GREEN AUDIT REPORT

2020-21

COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY (CUSAT) KOCHI, KERALA

CONTENTS

GREEN AUDIT
OF
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

1. Introduction

Rapid urbanization fueled by economic growth on a local, regional, and global scale has resulted in various environmental and ecological issues. India is a developing country that is utilising science and technology for its vivid advancements. On the one hand, there is an improvement in lifestyle, but on the other hand, it is leading to environmental exploitation. Luxurious living is posing an environmental threat, making it unsuitable for future generations. The general public believes that the government and its concerned agencies are responsible for environmental protection. The bulk of industries are focused on their production and marketing plans rather than the control of environmental dangers for which they are responsible. In general, every member of our society is liable for environmental problems, and it is our responsibility to work hard to preserve it. If we begin with ourselves, we will undoubtedly establish a favourable baseline for environmental preservation. In the light of this, adopting a Green Campus concept for anyorganization is very much essential. Human – health is associated with the quality of the surrounding environment. Healthier surroundings ensure a better quality of life for the inhabitants. Studies have shown that the productivity of an individual is linked with the quality of life. Therefore, the Green Campus concept assist in promoting sustainability by improving human and environmental health. However, to address the key issues leading to environmental and resource degradation on the campus, it is vital to generate comprehensive baseline data regarding the existing system. In this context we carried out a Green Audit on the campus. Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various

establishments. It is a management system instrument that is used methodologically to protect and conserve the environment. It's also utilised to keep the environment in good shape. For environmental protection, the audit suggests many standard metrics, methodologies, and initiatives.The green audit is beneficial for detecting and monitoring sources of pollution in the environment, and it focuses on waste management of all types, energy consumption monitoring, water quality and quantity monitoring, risks monitoring, stakeholder safety, and even disaster management. The objectives in the present report involved evaluation of biodiversity, water management practices and indoor air quality in the campus. The findings from this audit are expected to have an impact on student/faculty health, productivity, operational costs, and the ecological systems in the campus.

This audit is conducted by the experts:

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2. Objectives

This report focused mainly on the following topics

- ***Biodiversity***
- ***Water management***
- ***Air quality***

3.Study area

The Cochin University of Science and Technology (CUSAT) main campus is located at South Kalamassery, Kochi, Kerala. The area lies between 10°02.747'N and 76° 19.371'E.The campus has a total area of 182.43 acres.

4. *Biodiversity*

4.1. *Floral diversity*

A total of 245 species of flora have been identified and documented from the campus. The floral diversity of the campus is classified into trees, shrubs, herbs, climbers, creepers and aquatic plants belonging to 80 families. The campus consists of angiosperms, gymnosperms, pteridophytes and bryophytes. However, in this report, we focused on angiosperms, gymnosperms and pteridophytes. Fabaceae with 23 species is the dominant family, followed by Apocynaceae with 16 species, followed by other families. Angiosperms are predominant with 238 species of both major groups – dicotyledons and monocotyledons. A total of 201 species belonging to 63 families of dicotyledons are recorded from the study area. In comparison, monocotyledons are accounted with 37 species belonging to 17 families.

Poaceae is the dominant monocotyledon family (13 species), and Fabaceae is the dominant dicotyledon family (16 species). Gymnosperm flora of the campus includes Cycas revoluta (Cycadaceae) and Araucaria columnaris (Araucariaceae). These two species of gymnosperm are cultivated as ornamental plants. Pteridophytes includes four terrestrial ferns (Maidenhair fern, Blechnumorientale, Lady fern, Pin fern) and one aquatic fern (*Azolla pinnata*). The floral distribution in the campus is presented in Figure.1.

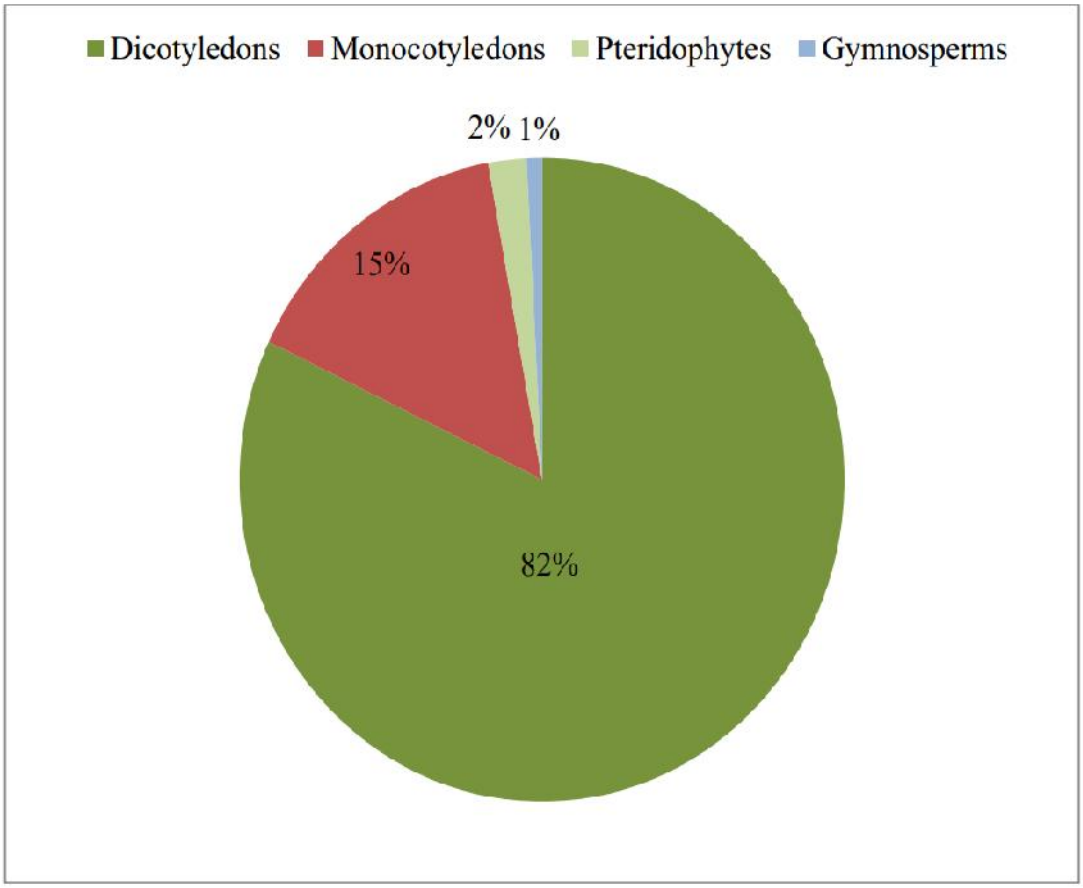

Figure.1. Floral distribution pie chart

Trees, shrubs, herbs, climbers and creepers of thecampus are classified into native, exotic and invasive alien species (Table.1). Native species under

trees, herbs and climbers are more diverse in number than exotic and invasive alien ones. *Mimosa pudica* is the only creeper identified as an exotic species from the campus. The list of trees, shrubs, herbs, climbers and creepers identified inside the campus is presented in Table.2, Table.3, Table.4, Table.5 and Table.6 respectively.

