Gobeshak Chatra Nivas (M.Phill. & research scholar hostel)	10	**3650**	0.200	**73**
5	DUIET hostel – I	30	**10950**	0.5	**182.5**
6	DUIET hostel – II	27	**9855**	0.350	**127.75**
7	Maniram Dewan Chatra Niwas	8	**2920**	0.100	**36.5**

Table 14: Waste generated by different girls' hostels

Sl. No.	Girls' hostel	Bio-Degradable (in kg/day)	Bio-degradable (in kg /year)	Non–Bio-degradable (in kg /day)	Non–Bio-degradable (in kg /year)
1	Jyomati Chatri Nivas	18	**6570**	4	**1460**
2	Nalinibala Devi Chatri Nivas	22	**8030**	8	**2920**
3	Aideo Handique Chatri Nivas	15	**5475**	7	**2555**
4	New Girls Hostel	6	**2190**	1	**365**
5	Girls Hostel For Professional Courses(Pushpalata Das Chatri Nivash)	12	**4380**	5	**1825**
6	Aideo Handique Chatri Nivas (New extended)	25	**9125**	7	**2555**
7	Padmakumari Gohain womens' Hostel(PKGH)	16	**5840**	7	**2555**
8	Swaranalata Baruah Chatr iNivas(SLBCN)	10	**3650**	3	**1095**
9	MRGCN	20	**7300**	15.5	**5657.5**

Table 15: Total estimates

	Bio-Degradable (in kg/day)	Bio-degradable (in kg /year)	Non–Bio-degradable (in kg /day)	Non–Bio- degradable (in kg /year)
Grand total	359	**131,035**	81.15	**29,619.75**

Food waste when thrown into land fields is responsible for 6% of global greenhouse gas (GHG) emissions, mainly Methane (CH_4), which is 25 times more efficient climate forcer (by trapping heat in the atmosphere) than carbon dioxide. For every kg of food waste thrown into landfills, 3.8 kgs CO_2 –equivalents (1 kg of CH_4 is equivalent to 25 kg of CO_2) gets emitted into the atmosphere. Based on this estimate, the total amount of GHGs produced by the canteens and hostels of Dibrugarh

University (Table 11 to Table 15) per day are 359 x 3.8 kgs= 1364.2 kgs or 131035 x 3.8 kgs = 497,933 kgs CO_2 –equivalents per year. A single car on an average generating about 13 kgs of GHGs per day, is an example

The carbon footprint of a food product is the total amount of GHG emitted throughout its lifecycle, expressed in kilograms of CO_2 –equivalents. Trash released nearly 800 million metric tons (882 million tons) of CO_2 equivalent in 2010 — about 11% of all CH_4 generated by humans. The food loss and waste generated annually 4.4 $GtCO_2$ equivalents, which is ~ 8% of total anthropogenic GHG emission globally. The contribution of food waste emission to global warming is almost equivalent (87%) to global road transport emission. Thus, minimizing food waste is recommendable.

Non-Bio-Degradable wastes are those wastes that cannot be broken down or degraded for many years. Thus, these wastes get accumulated and pollute the soil and water resources. Also due to the non-Bio-degradable nature, such wastes cover a huge amount of land that can create a lack of open space. In Dibrugarh University, the total amount of non-bio-degradable wastes that the canteens and hostels produce is 81.15 kg per day or 29,619.75 kg per year. These also can be utilized for earth filling etc.

Per Capita Paper Use:

Paper has been an indispensable part of human life ever since it was first invented in Ancient Egypt around 3700-3200 BC. The global demand for paper products is noteworthy, evidenced by the fact that more than 350 million tons are produced annually. According to WWF, over the years if the current paper production and consumption practices remain the same, then the increasing demand for paper will entail a lot of pressure on the last remaining natural forests and endangered wildlife living on the planet.

In order to understand the Environmental Sustainability of Dibrugarh University, it is very important to know the per capita paper use within the campus. As such a survey was conducted and the results are presented in Table 16 and Table 17.

Table 16: Per Capita Paper Use by Students per year, 2019

Sl. No.	Faculties of studies	Total Paper Use in Kg
1	Humanities and Social Sciences	7.27
2	Performing Arts	2.09
3	Science Disciplines	6.79
4	Commerce	7.27
5	Physical Education	4.64
Total		**28.06**

Table 17: Per Capita Paper Use by Authority per year, 2019

Sl. No.	Categories	Total Paper Use in Kg
1	Office	2003.2
2	Examination Branch	4062.94
Total		**6066.144**

From the data, it is understood that Per Capita Paper use by Students in Dibrugarh University is 28.0612 kg and as the total number of students in Dibrugarh University is 4631, so the total paper use in Dibrugarh University by students is (28.0612 kg x 4631) **129951.417 kg,** therefore the total use of paper in Dibrugarh University by Students and Administration in one year is (121645.30 + 6066.14) **136017.557 kg**. According to Yellow Printing, a China based printing company; approximately 10 trees which are 20-50 years old are required to turn out 500 kgs of A4 size paper. So, to produce **136017.557 kg** of paper (total paper used in Dibrugarh University per year), the required number of trees is **136017.557 kg/50 kg** = **2554.23 tress** per year.

