File Ref.No.84872/IQAC-SO/2021/Admn

UNIVERSITY OF CALICUT

Abstract

IQAC- Reports of the Committees constituted for conducting Environmental Audit, Carbon Foot Print ,Green Audit and Gender Audit -Approved for implementation - Orders issued.

IQAC

U.O.No. 4315/2022/Admn Dated, Calicut University.P.O, 15.02.2022

Read:-1.U.O.No. 7841/2021/Admn Dated, 10.08.2021.
2.U.O.No. 8036/2021/Admn Dated 13.08.2021.
3.Orders of the Hon'ble Vice-Chancellor in the file of even No. Dated 09-02-2022.

ORDER

1. As per paper read as (1) above, a Committee has been constituted for conducting Environmental Audit, Carbon Foot Print and Green Audit of University of Calicut with Prof. C C Harilal, Head, Dept. of Environmental Science, as its Convenor. Similarly, Smt. Layana Aanand, Assistant Professor, Centre for Women's Studies has been entrusted with the conduct of Gender Audit in the campus vide paper read as (2).

2. Prof. C C Harilal, Head, Dept. of Environmental Science, has submitted the Audit Reports on Environmental Audit, Carbon Foot Print and Green Audit of University of Calicut and Smt. Layana Aanand, Assistant Professor, Centre for Women's Studies, has submitted the Audit Report on Gender Audit in the University for approval and implementation.

3. Considering the matter in detail, the Hon'ble Vice Chancellor, vide paper read (3) above, has accorded sanction to approve and implement the following Audit Reports in the University of Calicut.

1.Environmental Audit Report

2.Report on Carbon Foot Print

3.Green Audit Report

4.Gender Audit Report

Orders are issued accordingly.

Sabu V.V

Assistant Registrar

To

1. Prof. C C Harilal, Head, Dept. of Environmental Science
2. Smt. Layana Aanand, Assistant Professor, Centre for Women's Studies

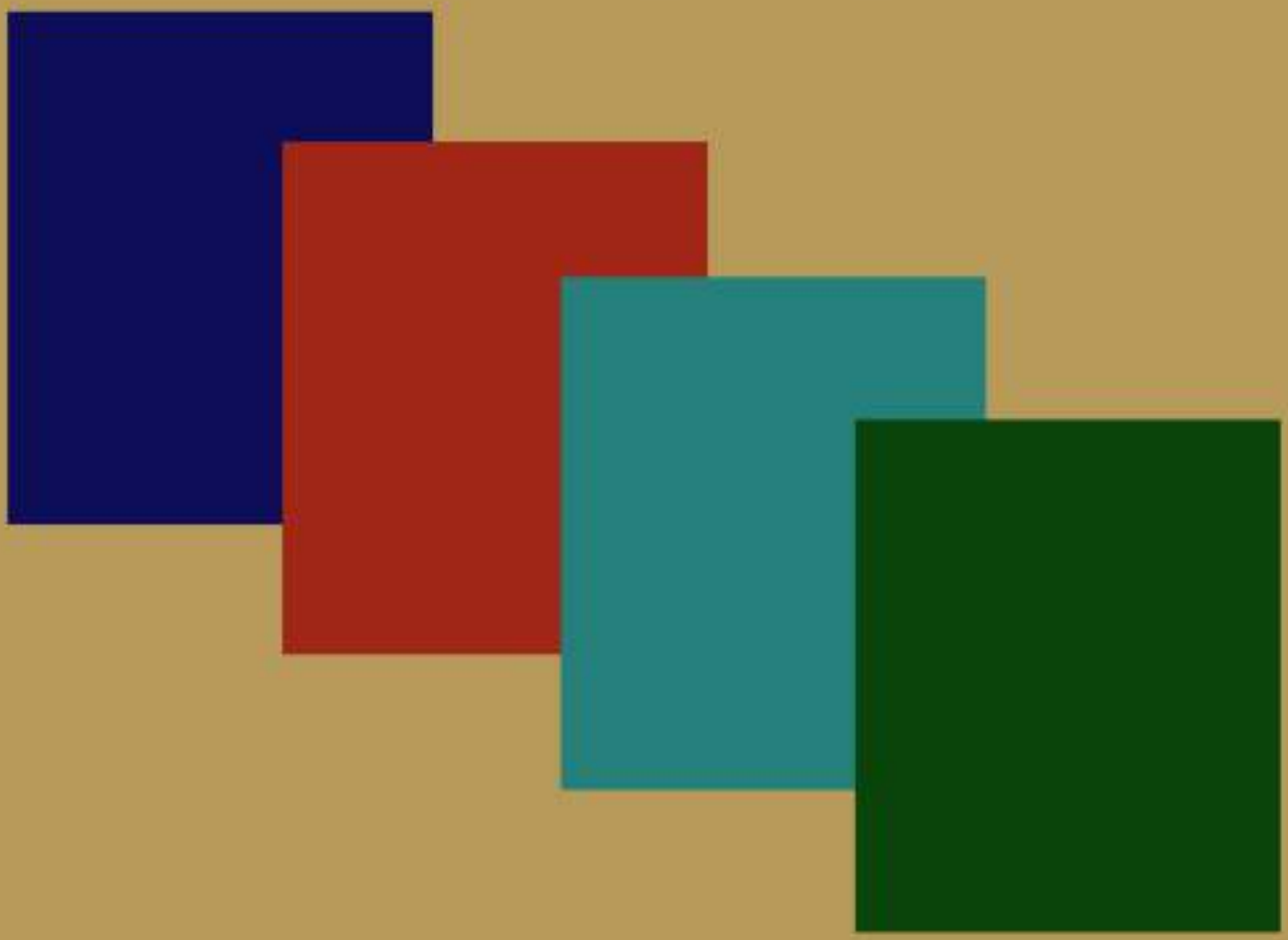
Copy to : PS to VC/PA to PC/P to R/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

ENVIRONMENTAL AUDIT REPORT
(2020-2021)



INTERNAL QUALITY ASSURANCE CELL
UNIVERSITY OF CALICUT
October 2021

UNIVERSITY OF CALICUT

ENVIRONMENTAL AUDIT REPORT
2020 – 2021

INTERNAL QUALITY ASSURANCE CELL
University of Calicut

October, 2021

UNIVERSITY OF CALICUT

ENVIRONMENTAL AUDIT REPORT OF THE CALICUT UNIVERSITY CAMPUS (2020 – 2021)

Convener

Dr. C.C. Harilal
Professor,
Division of Environmental Sciences
Department of Botany, University of Calicut
&
Coordinator, Department of Environmental Sciences,
University of Calicut

Committee members

Department of Environmental Sciences

Dr. Rathy. M.C. (Assistant Professor, Department of EVS)
Dr. T.R. Shanthi (Assistant Professor, Department of EVS)
Mrs. Shamili V.K. (Assistant Professor, Department of EVS)

Student coordinators

Department of Environmental Sciences

Akshara Madhu	K.B. Jithuna Das
Abhilash, P.T	Chaithra, P. J.
Sneha Prabha	Nimitha, K.
Sana, M. Ali	Akhila, A.
Reshma, R.	Sreelakshmi, K.B.
Preeja mol, P.	Husna
Nova Ramchandran	Sneha, S.
Greeshma, T.	Athira, T.P.
Sukanya, V.	Krishnendu, K.S.
Sruthi, M.	Liyana, K.
Athulya Ayyappan	Athira Pradeep
Shilpa, E.S.	Fathima Marva, K.

This study has been undertaken as per UO. No. 133086/IQAC-ASST1/2021/Admn (II), dated 12/08/2021, of the University of Calicut. The statements and conclusions drawn in the present report are the outcomes of a research study undertaken by a team for a specific purpose and in no way forms a policy document or a legal document of the University or its authorities.

EXECUTIVE SUMMARY

GEOGRAPHY AND AERIAL EXTENT

The area of the campus as per GPS survey is 2012869.80 square meters (497.388 Acres). The undulating terrain is mostly lateritic and is sloping to all directions. The magnitude of sloping is more towards the western (elevation: 57 – 73 m) and south western side than the east (elevation: 95 – 119 m).

As the terrain is undulating and sloping, there are chances of higher erosion and thereby removal of fertile topsoil. Erosion is evidenced by the lateritic rocks exposed at various locations of the campus. Hence it is customary to maintain adequate vegetation cover and to construct erosion prevention structures in high erosion prone areas of the campus. Owing to the specific terrain characteristics, water resources management of the campus needs to be addressed judiciously. The terrain characteristics is contributive to the development of rain water (run off) harvesting structures at strategic locations of the campus.

CLIMATE

The climate experience in the campus is mildly hot and humid with prominent rainy days during the monsoon season. March and April are the hottest and January and February are the coldest. The maximum temperature of the region ranges from 28.9 to 36.2 and minimum from 17.0 to 23.4. The wind is predominant from east as well as west during morning and evening hours. The speed of wind ranges from 0.7-5.1 m/sec. with a mean value of 2.08m/sec. The relative humidity ranges from 84 to 94% during morning hours. The humidity is more during peak monsoon months from June to September

Rainfall data for a period of 6 years (2014 – 2019) indicate that the lowest precipitation was in 2016 (1533 mm) and the highest in 2018 (3658.5). Mean values of precipitation was lowest in January (0.853mm) and highest in July (629.2mm). Annual average rainfall was noted to be 2803.82 mm.

Moderately higher temperature and wind velocity experienced in the region is indicative of the higher evaporation rate and resultant desiccation of water resources. It also points to the need for the development of adequate vegetation cover for the protection of soil and overcoming the drought situations. The higher rate of precipitation is promising to the development of water harvesting structures, both rooftop and runoff, for the effective management of the water resources.

VEGETATION AND LAND USE

Land use pattern of a region is linked to various geologic, geographic and developmental factors. This audit survey has assessed the land use pattern and changes in vegetation cover of the campus over a period of 5 years.

Natural vegetation in the campus is brought under two categories: Dense mixed and Medium mixed types. Dense vegetation cover an area of 8.5% of the total land area of the campus and is highly fragmented. Majority of the land is occupied by the medium-mixed type of vegetation (35.5%). Botanical garden (3.55%) and University Park (0.94%) are the two protected areas within the campus, which provides conservation to a wide range of plants and associated biodiversity. The Mango orchard (1.51%) is surrounded by dense and medium vegetation on one side and an extensive cover of Acacia (21.68%) on the other. Rubber plantation contributes to 1.16% of the total land area. Apart from this, completely barren area is estimated to be 385258.085 sq. m. (95.19 acres), representing 19.14% of the campus. About 3.1% of the campus is occupied by the university stadium and the built-up area to 4.8%.

In the present survey, the built-up area showed an increase from 4.405% to 4.812% over a period of 5 years. The vegetation cover (both dense and medium mixed type) has decreased to an extent of 0.534% over these years. The barren area also showed an increase of 1.240%. The area under Acacia plantation has decreased to an extent of 0.982%. Considering these aspects, the following recommendations are made.

As the built-up areas are likely to increase as part of various developmental initiatives in future, efforts are to be undertaken to bring more areas under vegetation cover. Presently barren lands contribute to 19.14% of the total land area and are mostly attributed by exposed rocky and lateritic regions. More scientific approaches are required for the conversion of such areas, for which selection of species and method of planting needs to be standardized.

In addition to the efforts for the control of barren areas, there has to be serious efforts for the conversion of medium mixed vegetation to the dense type. This is possible with the introduction of selected tree species, which attributes more biomass and maintains biodiversity.

It is equally important to control the expansion of invasive species like Acacia to conserve the growth of indigenous varieties. Acacia has recently been attributed with a wide range of ill effects, detrimental to both human health and ecology. They need to be replaced with healthy vegetation.

Maintenance of vegetation cover is more significant in the campus, as its topography is highly undulating and sloping towards all directions. Lack of a proper vegetation cover is likely to accelerate the erosion process, which in turn will take away the fertile topsoil, leaving the rocky terrain exposed.

WATER RESOURCES

A survey has been undertaken to assess the water requirements of the campus, percentage share of utilization by different segments of the campus, qualitative evaluation and environmental threats at parakkadavu region of Kadalundi river, qualitative evaluation of the water confining to the distribution system in the campus and an inventory on the water resources within the campus with reference to its quantity, quality and use pattern.

The survey revealed that an average of 10-16 Lakh Liters of water is required by the campus, daily. Major share of the water is utilized by the hostels meant for students (34%), residential areas of staff (29%), departments (21%), offices (8%) and the remaining share for miscellaneous purposes including irrigation, construction activities.

The University meets major requirements of water (~91%) from Kadalundi River. The water supply scheme comprises of an intake facility at Parakkadavu, booster facility at Chelari and a treatment facility at the Calicut University campus. The present study analyzed the quality of water confining to the Kadalundi river at Parakkadavu region in consecutive months. The study also analyzed the environmental threats associated with the region and the following observations are made:

The water level at Parakkadavu region of Kadalundi river is retreating at an alarming rate during summer months, leading to severe shortage and quality concerns. The University has to think of alternative sources of water for meeting such shortages in the near future. A detailed study is warranted in this regard.