Table 1: Classification of trees, shrubs, herbs, climbers and creepers into native, exotic and invasive alien species

Category	**Native (N)**	**Exotic (E)**	**Invasive alien species (IAS)**
Trees	57	18	8
Shrubs	25	24	4
Herbs	45	27	5
Climbers	11	8	3
Creepers	Nil	1	Nil

Table.2. List of trees identified in the campus.

Sl.No	**SCIENTIFIC NAME**	**COMMON NAME/LOCAL NAME**	**FAMILY**
1	*Acacia auriculiformis/ Racosperma auriculiforme*	Acacia/ Darwin black battle (IAS)	Fabaceae
2	*Acacia mangium*	Mangium (IAS)	Fabaceae
3	*Adenanthera pavonina*	Manjadi (E)	Fabaceae
4	*Aegle marmelos*	Koovalam/ Wood Apple (N)	Rutaceae

5	*Albizia julibrissin*	Silk tree (N)	Fabaceae
6	*Alstonia scholaris*	Ezhilampala (N)	Apocynaceae
7	*Anarcardium occidentale*	Cashew (E)	Anacardiaceae
8	*Annona squamosa*	Seethapazham (E)	Annonaceae
9	*Annonna muricata*	Mullatha (IAS)	Annonaceae
10	*Araucaria auracana*	Monkeypuzzle maram (E)	Auracariaceae
11	*Areca catechu*	Adakkamaram (N)	Arecaceae
12	*Artocarpus altilis*	Kadachakka/Bread fruit tree (A)	Moraceae
13	*Artocarpus heterophyllus*	Plavu/Jack tree (N)	Moraceae
14	*Artocarpus hirsutus*	Anjili /Anjili plavu (N)	Moraceae
15	*Azadirachta indica*	Aryaveppu (N)	Meliaceae
16	*Bauhinia variegata*	Mandaram (N)	Fabaceae
17	*Butea monosperma*	Plash (N)	Fabaceae
18	*Caesalpinia sappan*	Pathimukham (N)	Caesalpiniaceae
19	*Cananga odorata*	Kaattuchempakam (N)	Annonaceae
20	*Caryota urens*	Pana/ Aanappana (N)	Arecaceae
21	*Cassia fistula*	Kanikonna/Golden Shower tree (N)	Fabaceae
22	*Casuarina equisetifolia*	Kattadi maram (IAS)	Casuarinaceae
23	*Ceiba pentandra*	Panjimaram (E)	Malvaceae
24	*Chrysophyllum cainito*	Swarnapple/star apple (E)	Sapotaceae
25	*Cinnamomum tamala*	Therali (N)	Lauraceae
26	*Citrus sp.*	Lemon (N)	Rutaceae
27	*Cleodendrum trichotomum*	Periyila (IAS)	Lamiaceae

28	*Cocos nucifera*	Coconut (N)	Arecaceae
29	*Dalbergia latifolia*	Eeti tree (N)	Fabaceae
30	*Delonix regia*	Gulmohar (E)	Fabaceae
31	*Elaecarpus tuberculatus*	Badraksham (N)	Elaeoccarpaceae
32	*Eucalyptus globulus*	Eucalyptus (IAS)	Myrtaceae
33	*Ficus benghalensis*	Peral (N)	Moraceae
34	*Ficus benjamina*	Weeping fig (N)	Moraceae
35	*Ficus carica*	Athi (N)	Moraceae
36	*Ficus exasperata*	Parakam (E)	Moraceae
37	*Ficus religiosa*	Arayal (N)	Moraceae
38	*Flacourtia jangomas*	Luby tree/Indian Coffee Plum (N)	Salicaceae
39	*Garcinia gummi-gutta*	Kudampuli (E)	Clusiaceae
40	*Gliricidia sepium*	Seemakonna (IAS)	Fabaceae
41	*Hydnocarpus alpina*	kattumarotty (N)	Flacourtiaceae
42	*Hydnocarpus kurzii*	Marotty (N)	Flacourtiaceae
43	*Jacaranda mimosifolia*	Neeli gulmohar (E)	Bignonciaceae
44	*Lagerstroemia speciosa*	Manimaruthu (N)	Lythraceae
45	*Moringa oleifera*	Drumstick tree (N)	Moringaceae
46	*Magnolia champaca*	Champakam (N)	Magnoliaceae
47	*Mallotus philippensis*	Kurumkutti (N)	Rutaceae
48	*Mangifera indica*	Mavu (N)	Anacardiaceae
49	*Manilkara zapota*	Sapota (E)	Sapotaceae
50	*Marcaranga peltata/Macaranga peltata*	Vatta (N)	Euphorbiaceae