Environment and Sustainability as a subject in curriculum:

The University has one centre that is called the Centre for Studies in Atmospheric Studies, which is entirely committed towards the study of Environment in particular.

Even though all the departments and centres do not have any environment-specific paper, but definitely a few have introduced within their curriculum in general, some topics which are related to environment and its sustainability.

Many departments and centers time and again take initiatives to organize awareness program concerning the environment for the purpose of sensitizing the people. In view of the fact that the Dibrugarh University Swachh Bharat team has been playing a crucial role in bringing about various cleanliness drives, tree plantation and awareness campaigns in the nearby villages and schools, in this regard the activities and initiatives carried out by the Dibrugarh University Swachh Bharat Mission team within and outside the university campus should be reflected upon.

Number of courses/modules related to environment and sustainability offered

ENVIRONMENTAL GEOGRAPHY **Unit-I: Conceptual Basis** (a) Defining the field of Environmental Geography: Emergence of Environmental Geography as a branch of Geography and its scope and significance. (b) Man Environment Relationship: Historical perspective on man's interaction with environment; population growth and environment. (c) Approaches to the study of man-environment relationship. **Unit-II: Ecosystem in the context of Development** (a) Concept and type of ecosystem; functioning of and energyflow in eco-System. (b) Bio-geochemical cycles and biosphere as an ecosystem. (c) Environment and Development: Concept of environment and development; sustainable Development Concept.	Example of Courses/Modules Related to Environment and Sustainability Offered (Dibrugarh University, Dibrugarh)

Unit-III: Environmental Hazards. (a) Environmental hazards: Meaning and types. (b) Tectonic disaster and climatis hazards of the world and NE India. (c) Flood hazards with special reference to the floods of the Brahmaputra river. **Unit-IV:Environmental Issues** (a) Global Environment Problems: Types and extent of environmental problems withspecial reference to NE India (b) Environmental Pollution: Factors, types and effects of environmental pollution. (c) Major regions of the world affected by environmental pollution. **Unit-V:Environmental Management** (a) Concept of environmental management and its necessity. (b) Approaches to environment management and Environment-impact assessment. (c) Global and regional environmental programmes and policies.	

EDUCATION FOR SUSTAINABL EDEVELOPMENT

I	**Concept of Sustainable Development**	Genesis of the Concept Sustainable Development : Goals and Strategies Needs of Sustainable Development Rights of future generations. Reduce, Reuse and Recycle Teaching the Next Generation: Educating for Sustainable

		Development policies
II	**Earth Summits, Convention and Policies**	Summits and conventions: Rio – Earth Summit, New York Summit, Recent Earth Summits and its implications Plans and Policies: Kyoto protocol , Agenda 21; World policies based on sustainable development, cooperative responsibility and the environmental security
III	**Sustainability and Gender Education**	Human and Sustainable Development, with an emphasis on gender perspective Women & child health: Skill enhancement, capacity building for sustainable health
IV	**Education in Ecological Implications of Development and Responses to Ecological Issues**	Conservation and control. Environmentalism and eco-consciousness. 'Green Orientalism': Indigenous peoples. ESP: Equality, Sustainability and Peace. Carbon budget, Carbon Trade, Carbon Footprint

Number of courses/modules related to environment and sustainability offered in 2017 = 12courses

Recommendations:

1. Reduction of Paper Uses:

It is recommended that the use of paper should be reduced wherever possible. It is suggested that information which is being saved in the administrative office in hard copies are transformed into digital format, the use of paper will automatically get condensed. Similarly, applications of students, teachers, and officers seeking

leave or other authorization-related matters, in particular, should be in digital format Moreover, all applications from the Departments/Centers and Hostels' to be forwarded to the P & C Branch, have got to be in digital format. Moreover, Hostels' offices should also be provided with a desktop computer for documentation of leave/permission applications by the boarders as well as for sending e-mails to the P & C branch for the purpose of applying for hostel requirements.

A paper recycling unit should be installed immediately.

2. Exporting waste to NGO-Prayash:

- To each and every department and center, the university should make available large dustbins for collection of wastes so that the same could be taken away by the NGO-Prayash.
- Similar to Juti and Jo-Sag, the other canteens and hostels on a regular basis should be stringently directed to export their generated wastes to the NGO-Prayash.

- The Non-Bio-Degradable wastes should be used for earth filling in the construction of buildings etc.