An evaluation of the quality of water (WQI) of the Kadalundi river at Parakkadavu region is noted to be 'good', except for microbiological parameters. Also, the level of contaminants is found to be increasing during summer months. This points to the need for effective water treatment options to be adopted by the University during peak summer months. Emphasis needs to be given for the microbial contaminants in water.

The extent of anthropogenic pressures associated with Parakkadavu region are many. The major among them are open defecation and bathing. Also, a tributary reaching the intake station and sewers associated with the region are potential threats to the microbial quality of water. An estate staff needs to be employed in the region for regular clearing of bushes, hideouts and other unwanted canopy. The area needs to be fenced and a security staff need to be employed for preventing waste disposal and trespasses to the region.

An analysis of the quality of water (after treatment) in the distribution system within campus has been undertaken and is found to be excellent. However,the microbial quality of water in the distribution system has to be examined periodically for ensuring infallible treatment efficiency.

In addition to the above, an inventory has been made on the surface and ground water resources of the campus. Water resources within the campus comprise of 18 dug wells, 7 ponds and 3 tube wells. However, water availability at all seasons is restricted to 12 wells and 2 ponds. The three tube wells are in a sealed condition. Average ground water availability to the magnitude of 15.4 m^3 at a depth of 10.25 meters is noticed. The quality of both ground and surface water sources were analyzed as part of this survey and are within potability limits.

Most of the water resources within the campus are remaining unutilized or underutilized. As the quality confining to them are better, they can be utilized in laboratories, lavatories and for irrigation purposes. It is noted that ~ 1,12,388 litres of treated water (~7%) is used daily for gardening and

construction purposes. Efforts need to be undertaken for increasing the use efficiency of local water resources and thereby reducing the demand of water from external sources.

The campus follows the trend of utilizing treated water for a wide range of purposes, other than for drinking. It is highly suggested to have a separate water distribution system in the campus for laboratories, lavatories and irrigation purposes. Such a supplementary distribution system can utilize the raw water (untreated) from Kadalundi and water from other sources within the campus. This will reduce the cost of water treatment and ensures better treatment efficiency for water meant for drinking purposes.

WATER RESOURCES – RAIN WATER HARVESTING

A survey has been carried out to assess the feasibility of rain water harvesting (roof top and run off) in the campus. Data concerning rainfall, roof top characteristics and geographic features like slopes, stream flow and climatological characteristics like temperature and humidity were assessed. Accordingly, regions ideal for roof top and run off rain water harvesting are identified.

Considering the roof characteristics and ease of construction and maintenance of allied structures like capture, collection, treatment, storage and distribution facility, rooftop rain water harvesting is proposed in 14 strategic locations of the campus. The anticipated yield from these locations is coming to about 14.23 crore litres / year. The Engineering Department of the University of Calicut can further work on the feasibility of construction and the expenditure involved.

The terrain of the campus is slopping towards all the directions and the magnitude of sloping is more towards the west, south and north-east. Considering the topography and terrain characteristics, storage of runoff water using check dams is recommended in the following locations of the campus.

1) Western side of Ladies Hostel Complex and southern side of Deepthi CulturalCentre
2) Western side of Chemistry Department, towards the southern side
3) North of Tenhipalam PoliceStation and South of Working Men's Hostel, in the eastern side of NH66 or on an ideal location, west of NH 66, wherein passes the drainage from the University stadium

The Engineering Department can further work on the feasibility of construction and the expenditure involved.

WASTE MANAGEMENT

The present survey (2021) estimated the total magnitude (minimum) of solid waste generation in the campus to a tune of 557.226 kg. on a working day. The segregation of waste revealed higher extent of food refuse (57%), followed by paper (30%), plastic (11%), glass (1%) and metallic substances (1%). The reduction in the extent of waste generation from 613.896 kg./day (2016) can be attributed to the Covid imposed semi lockdown situations.

The implementation of Green Protocol in the campus in 2017 has help to reduce the magnitude of waste generation, especially of plastic origin, to a greater extent. Most of the departments are following green charter with a ban on flex banners and plastic carry bags and cups for social functions and academic programmes. However, lack of a centralized system of waste collection, segregation, processing and management is putting offices and departments in trouble, which force them to adopt to methods of their choice, which in most cases are not falling within the scope of the green protocol. The following suggestions and recommendations are placed in this perspective.

Offices and departments are to adhere more to the policies of Green Protocol, implemented in the University. They should adopt to various practices of` least waste generation. Adequate awareness initiatives and action programmes can be undertaken by offices and departments in this regard. Adequate administrative and financial services are to be mobilized by the University in this regard.

A centralized system of waste collection, processing and management need be developed by the University. Presently the offices and departments are constrained to retain the non-degradable wastes (plastics and other materials) and to process the degradable wastes collected by them at their centres, due to space requirements and technical constraints. The services by *Haritha Karma Sena* are not adequate in this perspective. A centralized facility for the collection of segregated wastes from offices and departments by the University will overcome the burden of individual offices / departments from processing their wastes using unscientific methods. Adequate manpower and infrastructure (including vehicles) under a house keeping department can be arranged by the University in this regard. There can be a central waste processing unit in the campus with incineration, compost, biogas and recycling facilities set at strategic locations. However, quarters and residential areas are to be insisted to manage household wastes, other than plastics by their own mechanisms, which are scientific. There should also be efforts for the management of sewage generated by hostels and canteens. A detailed study is warranted in this direction.

Presently biomedical waste management is undertaken by the Health Sciences Department of the University. Similarly, management of e-waste is through the University Science Instrumentation Centre (USIC), which collects and dispose the waste to outside recognized agencies. The present systems followed by them can be streamlined for better efficiency. However, with regard to chemical wastes, the University has to develop protocols for its effective disposal, in addition to their collection and storage.

There is high extent of littering and waste disposal in this campus from outside. The local populace and commercial centres need to be informed of this matter through offices of local governance. Travelers are also involved in littering and waste disposal. Adequate sign boards and surveillance facility needs to be arranged by the University in this regard. There can have a greater number of properly functioning waste bins at strategic locations of the campus to control littering.

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GEOGRAPHY AND AERIAL EXTENT

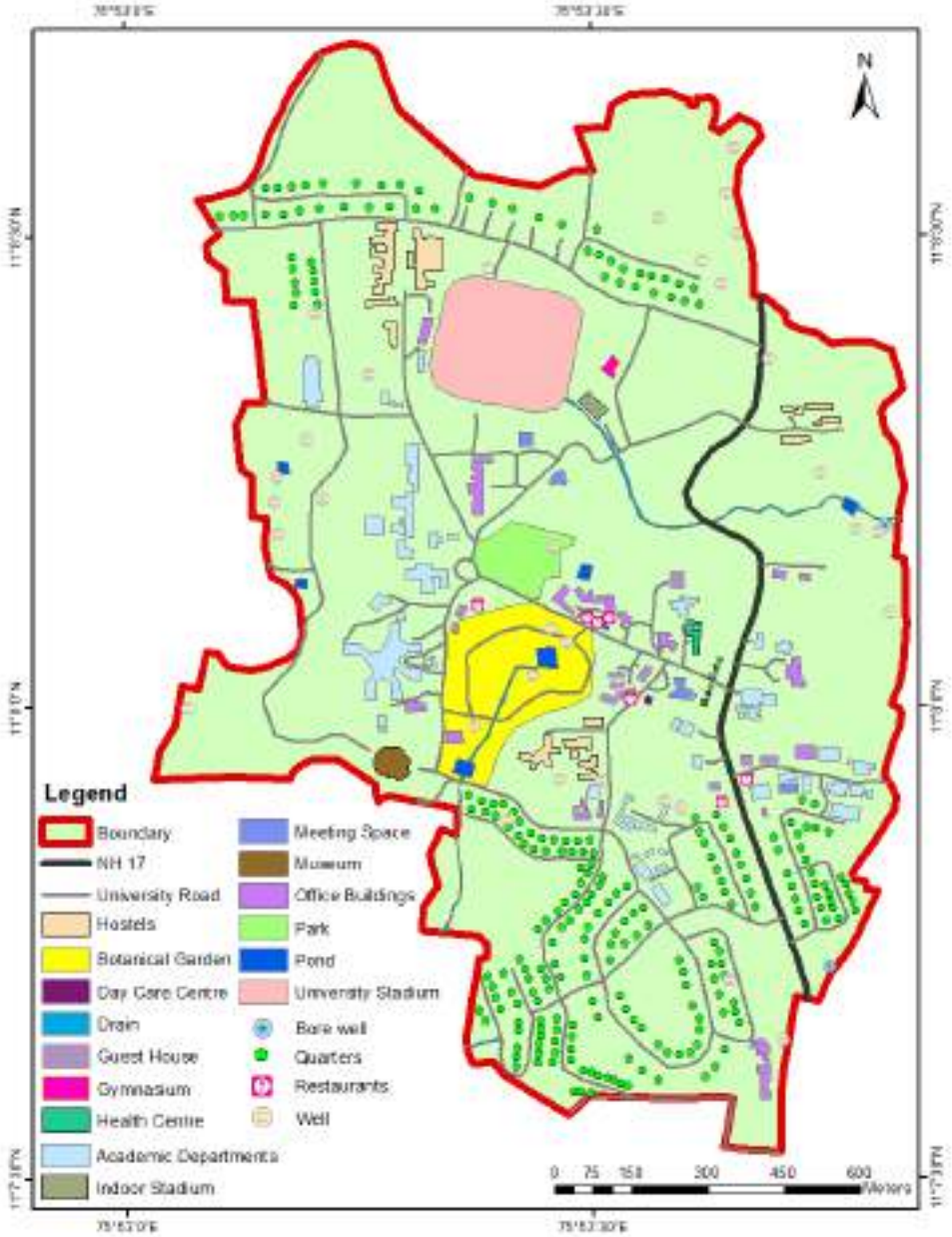
Objectives:

To assess the extent and terrain characteristics of the campus and to suggest strategies for effective land management practices.

Methodology:

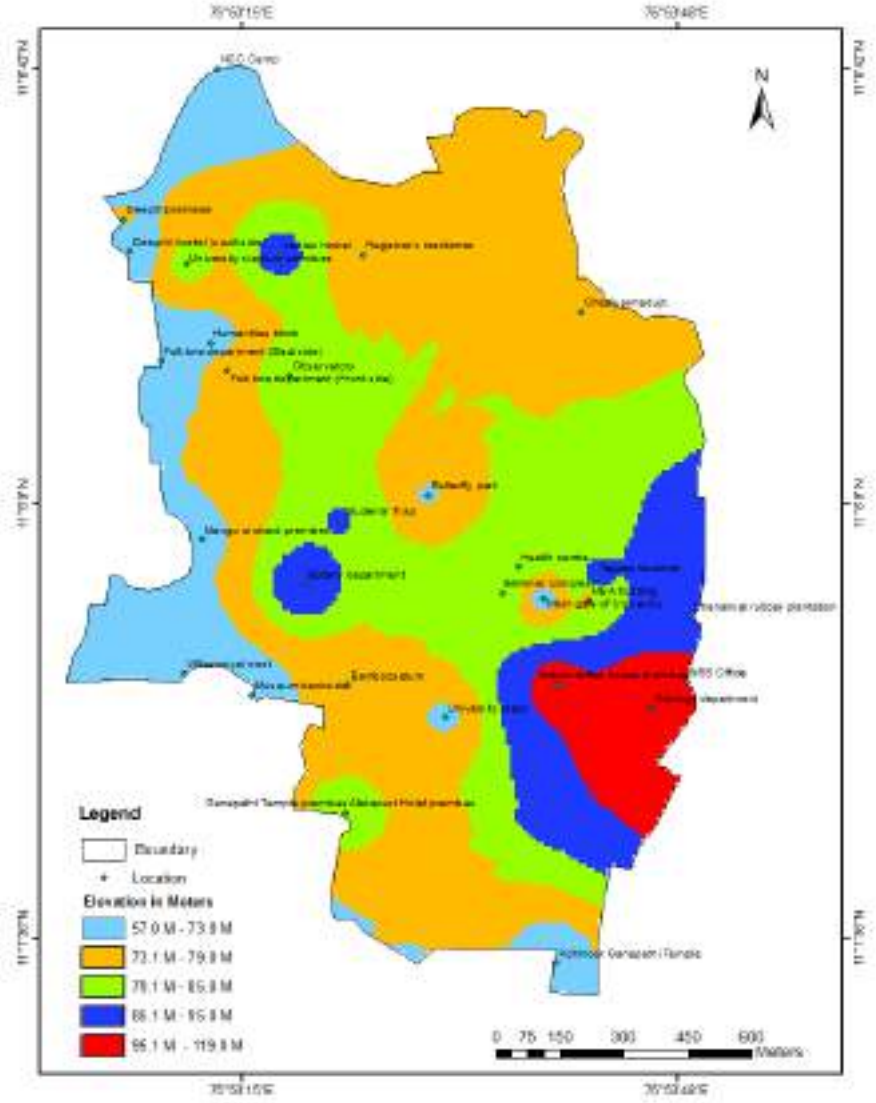
The physical map of the campus has been prepared in ARCGIS software. Major inputs were obtained through GPS survey. Google maps and imageries were used for demarcating locations. Maps available with the University Engineering Department was also referred for delineating boundaries.