51	*Millettia pinnata*	Ungu (N)	Fabaceae
52	*Mimusops elengi*	Elengi (N)	Sapotaceae
53	*Monoon longifolium/Polyalthia longifolia*	Aranna maram (N)	Annonaceae
54	*Murraya paniculata*	Maramulla (N)	Rutaceae
55	*Nephelium lappaceum*	Rambuttan (E)	Sapindaceae
56	*Nerium oleander*	Arali (N)	Apocynaceae
57	*Peltophorum pterocarpum*	Manjavaaka/ Chara konna (N)	Fabaceae
58	*Phyllanthus emblica*	Nelli (N)	Phyllanthaceae
59	*Pouteria campechiana*	Mottapazham (E)	Sapotaceae
60	*Psidium guajava*	Guava (E)	Myrtaceae
61	*Pterocarpus marsupium*	Vengana (N)	Fabaceae
62	*Samanea saman*	Mazhamaram (E)	Fabaceae
63	*Saraca asoca*	Ashokam (N)	Fabaceae
64	*Senna Spectabilis*	Scented Shower (IAS)	Fabaceae
65	*Simarouba glauca*	Lakshmi taru (E)	Simaroubaceae
66	*Spathodea campanulata*	African tulip tree (E)	Bignoniaceae
67	*Spondias pinnata*	Ambazham (N)	Anacardiaceae
68	*Sterculia foetida*	Peenari (N)	Malvaceae
69	*Sterculia guttata*	Kavalam (N)	Malvaceae
70	*Strychnos nux-vomica*	Kanjiram (N)	Loganiaceae
71	*Swietenia macrophylla*	Mahagonny (E)	Meliaceae
72	*Syzgium cumini*	Njaval (N)	Myrtaceae
73	*Syzygium samarangense*	Apple jamba	Myrtaceae

74	*Tamarindus indica*	Puli (N)	Fabaceae
75	*Tectona grandis*	Teak (N)	Lamiaceae
76	*Terminalia bellirica*	Thanni tree (N)	Combretaceae
77	*Terminalia catappa*	Indian Badam (N)	Combretaceae
78	*Terminalia elliptica*	Matti (N)	Combretaceae
79	*Trema orientalis*	Trema tree/Indian Charcoal tree (N)	Cannabaceae
80	*Vateria macrocarpa*	Vellappayin (N)	Dipterocarpaceae
81	*Vitex negundo*	Karinochi (N)	Lamiaceae
82	*Wrightia tinctoria*	Dandapala (N)	Apocynaceae
83	*Zanthoxylum rhetsa*	Mullila (N)	Rutaceae

Table.3. List of shrubs identified in the campus.

Sl.No	SCIENTIFIC NAME	COMMON NAME/LOCAL NAME	FAMILY
1	*Abutilon sp.*	Oorakam (N)	Malvaceae
2	*Allamanda cathartica*	Kolambichedi/Allamanda (E)	Apocynaceae
3	*Allamanda schottii*	Allamanda (E)	Apocynaceae
4	*Bougainvilla spectabilis.*	Bougainvilla (E)	Nyctaginaceae
5	*Breynia sp.*	Breynia (N)	Phyllanthaceae
6	*Caesailpnia pulcherrima*	Rajamalli (E)	Fabaceae
7	*Cajanus cajan*	Pigeon-pea or thuvara (N)	Fabaceae/Leguminosae
8	*Calotropis gigantea*	Erikku (N)	Apocynaceae
9	*Canna sp.*	Chakkarachembu/Canna (E)	Cannaceae
10	*Celosia sp*	Celosia (E)	Amaranthaceae

11	*Chlorophytum comosum*	Spider plant (E)	Asparagaceae
12	*Chromolaena odorata*	Communist paccha (IAS)	Asteraceae
13	*Cirnum asiatum*	Spider lilly (E)	Amaryllidaceae
14	*Clerodendrumin fortunatum*	Perikilam (E)	Lamiaceae
15	*Crossandra infundibuliformis*	Kanakambaram (N)	Acanthaceae
16	*Croton sp.*	Croton (N)	Euphorbiaceae
17	*Duranta erecta*	Golden dewdrops (E)	Verbenaceae
18	*Exoecaria cochinchinesis*	Chinese croton (N)	Euphorbiaceae
19	*Gardenia jasminoides*	Sugandhraj (N)	Rubiaceae
20	*Glycosmis pentaphylla*	Panal (N)	Rutaceae
21	*Gomphrena globosa*	Vadamalli (E)	Amaranthaceae
22	*Hibiscus rosa-sinsensis*	Hibiscus (N)	Malvaceae
23	*Ixora coccinea*	Thechi (N)	Rubiaceae
24	*Justicia adhatoda*	Adalodakkam (N)	Acanthaceae
25	*Lantana camara*	Arippoovu (IAS)	Verbenaceae
26	*Morus sp*	Mulberry (N)	Moraceae
27	*Murrayya koengii*	Curryveppu (N)	Rutaceae
28	*Musa paradisiaca*	Vazha/Banana ©	Musaceae
29	*Mussaenda erythrophylla*	Mosanda (E)	Rubiacea
30	*Memecylon randerianum*	Kayamboo (N)	Melastomataceae
31	*Nyctanthes arbortristis*	Pavizhamalli (N)	Oleaceae
32	*Pedilanthus tithymaloides*	Pedilanthus (E)	Euphorbiaceae
33	*Plumeria obtusa*	White frangipani (E)	Apocynaceae

34	*Plumeria pudica*	Plumeria/Ezhachempakam (E)	Apocynacae
35	*Rauvolfia serpentina*	Sarpagandhi (N)	Apocynaceae
36	*Ravenia spectabilis*	Lemonia (E)	Bignoniaceae
37	*Ricinus communis*	Avannakku (N)	Euphorbiaceae
38	*Ruellia humilis*	Wild petunia (E)	Acanthaceae
39	*Sauropus androgynus*	Veli cheera/ Madhuracheera (N)	Phyllanthaceae
40	*Sida acuta*	Wireweed/ Malamkurunthotti (E)	Malvaceae
41	*Sida cordifolia*	Kurunthotti (N)	Malvaceae
42	*Solanum paniculattum*	Solanum paniculatum (IAS)	Solanaceae
43	*Solanum torvum*	Turkey berry/Aanachunda (E)	Solanaceae
44	*Syngonium*	Syngonium sp (E)	Araceae
45	*Tabernaemontana heyneana*	Kundalappala (N)	Apocyanaceae
46	*Tabernamontana divaritica*	Nandyarvattam (N)	Apocynaceae
47	*Tecoma stans*	Yellow Elder (E)	Bignoniaceae
48	*Tibouchina urvilleanea*	Princess flower/ Melastoma (E)	Melastomataceae
49	*Tithonia diversifolia*	Mexican sunflower (IAS)	Asteraceae
50	*Trema micranthus*	Trema (E)	Cannabaceae
51	*Urena lobatta*	Caesar weed /Oorppanam (N)	Malvaceae
52	*Yucca gloriosa*	Yucca /Adam's Needle (E)	Asparagaceae
53	*Ziziphus oenoplia*	Thudali (N)	Rhamnaceae

Table.4. List of herbs identified in the campus.