The departments that generate chemical wastes should employ up-to-date techniques to decontaminate the wastes so that the chemical wastes do not impact the soil/atmosphere within the university campus. They should be urged upon to get thr proper mechanisms to lessen chemical waste generation.

3. Installation of Biogas Plant

The decomposable waste produced inside the university campus together with the hostels, quarters, canteens, etc must be used to generate biogas, which can be additionally supplied to the hostels in a phased manner.

4. Proper management of Vermi Compost Unit

The existing vermicompost unit needs suitable management procedures. All the operating cost is borne by the Nodal officer in person. University is supposed to get the organic manure only from this unit instead of buying the same from outsiders. An apt mechanism for sound running of this unit should be implemented without delay.

The transformation practice of waste to manure should be encouraged amid the university fraternity.

5. Reduction of Electricity Consumption:

- Employ of a solar inverter, solar power for pumping out water initially in the hostels is strongly recommended.
- Sensor based lights in the corridors of large departments or buildings can lessen electrical energy consumption. Wherever applicable, Reflectors can also be utilized.
- Rain water harvesting is an added alternative to trim down electricity consumption. This will add to water management as well.

6. Reduction of Vehicular Emission:

- Strict rules should be put into operation in the use of motorbikes for the students living in the hostels within the University Campus to trim down carbon footprints.

7. Organizing Awareness Campaigns:

- On the basis of this statement the University must conduct awareness programs amongst the people within and outside the university grounds on the topics of Carbon Emission, Energy Consumption, Swacchta, Waste Management, Waste to Wealth Conversion, Hygiene etc for ecological sustainability.

8. Energy Audit:

- Estimation of energy consumption on the whole in the university campus will dole out as an efficient institutional input to energy consumption as well as to storing up quantitatively. Hence an additional audit on energy consumption is recommended.

9. Green Building Design

Espousal of Green Building blueprint in future infrastructure, by means of energy-efficient supplies, is suggested.

10. Prohibition in small scale burnings:

A stern regulation to forbid any type of blazing in the university campus ought to be put into practice. These burnings emit greenhouse gases and their antecedents (Table 18), which notably contributes to long and short-term global warming. The short life span of the species does not signify that these are detached entirely from the atmosphere, but these get chemically transformed into further detrimental green house gases like carbon dioxide, ozone, etc. As an alternative to the burning of the plant leaves etc, those can be used to fill up lowlands or can be deposited in a pit to be changed into organic manure.

Table 18: Species released from small scale burnings (hence recommended to reduce these burnings)

	Species		Source	Concentration over Dibrugarh	Source Contribution (%)			Lifetime of the species	Effect on climate and air quality	Health effect
	Aerosols				**Biomass burning/agricultural/waste**	**Firework**	**Vehicular emission**			
1	Particulate matter (diameter <2.5 micron% <10 micron)	Particulate matter ($PM_{2.5}$/PM_{10})	Biomass burning, vehicular emission, dust,	5-30 µgm-3		57%	30%	1 week	perturbs radiation budget of the atmosphere, haze/fog, air pollution episodes e.g., Delhi Pollution	eye, nose, throat, lung irritation, worsens asthma and heart diseases
3	Black carbon	BC	Biomass burning, vehicular emission	5-23 µgm-3	9%	12%	61%	7-10 days	causes warming in the atmosphere	
4	Sulphate	SO_4	oxidation of SO_2	2-10 µgm-3				1 week	scatters radiation and results in atmospheric cooling	chronic respiratory disease, cardiovascular disease
	Trace Gases/Greenhouse Gases									
5	Sulphur Dioxide	SO_2	power plants, industries, vehicles	1-18 ppb		63%	17%	2-3 days	precursor of sulphate aerosols, acid rain	chronic respiratory disease, cardiovascular disease
6	Oxides of Nitrogen	NO_x	NO_2 is secondary while NO is emitted from combustion (fossil fuel, vehicles, biomass burning)	1-100 ppb		137%	33%	5 days	precursor of O_3, acid rain	respiratory disorder, allergy
7	Ozone	O_3	Secondary product, from photochemistry (NO_x, CO, CH_4, VOCS)	1-60 ppb		52% (due to increase in precursor)		7 days	atmospheric warming, it is a strong oxidizing agent in the atmosphere, thus changes the atmospheric composition	skin cancer, lung disease, chest pain
8	Carbon Monoxide	CO	combustion (fossil fuel, vehicles, biomass burning)	50-2500 ppb	59%	19%	23%	60 days	atmospheric warming, precursor of O_3	respiratory disease
10	Methane	CH_4	agriculture, livestock, biomass burning, fossil fuel	50-4500 ppb	14%			10 years	warming (second largest GHG), precursor of O_3 and OH	vomiting, nausea, lung diseases

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