Figure 1. Physical map of the campus



(Source: Environmental Audit Report, 2015)

Figure 2. Elevation map of the campus



(Source: Environmental Audit Report, 2015)

Inference

The area of the campus as per GPS survey is 2012869.80 square meters (497.388 Acres). The undulating terrain is mostly lateritic and is sloping. The magnitude of sloping is more towards the western side (elevation: 57 – 73 m) than the east (elevation: 95 – 119 m). It is also sloping towards the northern and southern sides.

Suggestions and recommendations.

The campus receives an annual average rainfall of 2803.82 mm. As the terrain is undulating, there are chances of high extent of erosion and thereby removal of fertile topsoil. Erosion is evidenced by the lateritic rocks exposed at various locations of the campus. Hence it is customary to maintain adequate vegetation cover and to construct erosion prevention structures in high erosion prone areas of the campus. Owing to the specific terrain characteristics, water resources management of the campus needs to be addressed judiciously. The terrain characteristics is contributive to the development of rain water (run off) harvesting structures at strategic locations of the campus.

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CLIMATE

Objectives

To assess the micro climatic conditions existing in the campus, which will help in resource conservation and management.

Methodology

Data related to maximum / minimum temperature, wind velocity and precipitation associated with the region have been either assessed or obtained from various agencies.

As the sustenance of water resources and soil management practices depends mostly on micro climatic conditions, data on maximum – minimum temperature prevalent in the area has been obtained from external agencies and are depicted in Table 01. Also, data concerning the wind velocity has been worked out and the details of precipitation has been obtained from external agency. The details are depicted in Tables 02 a and 2 b, respectively.

Table 01. Maximum / minimum temperature experienced in the region

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Temp (^{0}C) Max.	33.6	35.4	35.8	35.0	33.6	31.7	30.5	31.0	31.9	32.2	32.5	33.8
Temp (^{0}C) Min.	21.5	22.4	24.9	25.2	25.2	23.7	23.3	23.3	23.8	23.9	23.2	23.1

Data Source: CWRDM, Government of Kerala

Table 02 a. Results of sector wise wind velocity experienced in the campus

Sl. No.	Site name	Wind velocity (m/sec) in the AN hours
1	Kohinoor Ganapathi Temple	2.6
2	Near Geology department	2.8
3	Geology side quarters line	5.1
4	Seminar complex	1.3
5	Chenakkal rubber plantation	1.7
6	Chettiyarmad	3.5
7	Tagore Nikethan	1.4
8	Commerce Department	4.5
9	Health Centre	3.0
10	Pareeksha Bhavan	1.0
11	Administrative block	1.0
12	University Stadium	3.4
13	Acacia plantation near stadium	3.0
14	Ladies hostel	2.8
15	Near Deepthi hostel	0.8

16	Humanities block	2.1
17	Near mango orchard	0.9
18	Library Buildings	1.2
19	Student's Trap	1.5
20	Botany department	0.7
21	Museum Premises	1.3
22	Near Post no: C/VK 26	1.5
23	MEMS school premises	2.4
24	Near Jalanidhi board	1.5
25	Villunniyal	0.7
	Mean	2.08

Table 2 b. Rain fall data of Malappuram district (Source: IMD and WW-online)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total (Annual) mm
2014	1.1	0.5	0	49.8	236.4	542.1	856.8	615.9	297.4	371.1	121.3	40.7	3133.1
2015	0	0	37.2	167	187.2	593.8	411.5	264	266.8	291.8	232	36.3	2487.6
2016	0	1.8	2.6	4.7	154.5	585.2	406.5	186.3	73.2	87.1	14.8	16.3	1533
2017	4	0	29.4	26.6	122.9	568.8	427	459.7	472.7	211.1	95.6	37.1	2454.9
2018	0	5.9	19.1	105.4	403.6	860.8	888.4	914.5	59.9	277	110.9	13	3658.5
2019	0.02	1.6	15.5	121.6	121.3	396.5	785.3	890.4	250.4	630	283.8	59.4	3555.82
Mean	0.853	1.633	17.3	79.18	204.31	591.2	629.2	555.13	236.73	311.35	143.06	33.8	2803.82

Inference

The campus experiences mild hot and quite humid climate with heavy rainfall during monsoon months. March and April are the hottest and January and February are the coldest months. The maximum temperature ranges from 28.9 to 36.2 and minimum from 17 to 23.4. The wind is predominant from east as well as west during morning and evening hours. The wind speed was noted to range from 0.7 to 7.1 m/s under ideal conditions. The relative humidity ranges from 84 to 94% during morning hours. The humidity is more during peak monsoon months from June to September.

Rainfall data for a period of 6 years (2014 – 2019) indicate that the lowest precipitation was in 2016 (1533 mm) and the highest in 2018 (3658.5). Mean values of precipitation were lowest in January (0.853mm) and highest in July (629.2mm). Annual average rainfall was noted to be 2803.82 mm.

Suggestions and recommendations

Moderately higher temperature and wind velocity experienced in the region is indicative of the higher evaporation rate and resultant desiccation of water resources. It also points to the need for the development of adequate vegetation cover for the protection of soil and overcoming the drought situations. The higher rate of precipitation is promising to the development of water harvesting structures, both rooftop and runoff, for the effective management of water resources.

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VEGETATION AND LAND USE

Objectives:

To assess the nature and extent of land use and vegetation cover and to suggest management measures for effective land management.

Methodology:

Built-up area was assessed using Google map / imageries and GPS. Areas having vegetation cover were surveyed using GPS / Google map and the vegetation types were assessed using Mehar Homji's system of classification. Thematic maps pertaining to land use / vegetation cover were prepared using ARCGIS software. The extent of area occupied by various buildings, facilities and vegetation are given in Table 3. The percentage share of land use is given in Figure 3 (a & b) and the extent of barren area in Figure 4.

Table 3. Land use

Sl. No.	Land use pattern	Area (sq. m.)	Area in Acres	Percentage of total area
1	Botanical Garden	71492.796	17.6662546277	3.552
2	Park	18981.130	4.6903393693	0.943
3	Stadium	62607.965	15.4707650742	3.110
4	Dense Mixed Vegetation	171335.936	42.33803182431	8.512
5	Medium Mixed Vegetation	715995.6515	176.92637859274	35.571
6	Mango Orchard	30511.755	7.53961885851	1.516
7	Rubber Plantation	23434.10755	5.7906940854853	1.165
8	Acacia Plantation	436392.835	107.8350179622	21.681
9	Barren Area	385258.085	95.19934605723	19.140
10	Buildings	96859.54203	23.934514082058	4.812
	Total extent	2012869.803	497.39096051405	100

Inference:

The results of the present study (2020-21) are compared with the Environmental Audit Report of the year of 2015-2016 to assess the magnitude of changes in land use over a period of 5 years.

The area occupied by the campus, as per GPS survey is 2012869.803 square meters (497.39 acres**).** Of the total area, 3.1% is occupied by the university stadium and the built-up area is 4.8%. Natural vegetation in the campus is brought under two main types – Dense mixed and Medium mixed types. Dense vegetation covers a total of 8.5% of the total land area. Dense vegetation includes a thick population of plants from all hierarchies – from herbs, shrubs to trees. But this vegetation is

not uniform and is remaining fragmented due to geological / geographical reasons and land management practices. Majority of the land is occupied by the medium-mixed type of vegetation (35.5%). Botanical Garden (3.55%) and University Park (0.94%) are protected areas within the campus, which provides conservation to a wide range of plants and associated organisms. Plantations of mango varieties, rubber and Acacia are also seen in the campus. Mango orchard (1.51%) is surrounded by dense and medium vegetation on one side and an extensive cover of Acacia (21.68%) on the other. Acacia forms a major environmental concern in the campus, owing to varied reasons and are to be replaced with native vegetation in the near future. Rubber plantation contributes to 1.16% of the total land area. Apart from this, completely barren area is estimated to be 385258.085 sq. m. (95.19 acres), representing 19.14% area of the campus.