Sl.No	**SCIENTIFIC NAME**	**COMMON NAME/LOCAL NAME**	**FAMILY**

1	*Abelmoschus esculentus*	Venda/ Lady's finger (E)	Malvaceae
2	*Aerva lanata*	Cherula* (N)	Amaranthaceae
3	*Ageratum conyzoides*	Chickweed (E)	Asteraceae
4	*Aloe vera*	Aloe vera/Kattar Vazha (E)	Asphodelaceae
5	*Alternanthera sessilis*	Alternatheria (N)	Amaranthaceae
6	*Alysicarpus vaginalis*	Alysicarpus (N)	Fabaceae
7	*Ananas comosus*	Pineapple (E)	Bromeliaceae
8	*Anthurium andraeanum*	Anthurium (E)	Araceae
9	*Asparagus racemosus*	Shatavari* (N)	Asparagaceae
10	*Begonia malabarica*	Kayyalapulian (N)	Begoniaceae
11	*Biophytum sensitivum*	Mukutti* (N)	Oxalidaceae
12	*Callisia repens*	Turtle vine (E)	Commelinaceae
13	*Carica papaya*	Pappaya (E)	Caricaceae
14	*Capsicum frutescens*	Kandari mulakku (E)	Solanaceae
15	*Catharanthus pusillus*	Perwinkle/Kapavila (N)	Apocynaceae
16	*Catharanthus roseus*	Shavam nari* (E)	Apocynaceae
17	*Cleome viscosa*	Kaatukaduku (N)	Cleomaceae
18	*Commelina caroliniana*	Carolina day flower (N)	Commelinaceae
19	*Crotalaria retusa*	KiluKillukki (IAP)	Fabaceae
20	*Curcuma aeruginosa*	Kari manjal* (N)	Zingiberaceae
21	*Curcuma aromatica*	Kasthuri manjal* (N)	Zingiberaceae
22	*Cyanthillium cinereum (N)*	Poovamkurunila* (N)	Asteraceae
23	*Demodium trifolium*	Nilamparanda* (N)	Fabaceae

24	*Dendrophthoe falcata*	Ithikanni (N)	Loranthaceae
25	*Desmodium gangeticum*	Orula* (N)	Fabaceae
26	*Emilia sanchifolia*	Muyalcheviyan* (N)	Asteraceae
27	*Euphorbia hirta*	Asthma plant (IAS)	Euphorbiaceae
28	*Euphorbia nutans*	Nodding spurge (E)	Euphorbiaceae
29	*Evolvulus alsinoides*	Vishnukranthi (N)	Convolvulaceae
30	*Hedychium coronarium*	Hedychium (N)	Zingiberaceae
31	*Helicona rostrata*	Hanging loster (E)	Heliconiaceae
32	*Hemigraphis colorata*	Red flame ivy or Murikootti (E)	Acanthaceae
33	*Hyptis suaveolens*	Naatta poochedi (IAS)	Lamiaceae
34	*Ipomoea triloba*	Ipomoea (E)	Convolvulaceae
35	*Kalanchoe pinnata*	Elamulachi (E)	Crassulaceae
36	*Leucas aspera*	Thumba (N)	Lamiaceae
37	*Lilium sp.*	Lily (E)	Liliaceae
38	*Manihot esculenta*	Kappa/ Cassava (E)	Euphorbiaceae
39	*Mirabilus jalapa*	Naalumani plant (E)	Nyctaginaceae
40	*Naregamia alata*	Nilanarakam (N)	Meliaceae
41	*Nelumbo nucifera*	Lotus (N)	Nelumbonaceae
42	*Nymphaea nouchali*	Ambal (N)	Nymphaeaceae
43	*Ocimum gratissimum*	Rama tulasi (N)	Lamiaceae
44	*Ocimum tenuiflorum*	Krishna tulasi* (N)	Lamiaceae
45	*Orchid sp*	Orchid (E)	Orchidaceae
46	*Papaver somniferum*	Poppy plant (E)	Papaveraceae

47	*Phyllanthus niruri*	Keezhanelli (N)	Phyllanthaceae
48	*Piper longum*	Thippali (N)	Piperaceae
49	*Plectranthus barbatus*	Panikoorka (N)	Lamiaceae
50	*Plumbago zeylanica*	Plumbago zeylanica (N)	Plumbaginaceae
51	*Portulaca grandiflora*	Pathumani plant (E)	Portulacaceae
52	*Praxelis elematidea*	Praxelis (E)	Asteraceae
53	*Rosa indica*	Rosa (N)	Rosaceae
54	*Scadoxus multiflorus*	Ball Lily (E)	Aamaryllidaceae
55	*Scorparia dulcis*	Kallurukki (N)	Plantaginaceae
56	*Sesamum radiatum*	Kattellu (E)	Pedaliaceae
57	*Solannum melongona*	Vazhuthanna (N)	Solanaceae
58	*Solanum anguivi*	Putharichunda (N)	Solanaceae
59	*Solanum lycopersicum*	Thakkali (E)	Malvaceae
60	*Sphagneticola trilobata*	Singapore daisy (IAS)	Asteraceae
61	*Stachytarpheta cayennensis*	Stachytarpheta (IAS)	Verbenaceae
62	*Synedrella nodiflora*	Synedrella/Mudiyendrapacha (E)	Asteracae
63	*Tagetes minuta*	Marigold (IAS)	Asteraceae
64	*Tridax procumbens*	Tridax (E)	Asteraceae
65	*Tylophora indica*	Vallipala (N)	Apocynaceae
GRASSES			
66	*Axonopus compressus*	Blanket grass (N)	Poaceae
67	*Cymbopogon citratus*	Lemon grass(N)	Poaceae
68	*Cynnodon dactylum*	Paspalum(N)	Poaceae

69	*Cynodon dactylum*	Bermuda grass(N)	Poaceae
70	*Digitaria ischemum*	Smooth crab grass(N)	Poacea
71	*Digitaria sangualis*	Crab grass(N)	Poacea
72	*Eragrostis curvula*	Weeping love grass (N)	Poaceae
73	*Ischaemum rugosum*	Ischaemum rugosum (N)	Poaceae
74	*Kyllinga nemoralis*	Spike sedge (N)	Poaceae
75	*Miscanthus sinensis*	Zebra grass(E)	Poaceae
76	*Panicum virgatum*	Switch grass (E)	Poaceae
77	*Pennisetum polystachion*	Mission grass (E)	Poaceae

Table.5. List of climbers identified in the campus.