Fig. 3 (a). Vegetation and land resource utilization

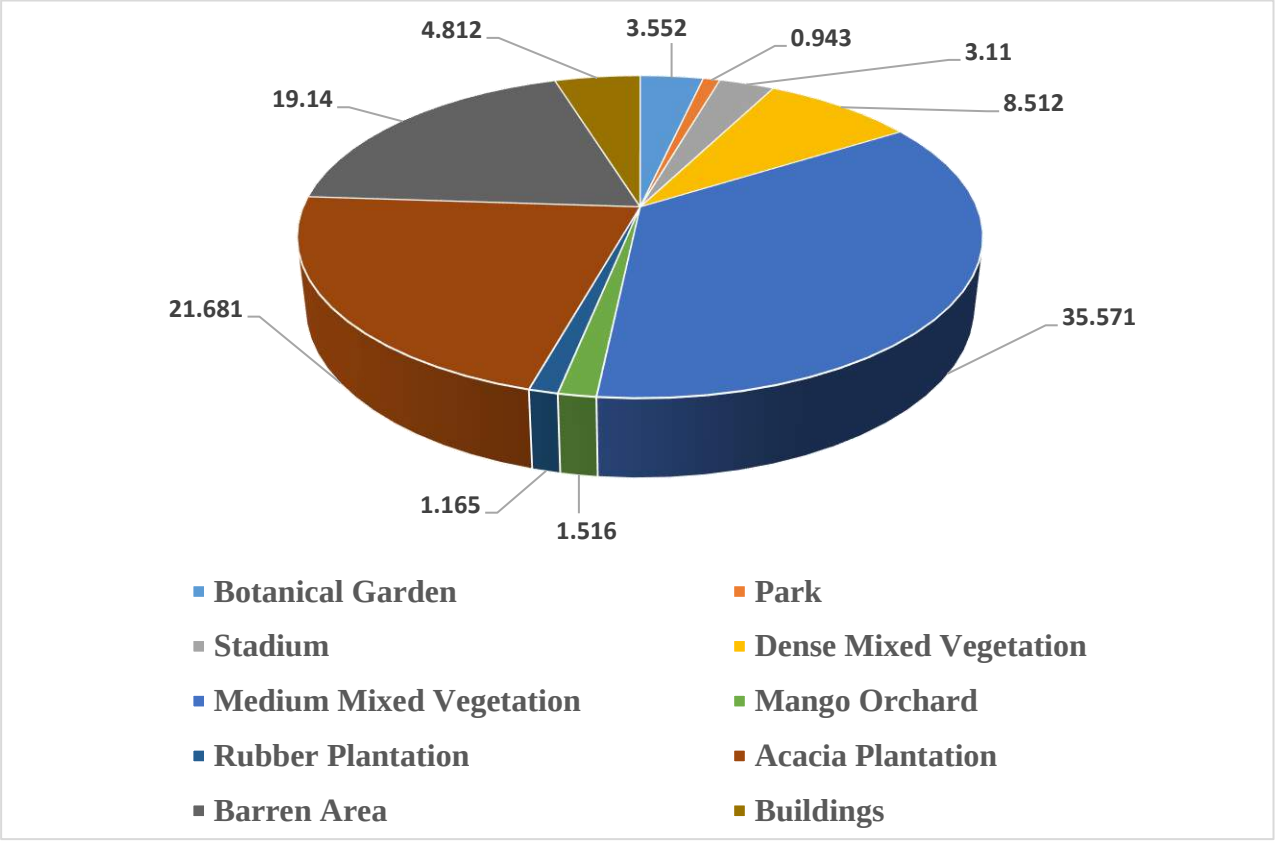


Fig. 3 (b). Vegetation

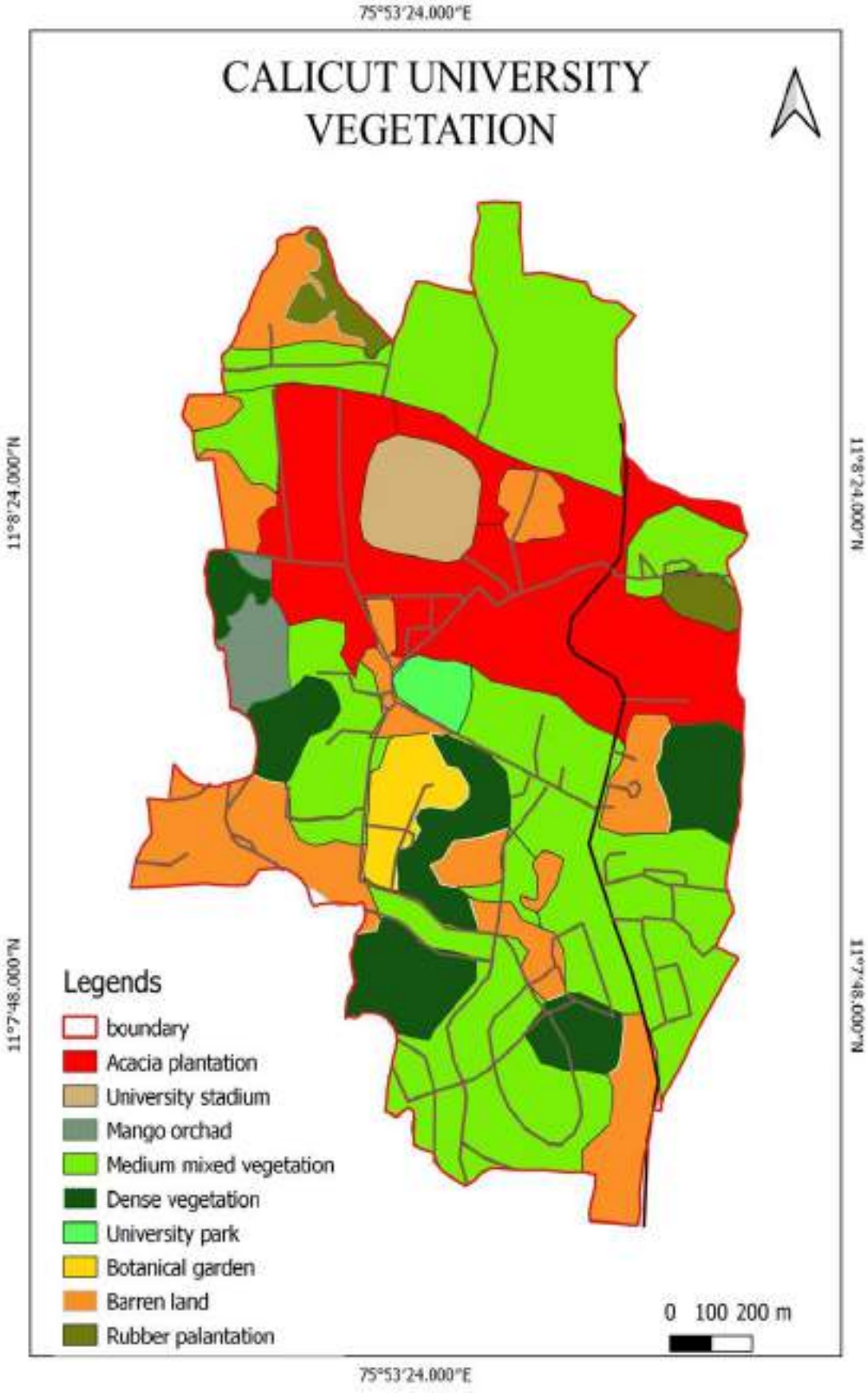
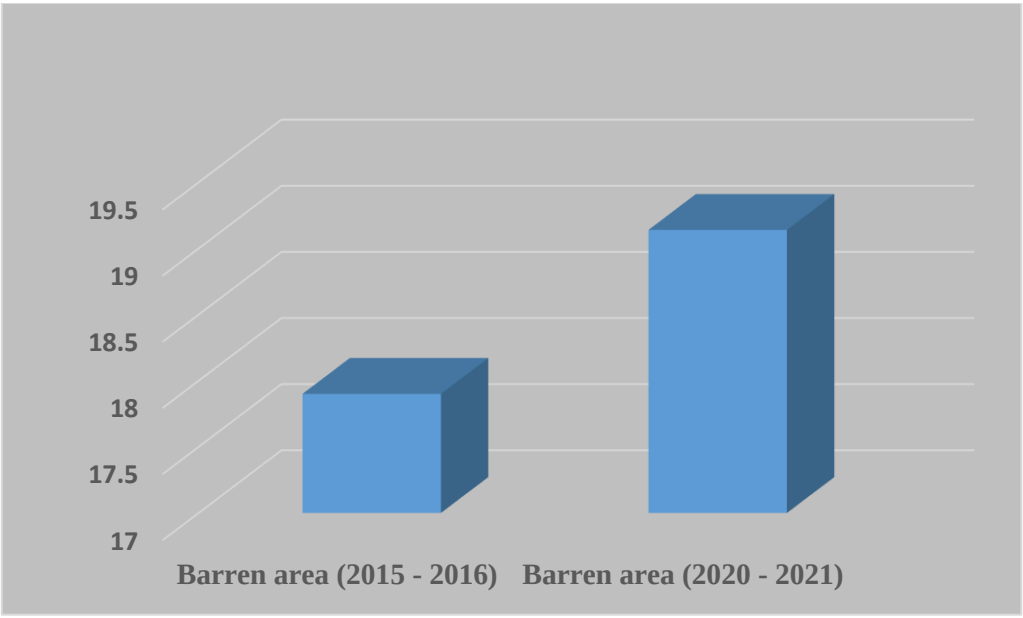


Fig. 4. Barren area (comparison)



Suggestions and recommendations

This audit survey assessed the land use pattern and vegetation cover of the campus for the year 2021-2022 and compared it with that of the earlier report of 2015 – 2016.

The area occupied by the buildings have increased from 4.405% to 4.812% over a period of 5 years. The vegetation cover (both dense and medium mixed type) has decreased to an extent of 0.534% over these years. The barren area also showed an increase of 1.240%. The area under Acacia plantation has decreased to an extent of 0.982%. Considering these aspects, the following recommendations are made.

As the built-up areas are likely to increase as part of various developmental initiatives in future, efforts are to be undertaken to bring more areas under vegetation cover. Presently barren lands contribute to 19.14% of the total land area and are mostly attributed by exposed rocky and lateritic regions. More scientific approaches are required for the conversion of such areas, for which selection of species and method of planting needs to be standardized.

In addition to the efforts for the control of barren areas, there has to be serious efforts for the conversion of medium mixed vegetation to the dense type. This is possible with the introduction of selected tree species, which attributes more biomass and maintains biodiversity.

It is equally important to control the expansion of invasive species like Acacia to conserve the growth of indigenous varieties. Acacia has recently been attributed with a wide range of ill effects, detrimental to both human health and ecology. They need to be replaced with healthy vegetation.

Maintenance of vegetation cover is more significant in the campus, as its topography is highly undulating and sloping towards all directions. Lack of a proper vegetation cover is likely to accelerate the erosion process, which in turn will take away the fertile topsoil, leaving the rocky terrain exposed.

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WATER RESOURCES

Objectives

To make an inventory on the water resources of the campus and their potentials for utilization
To assess the percentage share of utilization of water by different segments of the campus
To have an evaluation of the quality of water and the anthropogenic threats associated with the Kadalundi river at Parakkadavu region
To have an evaluation of the quality of water confining to the distribution system within the campus

Methodology

The sources of water supply to the campus were assessed and their quality for consecutive months were monitored. The quality of water in the distribution system within the campus was monitored. An inventory on the surface and ground water sources of the campus like ponds, wells and other water resources were undertaken. Their physical measurements were taken and their qualitative assessments were carried out with respect to standard protocols (APHA, 2000). Water Quality Index of these resources were worked out. An inventory on the water resources utilization pattern of the campus was made for suggesting management measures for their effective utilization.

Sources of water supply

The University of Calicut meets its requirement of water from Kadalundi river, ~10Km awayfrom the campus. The water supply system comprises of an intake facility at Parakkadavu, booster facility at Chelari and a treatment facility at the Calicut University campus (Plates 1-3).

Plate 1. Kadalundi river at Parakkadavu region

Plate 2. Pump house at Parakkadavu

Plate 3. Water treatment facility at Calicut University Campus

The water treatment facility in the campus (as per Engineering Department) comprises of a Rapid Sand Filter Bed, which has a daily capacity of 10-16 Lakhs Liters. In accordance with the requirements of water within the campus, every day, 10-16 Lakhs Liters of water are pumped from Kadalundi River. The collected water is then mixed with alum and limestone at a concentration depending on the turbidity of the raw water. The water is then passed through the sand bed for filtration and normally 80,000 liters of water is filtered in an hour. In order to confirm proper disinfection, filtered water is mixed with moderate levels of bleaching powder, which maintains chlorine concentration within a permissible limit. Treated water is collected in a base tank (4.5

Lakhs Liter capacity) and pumped (using three 15 HP motors) to two overhead tanks (5 and 2.25 Lakhs Liters capacity each). Before distribution, the treated water is checked for various quality parameters.

Water quality at source

The quality of water adjoining the intake facility at Parakkadavu was assessed in the months of January and February, 2020. Surface water samples from the main stream (R1, R2,R3 and R4), its tributary (RT1, RT2, RT3 and RT4) and from selected locations of the treatment facility (P1, P2 and T1) were assessed for various water quality parameters like pH, Conductivity, Resistivity, Salinity, Turbidity, TDS, Acidity, Alkalinity, Hardness, Chloride, DO, BOD, Phosphate, Sulphate, TPC and E coli, following standard methods. The sampling sites selected for the study are depicted in plate 4 and the results of waterquality in tables 4 and 5.

Plate 4.
Sampling sites of water quality assessment at Parakkadavu region of Kadalundi river

Table 4: Results of water quality adjoining the intake facility at Parakkadavu in the month of January, 2020.

Parameters	**Unit**	**R1**	**R2**	**R3**	**R4**	**RT1**	**RT2**	**RT3**	**RT4**	**P1**	**P2**	**T1**	**Mean**	**STDEV**
pH	_	7.39	7.28	7.43	7.44	7.28	7.2	7.26	7.42	7.39	7.53	7.48	7.37	0.10
Conductivity	µs	92.08	93.09	92.39	91.56	96.59	93.56	93.32	90.61	90.64	96.05	92.3	92.93	1.94
Resistivity	kΩ	11.96	11.92	11.93	12.03	11.42	11.77	11.81	12.07	12.14	11.33	11.93	11.85	0.26
Salinity	ppm	44.86	45.34	45.09	44.88	47.07	45.32	45.52	44.54	44.4	47.68	45.32	45.46	1.02
Turbidity	NTU	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.4	0.1	0.14	0.09
TDS	ppm	54.69	55.4	54.87	54.38	57.16	55.31	55.43	53.92	53.91	56.24	54.93	55.11	0.97
Acidity	Mg/l	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	5	5	5	2.27	1.75
Alkalinity	Mg/l	20	15	10	10	15	10	10	10	10	10	10	11.82	3.37
Hardness	Mg/l	40	30	30	50	20	20	50	40	40	30	30	34.55	10.36
Chloride	Mg/l	14.18	14.18	14.18	14.18	14.18	7.09	14.18	14.18	14.18	14.18	14.18	13.54	2.14
DO	Mg/l	5.04	5.88	5.04	5.04	5.88	3.36	5.04	5.04	5.04	4.02	5.04	4.95	0.72
BOD	Mg/l	1.008	3.162	1.68	1.008	3.192	0.672	1.68	1.68	3.024	3.024	0.672	1.89	1.03
Phosphate	Mg/l	0.141	1.131	0.141	0.130	0.129	0.113	0.134	0.141	0.145	0.141	0.145	0.23	0.30
Sulphate	Mg/l	3.11	3.02	3.14	3.12	2.92	3.12	3.06	3.06	3.02	3.09	3.11	3.07	0.06
TPC	CFU	43	54	50	41	78	38	81	37	28	71	122	58.45	27.43
E coli	CFU	8	6	nil	8	4	2	7	nil	2	2	0	4.33	3.0

Table 5: Results of water quality adjoining the intake facility at Parakkadavu in the month of February, 2020.

Parameters	**Unit**	**R1**	**R2**	**R3**	**R4**	**RT1**	**RT2**	**RT3**	**RT4**	**P1**	**P2**	**T1**	**Mean**	**STDEV**
pH	_	7.2	7.1	7.11	7.1	6.82	6.76	7.06	7.13	7.36	7.3	7.34	7.12	0.19
Conductivity	µs	109.3	113.0	111.4	108.1	129.3	122.6	105.8	102.4	110.6	109.0	108.2	111.79	7.69
Resistivity	kΩ	10.08	9.76	9.86	10.18	8.49	9.37	10.42	10.75	9.58	10.12	10.18	9.89	0.60
Salinity	ppm	51.1	52.44	52.01	50.56	60.37	57.26	50.34	48.34	51.6	51.48	50.46	52.36	3.44
Turbidity	NTU	0.1	0.5	0.4	0.3	0.8	0.5	0.4	0.4	0.5	0.8	0.1	0.44	0.23
TDS	ppm	65.03	67.28	66.3	64.35	77.13	72.67	63.26	60.64	65.81	64.88	64.38	66.52	4.59
Acidity	Mg/l	5	5	5	5	5	5	5	5	5	5	5	5.00	0
Alkalinity	Mg/l	50	55	40	40	50	45	45	40	50	45	35	45.00	5.92
Hardness	Mg/l	60	40	50	50	30	30	50	30	30	40	30	40	10.95
Chloride	Mg/l	28.36	28.36	28.36	28.36	21.27	21.27	21.27	21.27	28.36	28.36	28.36	25.78	3.58
DO	Mg/l	3.36	4.03	3.36	3.36	2.69	3.36	2.69	2.69	4.03	3.36	3.36	3.30	0.47
BOD	Mg/l	1.1	0.83	1.44	1.44	0.77	1.44	0.77	0.13	1.47	1.44	0.8	1.06	0.44
Phosphate	Mg/l	0.146	0.141	0.147	0.152	0.073	0.137	0.144	0.135	0.114	0.141	0.132	0.13	0.02
Sulphate	Mg/l	3.11	3.04	2.89	2.69	2.98	0.119	0.451	2.50	1.54	2.84	3.01	2.29	1.08
TPC	CFU	10	18	22	6	131	113	24	35	154	135	55	63.91	57.20
E coli	CFU	2	3	4	Nil	60	62	13	Nil	46	24	Nil	26.75	25.66

The analytical results were compared with the standard values (World Health Organization / Bureau of Indian Standards) determining potability, as depicted in Table 6. Also, Water Quality Index (WQI) of the samples was worked out (Table 7) and has been compared with the quality criteria as depicted in Table 8.

Table 6. Drinking water quality standards by WHO / BIS

Sl. No.	Parameter	Unit	WHO Limit	BIS Limit
1	pH	-	6.5-8.5	6.5-8.5
2	Turbidity	(NTU)	1	1
3	EC	Milli / Micro Siemens	5	5
4	Chloride	(mg/L)	250	250
5	TH as $CaCO_3$	(mg/L)	300	200
6	TDS	(mg/L)	500	500
7	Alkalinity	(mg/L)	200	200
8	Sulphate	(mg/L)	200	200
9	DO	(mg/L)	>7, 7-6, 6-4, 4-3 and <3 for category I, II, III, IV and V waters (NRA, 1991)	
10	BOD	(mg/L)	-	Should not exceed 2 mg O_2 l^{-1} For Class A and 3 mg O_2 l^{-1}, for Class B and C waters
11	Total coliforms	(cfu/ml)	Must not be detectable in any 100ml of sample	Must not be detectable in any 100ml of sample

Table 7: WQI of samples adjoining the intake facility at Parakkadavu for the months of January and February, 2020.

Sampling sites	Sampling 1 (January, 2020)	Sampling 2 (February, 2020)
R1	15.28	24.30
R2	19.22	46.70
R3	19.72	37.91
R4	17.91	29.47
RT1	25.10	66.99
RT2	15.17	44.68
RT3	42.49	70.94
RT4	19.73	36.69
P1	18.81	48.52
P2	19.72	29.14
T1	19.73	30.22
	21.17	42.32

Table 8. WQI developed by Brown et al., (1972)

Water Quality Index	Water Quality Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unfit for consumption

Quality assessment of water in the distribution network (within campus)

As stated earlier, an average of 10 - 16 lakh liters of treated water are distributed within the campus, daily. The water released to the distribution system is stored in accordance with the tanks mounted in different blocks / buildings of the University. Hostels, especiallythe ladies' hostel and guest houses are maintained with a 24-hour supply. Supply to all the other sectors is restricted in a way that it is made available during morning and evening hours.

The quality of treated water in the distribution system within the campus was assessed at various locations. Details of sampling locations (T1 – T7) are given in Table 9 and their quality in the months of January and February (2020) are depicted in Tables 10 and 11, respectively. WQI of the samples were assessed and is given in Table 12.

Table 9. Sampling locations in the treatment system

T1	Administrative block
T2	Pareeksha bhavan
T3	Tagore nikethan
T4	Ladies hostel
T5	Men's hostel
T6	Staff quarters
T7	Treatment plant (after treatment)

Table 10 – Results of water quality in the distribution system in the month of January, 2020

Parameters	T1	T2	T3	T4	T5	T6	T7	Mean
Temperature (°c)	26.5	26.3	26.8	26	26.4	26.8	26.2	26.4286
pH	7.40	7.54	7.55	7.63	7.57	7.59	7.57	7.55
Conductivity (µs)	103.9	107.0	103.9	105.3	104.7	104.0	109.5	105.471
Resistivity (KΩ)	10.50	10.29	10.60	10.04	10.54	10.59	10.06	10.3743
Salinity (ppm)	50.68	51.38	50.01	53.05	50.24	50.04	52.38	51.1114
Turbidity (NTU)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TDS (ppm)	61.92	63.57	61.83	65.52	62.28	61.87	65.15	63.1629
DO (mg/l)	4.032	4.032	4.032	4.032	4.032	4.032	3.36	3.936
BOD (mg/l)	0.672	1.344	0.672	0.672	1.344	0.672	0.672	0.864
Acidity (mg/l)	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Alkalinity (mg/l)	5	5	5	5	5	5	5	5
Hardness (mg/l)	30	30	30	40	30	40	30	32.8571

Chloride (mg/l)	29.77	29.77	29.77	29.77	29.77	29.77	29.77	29.77
Phosphate (mg/l)	0.1433	0.0176	0.1423	0.1454	0.0912	0.1484	0.1045	0.11324
Sulphate (mg/l)	2.052	2.0877	2.0736	2.052	2.080	2.0456	2.066	2.06527

Table 11 – Results of water quality in the distribution system in the month of February, 2020

Parameters	T1	T2	T3	T4	T5	T6	T7	Mean
Temperature (°c)	26.5	26	26	25.8	26.3	26.1	26.4	26.1571
pH	7.26	7.47	7.63	7.60	7.71	7.53	7.34	7.50571
Conductivity (µs)	111.8	112.3	117.9	112.7	112.7	128.8	113.0	115.6
Resistivity (KΩ)	9.847	9.788	9.344	9.794	9.770	8.554	9.76	9.551
Salinity (ppm)	53.04	53.0	55.52	53.20	53.31	59.58	50.46	54.0157
Turbidity (NTU)	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.14286
TDS (ppm)	66.42	66.82	70.28	66.92	67.08	76.62	64.38	68.36
DO(mg/l)	4.032	4.032	3.36	4.032	4.032	3.36	2.688	3.648
BOD(mg/l)	1.344	1.344	0.672	1.344	0.672	0.672	0.672	0.96
Acidity(mg/l)	2	2.5	2.5	2.5	2.5	2.5	2.5	2.42857
Alkalinity(mg/l)	15	10	15	15	15	15	15	14.2857
Hardness (mg/l)	40	30	30	30	30	40	30	32.8571
Chloride(mg/l)	49.63	39.704	29.778	29.788	29.788	39.704	39.704	36.8709
Phosphate(mg/l)	0.1433	0.1198	0.1321	0.1474	0.020	0.1474	0.1321	0.1203
Sulphate(mg/l)	2.073	2.298	2.263	2.445	2.382	1.926	2.063	2.20714

Table 12: WQI of samples in the distribution system in the months of January and February, 2020.

Sampling sites	Sampling 1 (January, 2020)	Sampling 2 (February, 2020)
T1	8.76	6.70
T2	12.25	12.36
T3	12.24	17.02
T4	22.71	15.83
T5	12.25	17
T6	15.75	12.48
T7	12.26	8.92
Mean	13.74	12.90

Quantitative and qualitative assessment of other water resources within the campus

Water resources like ponds, wells (dug wells and bore wells) and other water harvesting structures within the campus were identified through field surveys. Physical measurements of these water resources were taken. The quality of water has been assessed as per standard methods prescribed in APHA (2000). The list of water resources is depicted in Table 13 and their physical measurements in Table 14. The quality characteristics of well water samples for the months of January and February (2020) are depicted in Tables 15 and 16 and that of the pond water samples in Tables 17 and 18, respectively. The WQI of water samples analyzed in the months of January and February are depicted in Table 19 and their standard measurements in Table 20.

Table 13: Details of water resources identified within the Campus

Sl. No.	ID No	Location Latitude	Location Longitude	Landmark	Remarks
Wells					
1	W1	N 11° 07.846’	E 75° 53.551	Inside cu LP school	Protected, used by school authorities for various purposes
2	W2	N 11° 08.429’	E 75° 53.203’	West of Ladies Hostel	Not Protected, water is not used
3	W3	N 11° 07.642’	E 75° 53.704’	Near teachers flat Kohinoor	Protected, water used for non-drinking purposes by local populace
4	W4	N 11° 07.894’	E 75° 53.591’	Front side of cu high school	Not protected, water is not used for any purpose
5	W5	N 11° 07.925’	E 75° 53.509’	Near men’s hostel	Protected, used by printing press and for irrigation purposes
6	W6	N 11° 08.009’	E 7 5° 53.601’	Back side of seminar complex	Protected, water is occasionally used for irrigation purposes
7	W7	N 11° 08.078’	E 75° 53.468’	Inside botanical garden	Protected, water is used for irrigation purpose
8	W8	N 11° 08.085’	E 75° 53.455’	Inside botanical garden	Protected, water is used for irrigation purposes
9	W9	N 11° 07.93’	E 75° 53.373’	Inside botanical garden	Protected, water is used for irrigation purposes
10	W10	N 11° 08.038’	E 75° 53.468’	Inside botanical garden	Protected, water is not used
11	W11	N 11° 08.475’	E 75° 53.392’	North of stadium	Protected, water is used for irrigation and constructionpurposes
12	W12	N 11° 08.178’	E 75° 53.463’	Inside university park	Protected, water is used for irrigation purposes
13	W13	N 11° 08.193’	E 75° 53.156’	Inside mango orchard	No water
14	W14	N 11° 08.226’	E 75° 53.161’	Inside mango orchard	No water
15	W15	N 11° 07.760’	E 75° 53.440’	Near Rachana Nurseryschool	No water
16	W16	N 11° 07.905’	E 75° 53.573’	Inside CU High School	No water
17	W17	N 11° 08.554’	E 75° 53.660’	Near Chettiyarmad (NH)	Not protected, water is not used
18	W18	N 11° 08.193’	E 75° 53.819’	Near Police Station	No water
Bore wells					
1	B1	N 11°08.209’	E 75° 53.785’	Near Police Station	Has been sealed due to technical reasons
2	B2	N 11°07.727’	E 75° 53.755’	Opposite to Kohinoorground	Has been sealed due to technical reasons
3	B3	N 11° 08.267’	E 75° 53.174’	Near Philosophydepartment	Has been sealed due to technical reasons
Ponds					
1	P1	N11°08.068’	E 75°53.462’	Inside botanical garden	Water in all season, used for irrigation, construction purposes
2	P2	N11°07.948’	E75°53.353’	Inside botanical garden	Water is not constantly present
3	P3	N11°08.183’	E 75° 53.459’	Inside University park	Water is not used
4	P4	N 11°08.011’	E 75°53.013’	Near villunniyal temple road	Water is used for irrigation.
5	P5	N 11 °7.050	E 75°53.023’	Pond near the stream in Sky walk	Water is used by nearby people.
6	P6	N 11°8.015	E 75°53.006’	Mango orchard	Protected, water is used forirrigational purposes.
7	P7	N 11 °08.227’	E 75° 53.777’	Near Police station	No water

Table 14. Physical measurements of water resources within the Campus

Sl No.	ID	Radius (Meter)	Total depth (Meter)	Depth to water front (Meter)	Pitching height (Meter)	Depth of water column (Meter)	Volume of water (m^3)
WELLS							
1	W1	1.4	14.26	11.46	0.92	2.8	17.23232
2	W2	1.26	14.09	12.43	0.93	1.66	8.275206
3	W3	1.13	7.7	6.2	0.71	1.5	6.014199
4	W4	1.17	11.72	10.02	0.82	1.7	7.307188
5	W5	1.62	15.85	12.45	0.77	3.4	28.01809
6	W6	1.5	14.07	10.2	0.74	3.87	27.34155
7	W7	1.65	7.39	5.27	1	2.12	18.12314
8	W8	2.8	7.5	5.4	1.14	2.1	51.69696
9	W9	1.6	10.5	7.94	0.86	2.56	20.5783
10	W10	3	3.36	2.5	0.23	0.86	24.3036
11	W11	1.76	8.22	5.7	0.9	2.52	24.51069
12	W12	1.14	12.03	9.38	0.58	2.65	10.81397
13	W13	-	-	-	-	-	-
14	W14	-	-	-	-	-	-
15	W15	-	-	-	-	-	-
16	W16	-	-	-	-	-	-
17	W17	2.35	8.02	6.02	0.5	2	34.6813
18	W18	-	-	-	-	-	-
PONDS							
Sl. No.	ID	Radius /Length/ Breadth (Meter)	Total depth (Meter)	Depth to water front (Meter)	Pitching height (Meter)	Depth of water column (Meter)	Volume of water (m^3)
1	P1	40.8X28.6	2.99	2.52	Nil	0.47	171.08
2	P2	44X37.14	3.59	2.28	Nil	1.31	2140.75
3	P3	2.76	1.31	0	Nil	1.31	7.839
4	P4	2.16	0.74	0.24	Nil	0.5	1.832
5	P5	3.98	1.3	0.67	Nil	0.63	7.839
6	P6	4.25	0.9	0.08	Nil	0.82	11.634
7	P7	27.8X26.4	6.73	5.63	Nil	1.1	13.200
*** BORE WELLS**							
1	B1	#	#	#	#	#	#
2	B2	#	#	#	#	#	#
3	B3	#	#	#	#	#	#

* not under operation; - not having water during the survey period # not been assessed