Sl.No	**SCIENTIFIC NAME**	**COMMON NAME/LOCAL NAME**	**FAMILY**
1	*Abrus precatorius*	Kunnikuru (N)	Fabaceae
2	*Aganosma cymosa*	Paal valli (N)	Apocynaceae
3	*Antigonon leptopus*	Mexican creeper (E)	Polygonaceae
4	*Aristolochia indica*	Garudakkodi/Eswaramooli (N)	Aristolochiaceae
5	*Calycoptteris floribunda*	Pullani (N)	Combretaceae
6	*Cardiospermum halicacabum*	Uzhinja (N)	Sapindaceae
7	*Cleodendrum thomsoniae*	Bleeding heart vein (E)	Lamiaceae
8	*Clitoria ternata*	Shankupushpam (E)	Fabaceae
9	*Coccinia cordifolia*	Kaattukoval (N)	Cucurbitacea
10	*Cyclea peltata*	Padathali (N)	Menispermaceae
11	*Epipremnum aureum*	Money plant (E)	Araceae

12	*Ipomoea marginata*	Thiruthalli (N)	Convolvulaceae
13	*Merremia vitifolia*	Manja vayaravalli (IAS)	Convolvulaceae
14	*Mikania micrantha*	Bittervine (IAS)	Asteraceae
15	*Mimosa diplotricha*	Aanathottavadi (IAS)	Fabaceae
16	*Passiflora edulis*	Passion fruit(E)	Passifloraceae
17	*Passiflora foetida*	Passiflora foetida(E)	Passifloraceae
18	*Quisqualis indica*	Rangoon creeper (E)	Combretaceae
19	*Smilax zeylanica*	Kareelanchi (N)	Smilacaceae
20	*Tagian volucrata*	Payar (E)	Euphorbiaceae
21	*Tiliacora acuminata*	Valli kanjiram (N)	Menispermaceae
22	*Tragia involucrata*	Choriyannam (N)	Euphorbiaceae

Table.6. List of climbers identified in the campus.

Sl.No	SCIENTIFIC NAME	COMMON NAME/LOCAL NAME	FAMILY
1	*Mimosa pudica*	Thottavadi(E)	Fabaceae

4.1.1. ***Endemic and threatened species***

Four species of threatened flora identified from the campus includes *Rauvolfia serpentina* (endangered), *Hydnocarpus kurzii* (data deficient), *Vateria macrocarpa* (critically endangered), *Tabernaemontana heyneana* (near threatened) (Figure.2). *Rauvolfia serpentine* and *Tabernaemontana heyneana* are shrubs and *Hydnocarpus kurzii* and *Vateria macrocarpa* are

trees. All these four IUCN threatened plants are used for medicinal purposes. Out of these four plant *Tabernaemontana heyneana* and *Vateria macrocarpa* are endemic to southern Western Ghats. Thus special conservation should be given to these plants.

Rauvolfia Serpentina

Hydnocarpus kurzii

Vateria macrocarpa

Tabernaemontanaheyneana

Figure.2. Endemic and threatened species in the campus.

4.1.2. *Invasive alien species (IAS)*

An alien species is a species, subspecies or lower taxon introduced outside its natural past or present distribution, including gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce (CBD, 2002). An invasive alien species refers to an alien species whose introduction and spread threaten the region/habitat (CBD, 2002).

Acacia auriculiformis/ Racosperma auriculiforme, Acacia mangium, Annonna muricata, Casuarina equisetifolia, Cleodendrum trichotomum, Eucalyptus globulus, Gliricidia sepium, Senna Spectabilis, Chromolaena odorata, Lantana camara, Merremia vitifolia, Solanum paniculattum, Tithonia diversifolia, Crotalaria retusa, Euphorbia hirta, Sphagneticola trilobata, Stachytarpheta cayennensis, Tagetes minuta, Mikania micrantha, Mimosa diplotricha are identified as the invasive alien species of the campus. *Acacia auriculiformis/ Racosperma auriculiforme* found to be most dominant invasive alien species in the university campus. It was introduced to the campus for afforestation. Most of the garden plants in campus are found to be invasive. IAS can be classified into high risk, medium risk, low risk, and insignificant species based on their potential to produce negative impacts. *Wedelia trilobata/Singapore daisy, Mikania micrantha/bitter vine, lantana camera, Chromolaena odorata, Mimosa diplotricha, Merremia*

vitifolia are high risk IAS found in the campus. All these IAS except *Chromolaena odorata* are intentionally introduced plants for various purposes like as sources of animal food, for timber, afforestation, ornamental etc.Pollens of *Acacia sps.* are reported as allergens and causes respiratory diseases like asthma. Allelochemical produced by invasive plants cause growth retardation of native plants. IAS also have rapid and high propagation potential. If not managed effectively we will lose the current diversity of the campus in the near future. Some IAS are presented in figure.3.

Figure.3. Invasive alien species (IAS) in the campus.

4.2. ***Faunal diversity***

About 103 species of fauna are identified from the campus. Out of which, 43 are birds, 36 are butterflies, 5 are a moth, 6 are reptiles, 13 are mammals and 1 amphibian. The campus is also home to 23 other invertebrate organisms belonging to 16 orders. Birds visiting the campus is not bad since

42 species of birds are identified from the campus. House crow, rock pigeon and common myna are the dominant birds found on the campus. The presence of an appreciable diversity of butterflies on the campus is due to the abundance of butterfly host plants which include *Albizia sp, Pterocarpus marsupium, Manihot carthaginensis, Smilax zeylanica. Nectar providing plants like Lantana camera, Ixora coccinia, Saraca asoka, Tridax sp, Clerodentron sp., Cassia sp.* etc., retains the butterfly diversity of the campus. *Felis catus, Canis lupus, Bos tauras, Bubalus bubbalis* and *Capra aegagrus hircus* are the common mammals of the campus. The great diversity of herbivorus insects is thought to be linked to their interactions with host plants. CUSAT reservoir and pond support good fish fauna. Concrete ponds in various departments are home to many insects like damselflies and dragonflies because their life cycle have an aquatic larval stage. Amphibians also depend on this water systems.