Table 15. Results of well water samples in January 2020

Parameters	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	Mean
Temperature (°c)	28.7	27.5	28.2	27.4	27.3	27.5	27.6	28.7	27.3	27.2	27.3	27.4	27.6
pH	7.02	7.09	7.51	6.86	7.14	6.94	6.34	6.81	6.62	7.91	6.60	7.10	6.99
Conductivity (µs)	57.81	78.74	107.1	134.7	182.6	73.40	45.56	69.78	80.10	212.8	165.2	96.75	108.7
Resistivity (KΩ)	19.05	13.99	10.29	8.17	6.02	15.0	24.17	15.79	13.60	5.18	6.66	11.38	12.4
Salinity (ppm)	31.97	39.83	51.26	62.58	82.47	37.76	26.99	36.27	40.46	94.97	75.13	47.04	52.2
Turbidity (NTU)	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1
TDS (ppm)	34.40	46.79	63.85	80.19	108.7	43.68	27.12	41.53	47.92	126.3	98.32	57.58	64.69
DO (mg/l)	4.032	2.016	4.032	2.688	3.36	3.36	2.016	2.016	2.016	2.688	2.016	2.688	2.744
BOD (mg/l)	1.344	0.672	0.672	0.672	1.344	1.344	0.672	0.672	0.672	1.344	0.672	0.672	0.896
Acidity (mg/l)	1.25	2.5	1.25	1.25	2.5	2.5	2.5	1.25	2.5	2.5	2.5	1.25	1.9
Alkalinity (mg/l)	10	5	10	5	5	5	10	5	5	15	5	10	7.5
Hardness (mg/l)	10	30	40	50	50	30	10	30	20	40	30	40	31.66
Chloride (mg/l)	19.85	19.85	29.77	39.704	49.63	29.77	19.852	19.852	19.85	19.85	39.70	19.852	27.29
Phosphate (mg/l)	0.1454	0.1433	0.1525	0.1536	0.1525	0.1525	0.1525	0.1464	0.127	0.122	0.112	0.1065	0.138
Sulphate (mg/l)	2.052	2.298	2.143	2.550	2.270	2.663	2.249	2.129	2.073	2.045	2.256	2.171	2.2
Total cell count (CFU)	37	74	88	27	58	38	118	48	58	36	57	82	60.8
Total coliforms	6	59	0	15	0	2	0	9	0	0	3	30	10.3

Table 16. Results of well water samples in February 2020

Parameters	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	Mean
Temperature (°c)	27	27.2	26.9	-	27.1	26.8	26.5	26.8	26	27.2	26.4	26.5	26.7
pH	6.82	5.35	6.90	-	5.58	5.36	5.18	5.52	5.72	7.46	5.53	6.72	6.01
Conductivity (µs)	70.90	73.03	133.3	-	155.2	74.79	73.95	72.04	81.18	219.5	149.8	114.8	110.7
Resistivity (KΩ)	15.56	15.10	8.26	-	7.109	14.70	14.86	15.2	13.54	5.019	7.241	9.573	11.46
Salinity (ppm)	36.67	37.18	61.87	-	70.45	38.19	37.92	36.09	40.30	98.43	69.92	54.55	52.87
Turbidity (NTU)	0.2	0.2	0.3	-	0.9	0.6	0.3	0.2	0.2	0.7	0.2	0.4	0.3
TDS (ppm)	42.19	42.63	79.34	-	92.01	44.49	44.01	43.56	48.36	130.7	89.90	68.32	65.95
DO (mg/l)	3.36	1.344	2.016	-	2.016	2.016	2.016	2.688	2.688	4.032	2.688	3.36	2.565
BOD (mg/l)	1.344	0.672	1.344	-	0.672	0.672	0.672	0.672	0.672	2.688	0.672	1.344	1.038
Acidity (mg/l)	2.5	12.5	1.25	-	2.5	2.5	2.5	1.25	1.25	2.5	1.25	1.25	2.84
Alkalinity (mg/l)	10	10	15	-	10	10	10	10	10	15	10	15	11.3
Hardness (mg/l)	30	10	40	-	20	30	20	30	20	30	30	40	27.2
Chloride (mg/l)	29.77	39.70	29.77	-	39.704	39.704	29.77	39.704	49.63	19.85	49.63	29.77	36.09
Phosphate (mg/l)	0.1505	0.1311	0.090	-	0.1086	0.1382	0.1423	0.1168	0.144	0.045	0.135	0.142	0.122
Sulphate (mg/l)	2.445	2.270	1.792	-	2.375	2.656	2.368	2.249	2.094	2.298	2.291	2.333	2.288
Total cell count (CFU)	40	164	62	-	32	26	60	53	31	44	75	181	69.8
Total coliforms	2	8	3	-	0	0	2	8	0	1	1	0	2.2

- not having water during the survey period

Table 17 – Results of pond water samples in January 2020.

Parameters	P1	P2	P3	P4	P5	P6	Mean	Standard deviation
Temperature (°c)	25.8	26.3	26.2	27	26.4	26.1	26.3	0.4
pH	7.25	7.10	7.41	7.14	6.59	6.66	7.02	0.32
Conductivity (µs)	97.45	52.84	102.7	100.4	65.40	38.91	76.28	27.54
Resistivity (KΩ)	11.32	20.84	10.72	11.56	16.84	28.25	16.58	6.95
Salinity (ppm)	47.49	29.73	49.62	46.66	34.81	24.57	38.81	10.53
Turbidity (NTU)	0.6	0.4	0.3	0.2	0.2	0.8	0.4	0.240
TDS (ppm)	58.0	31.46	61.14	56.81	39.04	23.04	44.91	15.93
DO (mg/l)	4.032	3.36	4.032	4.032	2.688	3.36	3.58	0.548
BOD (mg/l)	1.344	0.672	0.672	0.672	0.672	1.344	0.896	0.347
Acidity(mg/l)	1.25	1.25	1.25	1.25	1.25	2.5	1.4	0.510
Alkalinity(mg/l)	5	5	10	5	15	5	7.5	4.18
Hardness (mg/l)	30	20	30	30	10	10	21.66	9.83
Chloride(mg/l)	19.852	19.852	29.77	29.77	19.852	19.852	23.15	5.12
Phosphate(mg/l)	0.0698	0.1065	0.1433	0.1444	0.1464	0.1076	0.119	0.030
Sulphate(mg/l)	1.926	2.235	2.010	2.796	2.382	2.354	2.283	0.310
Total Cell count (CFU)	67	123	34	50	70	49	65.5	31.09
Total coliform	5	8	13	9	20	13	11.3	5.24

Table 18 – Results of pond water samples in February 2020

Parameters	P1	P2	P3	P4	P5	P6	Mean	Standard deviation
Temperature (°c)	26	26.3	26	26.2	25.6	26	26	0.240
pH	6.86	5.58	8.36	7.34	5.66	5.54	6.5	1.16
Conductivity (µs)	92.32	73.03	129.4	98.94	70.58	40.63	84.15	30.11
Resistivity (KΩ)	11.93	15.1	8.512	11.08	15.63	27.1	14.89	6.53
Salinity (ppm)	44.87	39.81	60.05	47.07	42.16	24.73	43.11	11.44
Turbidity (NTU)	2.0	0.2	0.2	0.2	0.2	0.5	0.55	0.720
TDS (ppm)	54.94	47.56	77.0	59.03	36.51	24.16	49.86	18.38
DO(mg/l)	4.032	4.032	4.032	4.032	2.688	2.016	3.472	0.893
BOD(mg/l)	0.672	2.688	0.672	0.672	0.672	0.672	1.008	0.823
Acidity(mg/l)	2.5	2.5	2.5	2.5	2.5	1.25	2.291	0.510
Alkalinity(mg/l)	10	10	15	15	10	10	11.66	2.58
Hardness (mg/l)	50	40	50	40	10	10	33.33	18.61
Chloride(mg/l)	19.852	29.77	39.704	49.63	29.77	39.704	34.73	10.41
Phosphate(mg/l)	0.1403	0.1321	0.1035	0.1495	0.1495	0.1229	0.132	0.017
Sulphate(mg/l)	1.982	1.968	2.445	2.494	2.143	2.438	2.245	0.243
Total Cell count (CFU)	34	98	40	51	39	36	49.66	24.40
Total coliform	2	5	0	3	4	6	3	2.16

Table 19. WQI of samples from various water resources of the campus in the months of January and February 2020.

Sampling site	January, 2020	February, 2020
Wells		
W1	3.11	6.40
W2	6.13	41.16
W3	12.3	6.46
W4	5.50	-
W5	5.36	42.79
W6	4.98	42.49
W7	15.45	45.81
W8	5.13	34.27
W9	8.61	30.84
W10	23.09	23.22
W11	9.01	34.57
W12	5.08	8.98
Mean	8.645	28.81
Ponds		
P1	11.13	27.42
P2	7.20	34.26
P3	11.16	48.47
P4	6.12	10.13
P5	9.78	30.67
P6	20.19	37.65
Mean	10.93	31.43

Table 20. WQI developed by Brown et al., (1972)

Water Quality Index	Water Quality Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
>100	Unfit for consumption

Water resources utilization in the campus

Water resource utilization in the campus is given in figure 5. The daily use of water by various sections of the campus community are depicted in Table 21 and their graphical representation in figure 6.

Figure 5. Water resources utilization in the campus

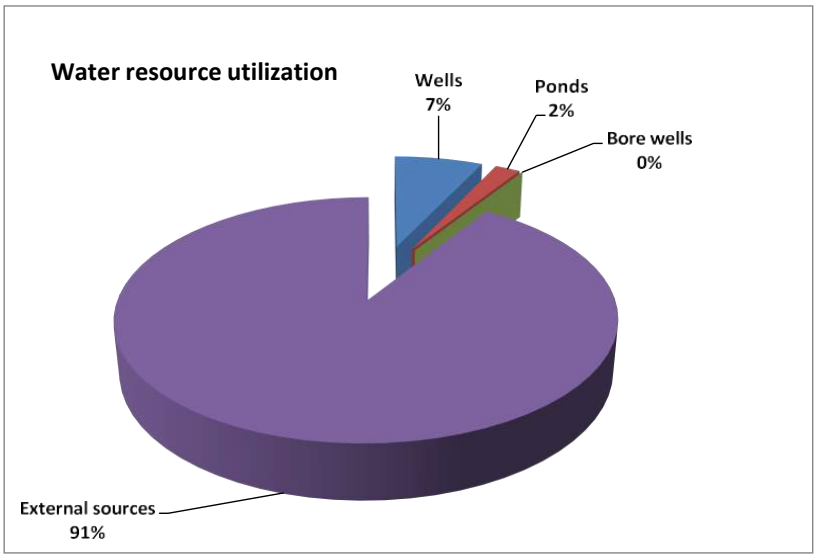
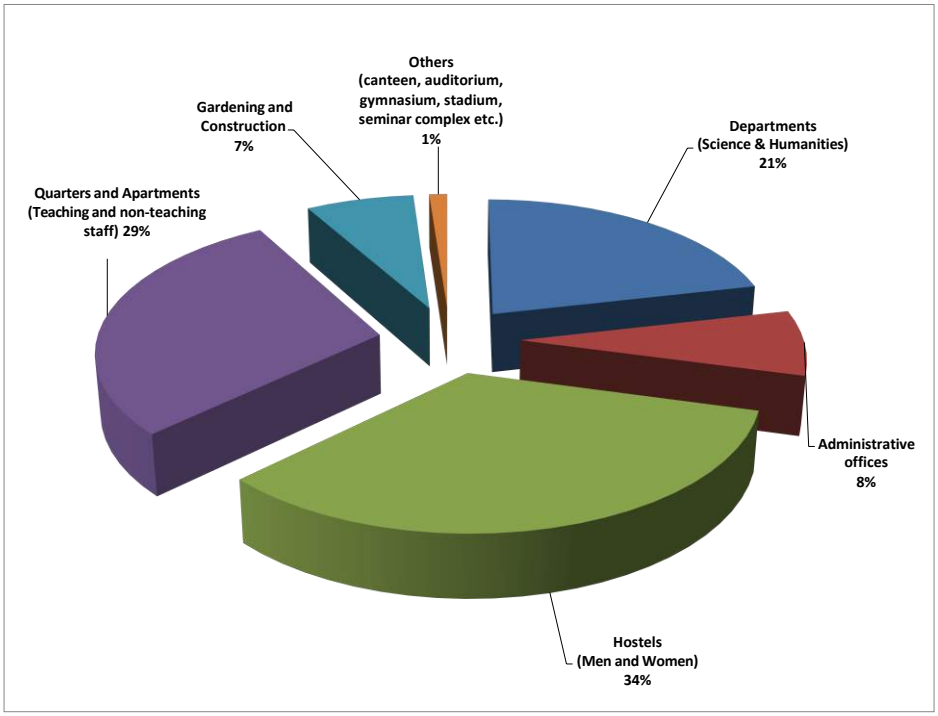


Table 21.
Daily water consumption by different sectors of Calicut University campus

Sl. No.	Sector	Consumption of water (Liters)
1	Hostels (Men's and Women's Hostels, Working Men's and Women's hostels)	539255
2	Quarters and Apartments (Flats, hostels and quarters of teachers and other office staff)	462996
3	Departments (All Science and Humanities departments)	342626
4	Administration and other Offices (Administration block, Pareeksha Bhavan, Tagore Niketan, Distance education etc.	123985
5	Gardening and Construction activities	112388
6	Others (canteen, auditorium, gymnasium, stadium, seminar complex etc.)	18750
Total		1600000

Figure 6. Water resource consumption pattern



General observations

It is estimated that the daily requirement of water for the University campus at Tenhipalam is about 10 – 16 lakh litres. Only 9% of the water requirement of the campus is met from water resources within the campus. Remaining 91% is met from Kadalundi river. The water supply system comprises of an intake facility at Parakkadavu, booster facility at Chelari and a treatment facility in the Calicut University campus. The treatment facility comprises of alum / limestone addition, Rapid Sand Filtration and chlorination. The treated water is supplied through its in-house distribution system within thecampus.

The major share of treated water within the campus is utilized by Hostels meant for students (~34%) and residential areas of teachers and administrative staff (~29%). This is followed by the Departments (~21%) and administrative offices (~8%). Approximately 7% of water is utilized for irrigation purposes and around 1% is utilized by common facilities like canteens, seminar halls etc.

An assessment of the quality of water at the source (Parakkadavu) during early summer months (January and February) revealed that it is “Good” in terms of Water Quality Index. However, drastic deterioration in water quality was noticed with the progress of time from January to February. Microbial count represented by Total Coliforms and E. coli was higher in most of the sites studied. This is indicative of the poor quality of water during peak summer months (March – May). As Parakkadavu region experiences drastic decline in water table during peak summer months, the deterioration in water quality is certain. Also, the region is under terrific threat due to

human intervention. People are making use of the premises of the intake well for open defecation and bathing. Few sewers adjoining this region are also causing threats to the water quality, especially during monsoon months.

The quality of treated water in the distribution system has been assessed at various locations within the campus. The quality, in accordance with WQI, was noted to be "Excellent". However,the microbial quality of water in the distribution system has to be examined in detail for ensuring infallible treatment efficiency.

An inventory of the water resources associated with Calicut University campus has been prepared in the early summer months. Their physical measurements were taken and quality parameters were assessed. Altogether 18 dug wells and 7 ponds are randomly located in the campus. In addition, 3 tube wells are also noticed, but are sealed by the authorities due to technical issues. 13 out of 18 wells and 6 out of 7 ponds contained water in varying levels during the months of January and February, 2020.

An assessment of the existing wells indicated an average water availability to the magnitudeof 21.45 m^3 at a depth of 10.362 meters at ideal locations in the campus. A negative correlation (-0.2468) between the depth of well and the volume of water contained in it is noticed, which is indicative of the random availability of groundwater within the campus. The terrain characteristics also influence the same. As far as surface water sources like ponds concerned, a positive correlation (0.233922) has been noticed between depth of pond and volume of water contained in it. However, lesser extent of water contained in some of the major ponds are indicative of excess evaporation and inadequate recharge process associated with them.

The quality of both ground and surface water sources associated with the campus is nearer to potability limits and are falling in "Good' category as per WQI. However, water quality is found to deteriorate with the progress of summer. Most of the water resources within the campus are remaining unused or underutilized. It is noted that an inadequate quantity of water during summer seasons and lack of installed infrastructure for tapping water from these sources are acting as adverse factors in the effective utilization of these resources.

Suggestions and recommendations

The water table in Parakkadavu region of Kadalundi river is retreating at an alarming rate, leading to severe shortages and quality deterioration in the summer months. The University has to think of alternative sources of water for meeting such shortages in the near future. A detailed study is warranted in this regard.

As the level of contaminants is increasing progressively with a decrease in water level during the summer months, effective treatment options need to be adopted by the University during this period. This has to be seriously dealt in the case of microbial contaminants inwater.

The extent of anthropogenic pressures associated with Parakkadavu region are many. The main among them are open defecation and bathing. Also, a tributary reaching the intake station and sewers associated with the region are potential threats to the microbial quality of water. An estate staff need to be employed in the region for regular clearing of bushes, hideouts and other unwanted canopy. The area needs to be fenced and a security staff need to be employed for preventing waste disposal and trespasses to the region.

The physico-chemical quality of treated water in the distribution system within the campus was noted to be Excellent in terms of WQI. However,the microbial quality of water in the distribution system has to be examined periodically for ensuring infallible treatment efficiency.

Most of the water resources within the campus are remaining unutilized or underutilized. As the quality confining to them are better, they can be utilized in laboratories, lavatories and for irrigation purposes. It is noted that ~ 1,12,388 litres of treated water (~7%) is used daily for gardening and construction purposes. Efforts need to be undertaken for increasing the use efficiency of local water resources and thereby reducing the demand of water from external sources.

The campus follows the trend of utilizing treated water for a wide range of purposes, other than for drinking. It is highly suggested to have a separate water distribution system in the campus for laboratories, lavatories and irrigation purposes. Such a supplementary distribution system can utilize the raw water (untreated) from Kadalundi and water from other sources within the campus. This will reduce the cost of water treatment and ensures better treatment efficiency for water meant for drinking purposes.

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WATER RESOURCES – RAIN WATER HARVESTING

Objective:

To assess the feasibility of rain water harvesting (Roof top and surface runoff harvesting) in Calicut University campus.

Methodology

For a feasibility study, the following attributes were worked out.

1. Rainfall data concerning the campus
2. Nature and magnitude of roof top catchments
3. Slope and terrain characteristics of the campus
4. Micro climatic conditions (temperature and wind velocity) of the campus

The rainfall pattern experienced in the district, as obtained from various sources is depicted in Table 22.

Table 22. Rainfall data of Malappuram district (Source: IMD (2014-2018) and World Weather online (2019)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total (Annual) mm
2014	1.1	0.5	0	49.8	236.4	542.1	856.8	615.9	297.4	371.1	121.3	40.7	3133.1
2015	0	0	37.2	167	187.2	593.8	411.5	264	266.8	291.8	232	36.3	2487.6
2016	0	1.8	2.6	4.7	154.5	585.2	406.5	186.3	73.2	87.1	14.8	16.3	1533
2017	4	0	29.4	26.6	122.9	568.8	427	459.7	472.7	211.1	95.6	37.1	2454.9
2018	0	5.9	19.1	105.4	403.6	860.8	888.4	914.5	59.9	277	110.9	13	3658.5
2019	0.02	1.6	15.5	121.6	121.3	396.5	785.3	890.4	250.4	630	283.8	59.4	3555.82
Mean	0.853	1.633	17.3	79.18	204.31	591.2	629.2	555.13	236.73	311.35	143.06	33.8	2803.82

Feasibility studies were carried out on the nature and magnitude of roof tops of various buildings within the campus for their effective utilization as catchment areas. Assessments were carriedout using Google maps and field level observations. Data so generated are listed in Table 23.

Table 23. Nature and magnitude of roof top catchments.

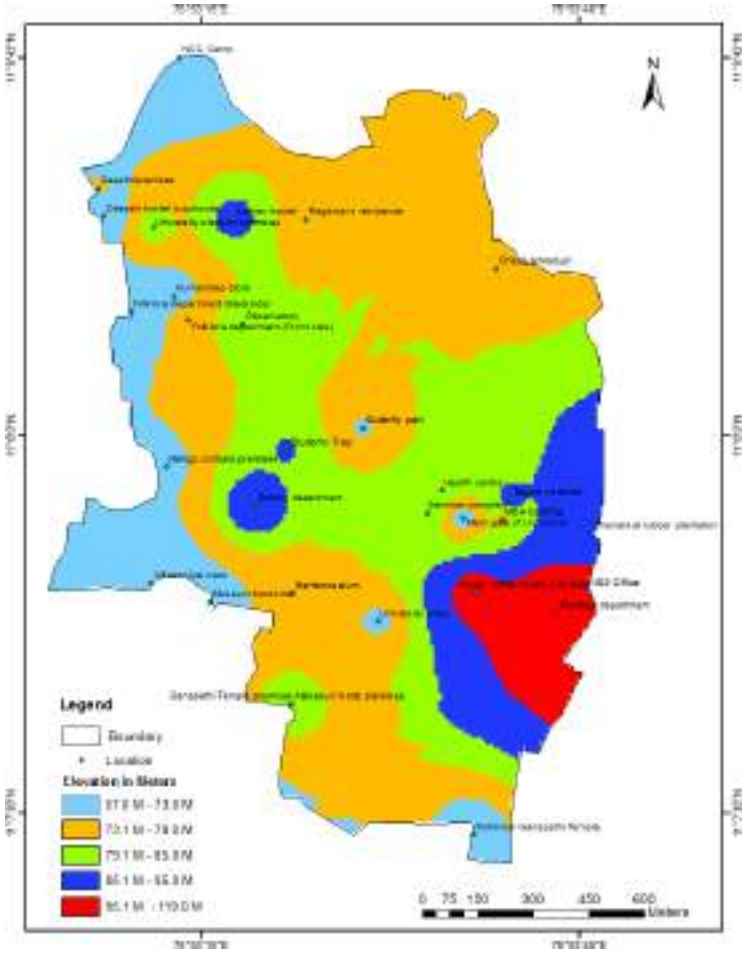
Sl. No.	Name of the building	Nature of roof (M^2)	
1	Tagore Nikethan and adjoining areas	Slope	Flat
	(Tagore Nikethan, distance education, commerce and management studies, career guidance cell)	3155.09	
2	Buildings in Chenakkal area	4604.15	
	(Auditorium, annexed buildings of distance education, NSS office and the building of the Department of Law		

3	Sports complex	3167.23	1122.0
	Sports hostel, Jimmi George and PT Usha stadiums, Sports Pavlion and Senate House		
4	Ladies Hostel and allied buildings	3547	5739.42
	Parijatham, Mulla, Devadharu, Everest, Working Women's Hostel and other annex buildings		
5	Boys Hostel complex, Chettiarmad	1229.3	736.42
	Hostel I, II and III		
6	Observatory building	200	150
7	History department building		2575
8	Education department and allied buildings	2717.52	2056.69
	Teacher Training Centre, Fitness Centre and alliedbuildings		
9	Building of Journalism and Mass communication	863.68	
10	CHMK Library	2200	
11	Buildings adjoining CHMK Library	1256.29	
	Computer Science building, Manuscript Library, Open air stadium		
12	Administrative block		1300
13	Process room near Chemistry Department	534	
14	Central Science Complex buildings	4732.7	4627.16
	Central complex and all the eight radiating arms togetherwith animal house		
15	USIC	694.55	
	Department of Environmental Science	557	
16	Museum buildings	2659.23	
17	University press and allied buildings including Geology Department	749.88	594
18	Men's Hostel and allied buildings	4218.08	1903
19	Guest house buildings	588.31	1154.45
20	Miscellaneous buildings	340.51	471.31
	Buildings of water treatment plant, DSU office and Canteen		
21	Health Science buildings	1312.85	1517.18
	Department of Health Sciences and Health Centre		
22	EMS seminar complex	1279	
23	Buildings occupied by University Chairs	861.74	244
	Gandhian studies, Marxian studies and Christian studies		

24	UGC guest house and nearby buildings	336.94	633.53
25	Pareeksha Bhavan and neighboring buildings	3159.02	771
	All buildings of Pareeksha Bhavan and Day Care Centre		
24	Buildings of Engineering Department	695.42	203.04
25	Buildings associated with Park / Botanical Garden andnearby buildings	594.2	253.83
	Park House, Touch and Feel Garden, IAAT office, Biomass Centre, Green Houses, Generator rooms etc.		
26	Residential areas	25335.03	9969.76
	Total (M^2)	71588.72	36021.8
	Grand Total (M^2)	107610.5	

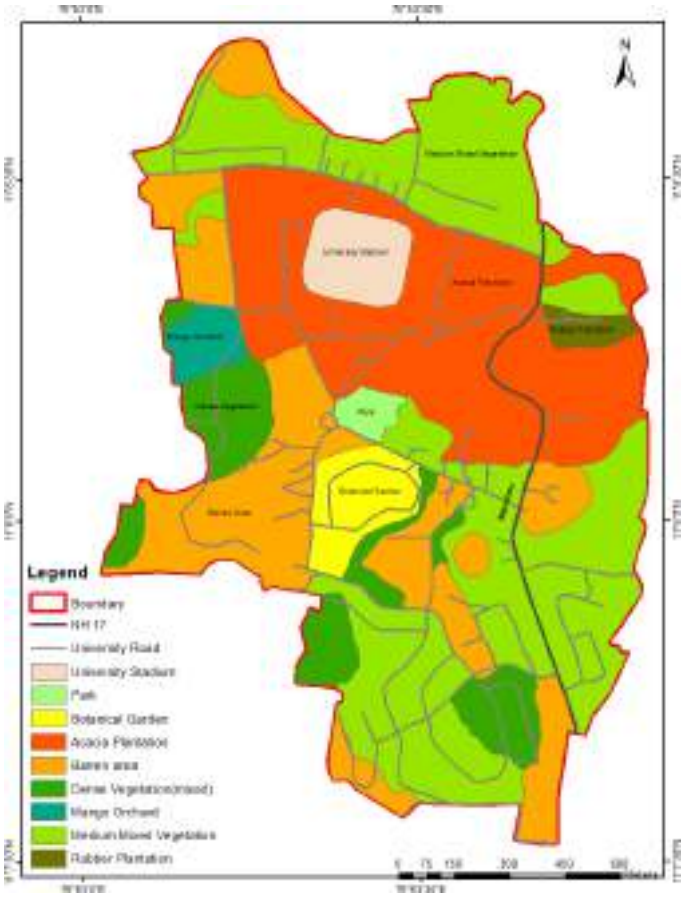
Similarly, for assessing the feasibility of surface runoff harvesting, data on terrain characteristics and land use pattern of the Campus have been obtained from Environmental Audit Report (2015). Thematic maps depicting terrain characteristics of the campus (figure 7) and landuse pattern of the campus (figure 8) were considered for delineating regions ideal for run off rain water harvesting.