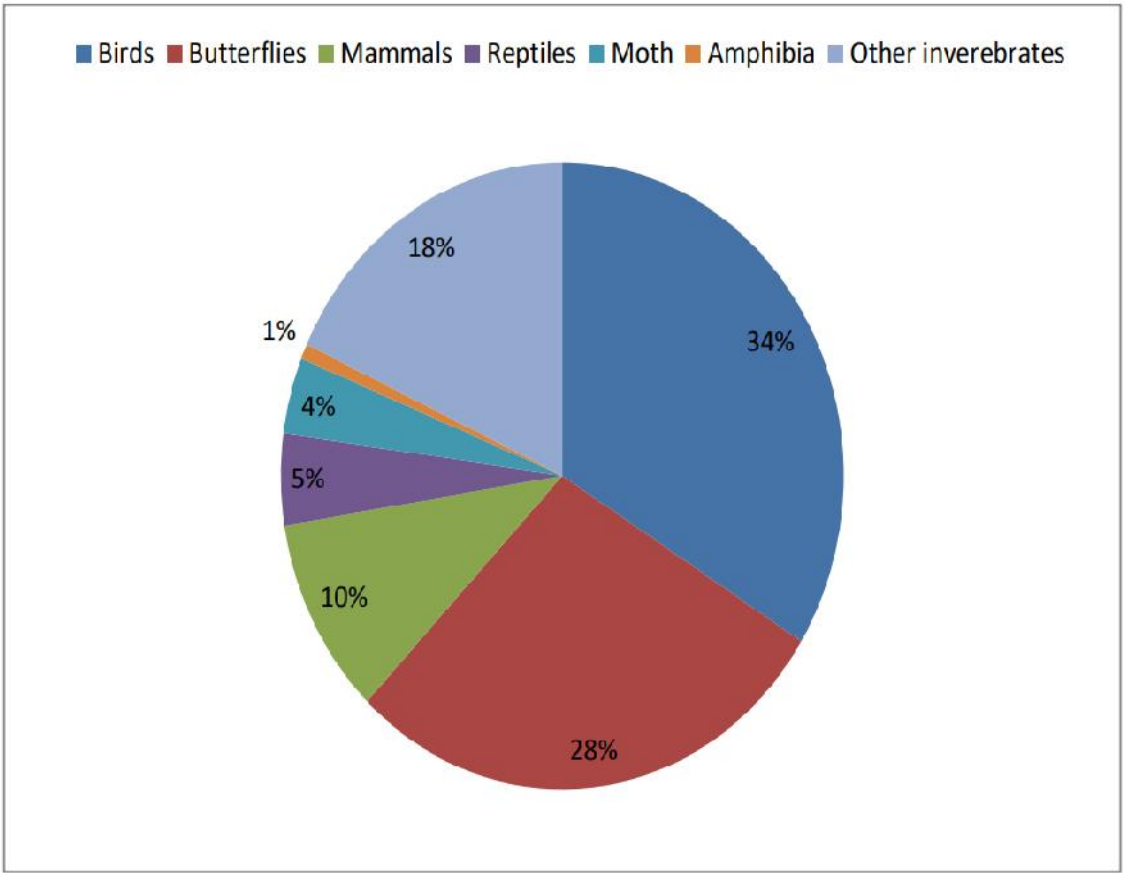

Figure.4. Faunal distribution pie chart

Table.7. List of birds identified from the campus.

Sl.No	COMMON NAME	SCIENTIFIC NAME
1.	House crow	*Corvus splendens*
2.	Rock pigeon	*Columba livia*
3.	Common Myna	*Acridotheres tristis*
4.	Asian Koel	*Eudynamys scolopacea*
5.	Greater Coucal	*Centropus sinensis*
6.	Black rumped flame back	*Dinopium bengalensis*
7.	Indian pond Heron	*Ardeola grayii*

8.	Median Egret	*Mesophoyx intermedia*
9.	Rose ringed Parakeet	*Psittacula krameeeri*
10.	Indian tree pie	*Dendrocitta vagabunda*
11.	Purple rumped sunbird	*Leptocoma zeylanica*
12.	Scaly breasted munia	*Lonchura punctualata*
13.	Blue-tailed bee eater	*Merops phillippinus*
14.	Red –whiskered bulbul	*Pycnonotus jocosus*
15.	Magpie robbin	*Copsychus saularis*
16.	Black drongo	*Dicrurus macrocercus*
17.	Great racket tailed drongo	*Dicrurus paradiseus*
18.	White Throated kingfisher	*Halcyon smyrnensis*
19.	White headed babbler	*Turdoides affinis*
20.	White cheeked barbet	*Meglaima virdis*
21.	Golden Oriole	*Oriolus oriolus*
22.	Black naped oriole	*Oriolus chinensis*
23.	Common kingfisher	*Alcedo atthis*
24.	Brahminy kite	*Haliastur indus*
25.	Black kite	*Milvus migrans*
26.	Shikra	*Accipiter badius*
27.	House sparrow	*Passer domesticus*
28.	Indian cuckoo	*Cuculus micropterus*
29.	Barn owl	*Tyto alba*
30.	Lesser Whistling duck	*Dendrocygna javanica*
31.	Red vented bulbul	*Pycnonotus cafer*

32.	Rosy starlings	*Pastor roseus*
33.	Spider hunter	*Arachnothera*
34.	Indian robin	*Saxicoloides fulicatus*
35.	Indian roller	*Coracias benghalensis*
36.	Indian jungle crow	*Corvus culminatus*
37.	cormorant	*Phalacro coracidae*
38.	Jungle babbler	*Turdoides striata*
39.	Ceylon grey tit	*Parus major*
40.	Emerald dove	*Chalcophaps indica*
41.	Common swift	*Apodidae*
42.	Common quail	*Coturnix coturnix*

Table.8. List of butterflies identified from the campus

Sl.No	**COMMON NAME**	**SCIENTIFIC NAME**
1.	Pioneer butterfly	*Belenois aurota*
2.	Common angled castor	*Ariadne ariadne*
3.	Tawny castor	*Acraea terpsicore*
4.	Common Rose butterfly	*Pachliopta aristolochiae*
5.	Common mormon	*Papilio polytes*
6.	Chocolate pansy	*Junonia iphita*
7.	Tailed jay	*Graphium agamemnon*
8.	Lime butterfly	*Papilio demoleus*
s9.	Painted sawtooth	*Prioneris sita*
10.	Common crow	*Euploema cow*

11.	Common wanderer butterfly	*Pareronia valeria*
12.	Grey pansy	*Junonia atlites*
13.	Mottled emigrant	*Catopsilia pyrantha*
14.	Common grass yellow	*Eurema hecabe*
15.	Crimson Rose butterfly	*Pachliopta hecta*
16.	Blue tiger	*Tirumala limniace*
17.	Dark blue tiger	*Tirumala septentrionis*
18.	Plain tiger	*Danaus chrysippus*
19.	Common palmfly	*Elymnias hypermnestra*
20.	Banana skipper	*Erionta thrax*
21.	Red pierrot	*Talicada nyseus*
22.	Pysche	*Leptosia nina*
23.	Common eggfly	*Hypolimnas bolina*
24	Striped tiger	*Danaus genutia*
25	Plain cupid	*Chilades pandava*
26	Common cerulian	*Jamides celeno*
27	Common quaker	*Orthosia cerasi*
28	Common baron	*Euthalia aconthea*
29	Common four ring	*Ypthima huebneri*
30	Common bush brown	*Mycalesis perseus*
31.	Common rustic	*Mesapamea secalis*
32.	Common sailor	*Neptis hylas*
33	Chestnut bob	*Iambrix salsala*

34	Common jezebel	*Delias eucharis*
35	Common evening brown	*Melanitis leda*

Figure.5. Some butterfly species in the campus.

Table.9. List of moths identified from the campus.

Sl.No	COMMON NAME	SCIENTIFIC NAME
1.	Crotalaria moth	*Utetheisa lotrix*
2.	Blue tiger moth	*Dysphania percota*
3.	Hawk-moth	*Daphnis nerii*
4.	Tiger moth	*Asota caricae*
5.	Ailanthus webworm moth	*Atteva fabriciella*

Table.10. List of mamals identified from the campus.

Sl.No	COMMON NAME	SCIENTIFIC NAME
1.	Domestic cat	*Felis catus*
2.	Dog	*Canis lupus*
3.	Indian grey mangoose/keeri	*Herpestes edwardsii*
4.	Three-Striped Palm Squirrel/Annan	*Funambulus palmarum*
5.	Indian flying fox	*Pteropus gigantecus*
6.	House Rat	*Rattus rattus*
7.	Brown Rat/ Panni Eli	*Rattus norvegicus*
8.	Jackal/Kurukkan	*Canis aureus*
9.	Toddy cat/ marapatti	*Paradoxurus jerdonii*
10.	Jungle cat	*Felis chaus*
11	Cow	*Bos tauras*
12.	Buffalo	*Bubalus bubbalis*
13.	Goat	*Capra aegagrus hircus*

Table.11. List of reptiles identified from the campus.

Sl.No	COMMON NAME	SCIENTIFIC NAME
1.	Cobra	*Naja naja*
2.	Rat snake	*Pytas mucosa*
3.	Garden lizard	*Calotes versicolor*
4.	House gecko	*Hemidactylus sp.*
5.	Common Skink	*Mabuya carinata*
6.	Monitor lizard	*Varanus bengalensis*

Table.12. List of amphibians identified from the campus.

Sl.No	COMMON NAME	SCIENTIFIC NAME
1.	Indian bullfrog	*Hoplobatrachus tigerinus*

4.3. ***Threats to biodiversity***

Dumping of waste in many places on campus is a threat to both fauna and flora of the campus. Dumping of non-biodegradable waste, especially plastics, threatens floral diversity by blocking the percolation of water into the soil, making water unavailable for plants. Animals and birds used to eat plastic waste and papers along with food waste. It leads to the accumulation of plastics in animal's digestive systems and causes health problems. It boosts the growth of vectors like flies and mosquitos and thereby causes

disease spreading. Waste dumping also produces a foul smell which dulls the aesthetic values of the campus. Improper waste disposal is the main threat to both flora and fauna of the campus. Mass clearance of plants and trees for construction works is the main reason behind the disappearance of many native plants and trees. Unplanned construction activities will lead to urban heat island formation. It also causes habitat destruction and eventually affect the faunal diversity of the campus. The invasive species like *Acacia auriculiformis*, *Mikania micrantha, Chromolaena ordata* and invasive grasses like zebra grass dominate the campus. These aliens never support indigenous plants. Lab waste, including hardwires and chemicals released directly into the soil, is deteriorating soil quality and making soil unsuitable for supporting plants. It also affects soil micro and macrofauna.

4.4. ***Recommendations***

In order to improve the diversity of the campus, the following suggestions are proposed:

- Convert the barren area to a forest using the miyawaki afforestation method.
- Nakshatra vannam, medicinal garden, bamboo gardening is possible in the campus.
- Plant native species that enhance our natural environment and ecology. The following trees are the indigenous varieties of the campus:

1. Manimaruthu (*Lagerstroemia speciosa*)
2. Mazhamaram (*Samanea saman*)
3. Chembakam (*Magnolia champaca*)
4. Anjilli (*Atrocarpus hirustus*)
5. Cashew (*Anacardiaceae occidentale*)
6. Neem (*Azardicta indica*)
7. Kannikonna (*Cassia fistula*)
8. Guava (*Psidium guajava*)
9. Nelli (*Phyllanthus emblica*)
10. Dandapala (*Wrigtia tinctoria*)
11. Karinochi (*Vitex negundo*)
12. Ashokam (*Saraca asoca*)
13. Kanjiram (*Strychnos nux-vomica*)

5.Water management

The water resources in the campus mainly include a water reservoir (capacity : 75 lakh liters) (Figure.6), pond (capacity : 15 lakh liters) (Figure.7), two dug wells, and six bore wells.Both the reservoir and the pond have a natural base, that also acts as a groundwater recharger. The influx of water to these systems comes from both the rainwater runoff and also from the ground below. The low-lying area on the campus was selected as the site for these systems as it would enable storm water to flow into it without the help of any artificial means like pipes. Recently, university also constructed several *mazhakuzhy* (constructed pits for accommodating rainwater) for recharging ground water in the campus. Despite these resources, the campus is experiencing a shortage of sufficient water. The campus gets most of its water from Kerala Water Authority (KWA).

Figure.6. Water reservoir

Figure.7. Pond.

To check the condition of the existing water systems in the campus, we carried out physicochemical and bacteriological analysis of water samples.The samples were obtained from reservoir, open pond, dug well and borewell. The results were compared with the drinking water (IS-10500) standards(Table.13 and Table.14).

Table 13. Physicochemical parameters of water samples collected from well, reservoir, pond and borewell.

Parameters	**Dug well**	**Reservoir**	**Pond**	**Borewell**	**Drinking water IS 10500**
Temperature (°C)	30.7	30.9	30.9	31	_
pH	5.0	6.18	5.68	5.89	6.5 to 8.5
TDS (ppm)	5.89	68.36	53.91	199.1	500
Conductivity (µS/cm)	101.1	73.33	57.63	213.4	_
Redox potential (mv)	66.5	25.2	44.9	4.9	_
Salinity (ppm)	38.96	29.61	24.55	74.99	_
Dissolved Oxygen (mg/L)	0.788	1.176	4.312	4.81	_
Chloride (mg/L)	7.09	4.254	3.545	3.545	250
Alkalinity (mg/L)	10.2	20.4	10.2	102.0	200
Biochemical Oxygen Demand (mg/L)	2.15	3.52	1.17	0.5	_

Total hardness (mg/L)	5.6	17.2	9.6	78.7	300
Turbidity (NTU)	3.3	0.5	0.3	10.9	5
Total Solids (mg/L)	45	4	44	56	_
Total Suspended Solids (mg/L)	0.029	0.014	0.004	0.011	_
Calcium (mg/L)	7.893	3.553	2.336	15.082	75
Magnesium (mg/L)	1.524	1.80	0.988	15.57	30
Sodium (mg/L)	9.416	5.420	4.158	8.828	_
Potassium (mg/L)	0.981	0.341	1.383	4.380	_
Sulphate (mg/L)	3.19	3.65	0.04	9.40	200
Nitrite (mg/L)	BDL	0.04	0.03	0.01	_
Nitrate (mg/L)	0.14	0.36	0.96	0.02	45
Phosphate (mg/L)	0.01	BDL	BDL	0.03	_
Ammonia (mg/L)	0.14	0.23	0.03	0.05	0.5
Iron (mg/L)	0.09	BDL	BDL	0.89	0.3

Table 14. Bacteriological parameters of water samplescollected from well, reservoir, pond and borewell.

Parameters	Dugwell	Reservoir	Pond	Borewell	Drinking water IS 10500
Total Coliform (MPN /100 mL)	43	1100	Absent	Absent	Shall not be detectable in any 100 ml sample.
E. coli (MPN /100 mL)	Absent	Absent	Absent	Absent	Shall not be detectable in any 100 ml sample

From table.1. it is clear that pH values of the samples from reservoir (6.18), pond (5.68), dug well (5.00) and borewell (5.89) did not comply with the required pH (6.5 – 8.5) as per the drinking water standard. All the other parameters of reservoir, pond and dug well were within the limits. In the case of borewell elevated levels of turbidity (10.9 NTU) and iron (0.89mg/L) were observed. The observed values were above the prescribed limits. The bacteriological tests revealed presence of coliforms in dug well (43/100 ml) and reservoir (1100/100 ml) samples indicating bacteriological contamination (Table.2). Thus, the water from these systems (dug well and reservoir) are not suitable for drinking without appropriate treatment. The presence of E.

coli was not detected in samples collected from dug well, pond, reservoir and bore-well.

5.2.Social activity

CUSAT was a part of a major water harvesting programme in Thuruthikkara Panchayat. In a village of 349 families, more than 160 well-recharging units were installed and their wells never dried up after that. The quality of well water also substantially increased. The chemical oceanography department at CUSAT supported the well-recharging initiative by testing the water quality of all wells in the village free of cost. The Thuruthikkara model has been acclaimed as successful and it was showcased in the Kerala Water Summit 2019 as the best water conservation model.

5.3. *Recommendations*

- Undertake periodic study to access undesirable changes in the water quality of existing water resources and its timely treatment.
- Efficient use of water-storage space and regular maintenance activity to reduce contamination. For example, there are 26 departments and 11 hostels on the whole campus. Rooftop rainwater harvesting can be considered a better option for effective water management.
- Developing creative solutions using informatics to prevent severe water shortage crisis.

6. ***Indoor air quality***

Humans spend more than 80% of their lifetime in indoor environments. On university campuses, students often spend a considerable amount of time in various indoor spaces such as classrooms, laboratories, libraries etc. Recent studies have linked indoor air quality with cardiovascular and respiratory diseases. In indoor environments, inhabitants are exposed to various hazardous compounds due to lower degradation rates. Indoor dust is an important matrix that exposes humans to a broad spectrum of chemicals.Further, with new chemicals being introduced into various consumer products and materials every day, there is an urgent requirement to detect the migration of these compounds into the dust and their effect on human health. Some of these pollutants are reported to be endocrine disruptors, mutagenic and carcinogenic. In this context, we analysed dust samples collected from classrooms, laboratories and photocopying centres within the campus. A total of 19 organic contaminants were detected in our study. The compounds belonged to various classes such as plasticisers, plasticiser metabolites, photo-initiators, personal care products, pharmaceutical intermediates, surfactants, and pesticides. Some prime hazardous compounds identified include benzophenone (endocrine disrupter) and α-methylstyrene (human carcinogen) and pesticides such as metaldehyde and ethofumesate. The accumulation of these pollutants in

these environments can be mainly attributed to improper ventilation and poor cleaning practices.

6.1. ***Recommendations***

- Continuous monitoring and quantification of hazardous substances such as heavy metals and contaminants of emerging concern (CEC) in indoor air and dust.
- Management practices involving regular cleaning, equipment maintenance and installation of efficient ventilation systems should be carried out at the earliest. This can reduce the ill-impacts resulting from acute and chronic micro pollutant exposure.

7. Conclusion

This assessment focused on the energy consumption pattern and existing waste management practices in the campus. It is recommended to promote planting of native species that enhance our natural environment and ecology, rooftop rainwater harvesting as a better option for effective water management and continuous monitoring of hazardous substances in indoor air and dust.