Figure 7. Map of the terrain characteristics of Calicut University Campus



Data source: Environmental Audit Report, 2015

Figure 8. Map of the land use pattern of Calicut University Campus



Data source: Environmental Audit Report, 2015

As the sustenance of water resources also depends on micro climatic conditions, data on maximum – minimum temperature prevalent in the area has been obtained from external agencies and has been depicted in Table 24. Also, data concerning wind velocity experienced within the campus has been obtained from Environmental Audit Report (2015) and are depicted in Table 25.

Table 24. Maximum / minimum temperature experienced in the campus

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Temp.(^{0}C) Max.	33.6	35.4	35.8	35.0	33.6	31.7	30.5	31.0	31.9	32.2	32.5	33.8
Temp.(^{0}C) Min.	21.5	22.4	24.9	25.2	25.2	23.7	23.3	23.3	23.8	23.9	23.2	23.1

Data period: 2015; Data Source: CWRDM, Government of Kerala

Table 25. Sector wise temperature and wind velocity of the campus

Sl.No.	Sites	Wind velocity (m/sec)
1	Kohinoor Ganapathi Temple	2.6
2	Near Geology department	2.8

3	Geology side quarters line	5.1
4	Seminar complex	1.3
5	Chenakkal rubber plantation	1.7
6	Chettiyarmad	3.5
7	Tagore Nikethan	1.4
8	Commerce Department	4.5
9	Health Centre	3.0
10	Pareeksha Bhavan	1.0
11	Administrative block	1.0
12	University Stadium	3.4
13	Acacia plantation nearstadium	3.0
14	Ladies hostel	2.8
15	Near Deepthi hostel	0.8
16	Humanities block	2.1
17	Near mango orchard	0.9
18	Library Buildings	1.2
19	Student's Trap	1.5
20	Botany department	0.7
21	Museum Premises	1.3
22	Near Post no: C/VK 26	1.5
23	MEMS school premises	2.4
24	Near Jalanidhi board	1.5
25	Villunniyal	0.7
	Mean	2.08

Data source: Environmental Audit Report, 2015

General observations

The campus is solely depending on external water resources (91%) for meeting its requirements. As of now, there are no serious efforts of rain water harvesting in the campus. This has necessitated a feasibility study on rain water harvesting, both roof top and run off, in the campus.

Rainfall data for a period of 6 years (2014 – 2019) indicated that the lowest precipitation wasin 2016 (1533 mm) and the highest in 2018 (3658.5). Mean values of precipitation was lowest in January (0.853mm) and highest in July (629.2mm). Annual average rainfall was noted to be 2803.82 mm. Higher rainfall in the district, like other districts of the state, is indicative of an effective water harvesting potential of the campus.

Information on temperature and wind velocity are significant for the maintenance of harvested rain water. Data on temperature procured from other agencies revealed that the maximum temperature of 35.8^{o}C was in the month of March and minimum of 21.5^{o}C in the month of January. Mean highest temperature of 33.08^{o}C and lowest of 23.625 ^{o}C are typical of a tropical climatic condition of the State. Similarly, an analysis of the wind velocity concerning various areas of the campus revealed a range of 0.7-5.1 m/sec. with a mean value of 2.08m/sec.

Studies on the roof area of buildings within the campus revealed an estimate of 107610.5 M^2, of which slope roof (due to basic construction pattern or truss work) was to the extent of 71588.72 M^2 and plain roof to 36021.8 M^2. An estimated yield of roof top rainwater in the campus is 301720472.11 litres, which is fit enough to cater to the requirements of the campus for about 188.5 days, keeping the present minimum use of 16 lakh litres of water per day. The estimated yield from runoff rain water harvesting alone (5342004130.5 litres) is 17.7 times higher than that from rooftop harvesting. As of now, there no serious effort for rain water harvesting, both roof top and run off, in the campus. Considering the demand of waterresources and the circumstances ideal for rain water harvesting in the campus, certain installations are proposed in connection with the buildings, the details of which are depicted in Table 26.

Similar to roof top rain water harvesting, possibilities of surface runoff harvesting within the campus has been worked out. The terrain map prepared on this account revealed that the magnitude of sloping is more towards the western side (elevation: 57 – 73 m) than the east (elevation: 95 – 119 m). It is also sloping towards the north and south. Surface runoff harvesting is possible with the help of check dams and water trenches and the sites ideal for such installations are proposed, taking into account the terrain and land use pattern of the campus.

Suggestions and recommendations

Considering the roof characteristics and ease of construction and maintenance of allied structures like capture, collection, treatment, storage and distribution facility, rooftop rain water harvesting is proposed in the following strategic locations in the campus. The anticipated yield attributes from various locations are also given in table 26. The Engineering Department of the University of Calicut may further work on the feasibility of construction and the expenditure involved.

As the rate of percolation of water is higher, all storage structures should be made with concrete. As the extent of evaporation is higher, the storage structures should have medium elevated roofs made with polycarbonate materials, facilitating aeration and preventing direct solar incidence. The University may also employ special labour force for the maintenance of facilities like collection, transport, treatment, storage and distribution, connected with roof top rain water harvesting.

Table 26. Proposed locations of roof top rainwater harvesting

Sl. No.	Location of buildings within University campus	Area of roof slope	Area of plain roof	Yearly yield of rain water in litres
1	Tagore Nikethan and adjoining areas (Main building of Tagore Nikethan, distance education, commerce and management studies)	3092.4	0	8670532.968
2	Sports complex (Sports hostel, Jimmi George Gymnasium and PT Usha Indoor stadium)	2136.11	1122.0	9135153.98

3	Ladies Hostel and allied buildings (Hostels like Parijatham, Mulla, Devadharu, Everest, Working Women's Hostel and other annex buildings)	3547	5739.42	26037450.12
4	History department building	0	2575	7219836.5
5	Building of Education department / Psychology Departments and Teacher Training Centre	0	2067.75	5797598.805
6	Language Block and allied buildings	2717.52	0	7619436.926
7	Building of Journalism and Mass communication	863.68	0	2421603.258
8	CHMK Library	2200	0	6168404
9	Central Science Complex buildings (Central complex and all the eight radiating arms together with animal house)	4732.7	4627.16	26243362.67
10	Museum buildings	2659.23	0	7456002.259
11	Men's Hostel and allied buildings	4218.08	1903	17162406.53
12	Guest house buildings	588.31	1154.45	4886385.343
13	Health Science buildings (Department of Health Sciences and Health Centre)	1312.85	1517.18	7934894.715
14	Pareeksha Bhavan (All buildings in Pareeksha Bhavan Compound)	1625.62	355.19	5553834.694
	Total	29693.5	21061.15	142306902.8

The campus is slopping towards all the directions and the magnitude of sloping is more towards the west, south and north-east. Considering the topography and terrain characteristics, storage of runoff water using check dams is recommended at the following locations of the campus. The area and size of storage structures proposed for runoff water harvesting is given in Table 27. The Engineering Department of the University of Calicut may further work on the feasibility of construction and the expenditure involved.

Table 27. Proposed locations of runoff rain water harvesting

Serial No.	Coordinates	Area suggested	Installations required	Size	Storage capacity
1	11°14'1.132"N 75°88'5.569"E	Western side of Ladies Hostel Complex and southern side of Deepthi Cultural Centre	Check dams for the collection of runoff water. Overflow / regulator facility for capacity control	75m x 50m x 3 m	11250 m^3

2	11º13’5.406”N 75º88’6.848”E	Western side of Chemistry Department, towards the northern side	Check dams for the collection of runoff water. Overflow / regulator facility for capacity control	100m x 50mx 3m	15000m^3
3	11º13’6.958”N 75º89’5.801”E	North of Tenhipalam PoliceStation and South of Working Men’sHostel, in the eastern side of NH66 or on a location which receives run off water from the University stadium	Check dams for the collection of runoff water. Overflow / regulator facility for capacity control	100m x 50mx 3m	15000m^3

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WASTE MANAGEMENT PRACTICES

Objectives:
To assess the magnitude and composition of solid / liquid waste generated in the campus.
To assess the existing practices of waste disposal in the campus
To propose management measures for sustainable waste management practices.

Methodology:
The entire work has been scheduled in three phases.

1. Questionnaire Survey: A questionnaire-based survey has been carried out in all teaching and administrative departments, residences and other offices associated with the University for gathering information pertaining to the nature and type of waste generation, its magnitude, existing disposal and recycling practices and suggestions for sustainable waste management.

2. Quantification and characterization of waste generated: Waste generated on a daily basis from various teaching, administrative, residential and other affiliated departments within the campus were collected, segregated and quantified following CPHERI (1971). The weight percentages of various components were estimated and reported.

3. Field Survey: The entire campus has been surveyed for a verification on the source, nature and type and management of waste generated. This has helped in finding out regions with unscientific disposal practices, together with an assessment of the magnitude of waste remaining unattended.

Results on the questionnaire survey of the waste management practices in the campus are depicted in Table 28 and the magnitude of waste generation from various sectors of the campus are depicted in Table 29. Similarly, magnitude of segregation of waste, its present management practices and the percentage composition are depicted in Figures 1 – 5 respectively.

Table 28. Survey results of waste management practices in the campus

Sl. No.	Name of the Department	Frequency of cleaning		Nature of collection		Segregation of	Biodegradable waste		Non – bio degradable waste					Existing waste management practices						
		Daily	Weekly	Waste bins	Others		Paper waste	Food waste	Plastic waste	Chemicals / Lab refuses	Sanitary Pads	E - waste	Medical waste	Open Dumping	Pit dumping	Open Burning	Pit burning	Landfills	Collected for cattle	Composting
1	Arabic	Y		Y		N	Y	Y	Y					Y		Y				
2	Biotechnology	Y		Y		N	Y	Y	Y	Y						Y				

3	Botany	Y		Y		Y	Y	Y	Y	Y						Y			
4	Chemistry	Y		Y		N	Y	Y	Y	Y						Y				
5	Center for women studies	Y		Y		N	Y	Y	Y					Y	Y	Y				
6	Computer Sciences	Y		Y		N	Y	Y	Y							Y				
7	Commerce and Management Studies	Y		Y		N	Y	Y	Y					Y			Y			
8	Education	Y		Y		N	Y	Y	Y							Y				
9	English	Y		Y		N	Y	Y	Y			Y				Y				
10	Hindi	Y		Y		N	Y	Y	Y			Y				Y				
11	History	Y		Y		N	Y	Y	Y			Y		Y						
12	Journalism and Mass communication	Y		Y		N	Y	Y	Y							Y				
13	Library and Information Sciences	Y		Y		N	Y	Y	Y			Y					Y			
14	Life long learning and Extension	Y		Y		N	Y	Y	Y						Y					
15	Life sciences	Y		Y		Y	Y	Y	Y	Y							Y	Y		
16	Malayalam and Kerala Studies	Y		Y		N	Y	Y	Y								Y			
17	Mathematics	Y		Y		N	Y	Y	Y			Y				Y				
18	Nanoscience and technology	Y		Y		N	Y	Y	Y	Y						Y				
19	Philosophy	Y		Y		N	Y	Y	N	Y				Y		Y				
20	Physics	Y		Y		N	Y	Y	Y	Y						Y				
21	Physical Education	Y		Y		N	Y	Y	Y			Y				Y				
22	Psychology	Y		Y		N	Y	Y	Y			Y			Y	Y				
23	Political Science	Y		Y		N	Y	Y	N					Y	Y		Y			
24	Russian and Comparative Literature	Y		Y		N	Y	Y	Y							Y				
25	Sanskrit	Y		Y		N	Y	Y	N							Y				
26	School of Folklore Studies	Y		Y		N	Y	Y	N					Y						
27	School of Distance education	Y		Y		N	Y	Y	Y								Y			
28	Statistics	Y		Y		N	Y	Y	Y							Y				
29	Zoology	Y		Y		N	Y	Y	Y	Y						Y				
30	CH library	Y		Y		N	Y	Y	N							Y				
31	Guest house	Y		Y		N	Y	Y	Y							Y				
32	Health centre	Y		Y		N	Y	Y	N				Y		Y		Y			
33	Publication and Printing	Y		Y		N	Y	Y	N					Y		Y		Y		
34	Canteen	Y		Y		N	Y	Y	Y							Y			Y	
35	Hostels	Y		Y		N	Y	Y	Y		Y						Y			
36	Higher secondary school	Y		Y		N	Y	Y	Y								Y			

37	Rachana Nursery	Y		Y		N	Y	Y	Y							Y				
38	GMHSS Calicut University Campus	Y		Y		N	Y	Y	Y								Y			
39	Artecia Nursery	Y		Y		N	Y	Y	Y							Y				
40	Preeksha Bhavan	Y		Y		N	Y	Y	Y								Y			
41	Chair for Gandhian Studies		Y	Y		N	Y	Y	N							Y				
42	Guest house canteen	Y		Y		N	Y	Y	Y					Y			Y			
43	USIC	Y		Y		N	Y	Y	Y			Y			Y	Y		Y		
44	EMMRC	Y		Y		N	Y	Y	N						Y					
45	Tagore nikethan	Y		Y		N	Y	Y	Y							Y	Y			
46	AD Finance	Y		Y		N	Y	Y	Y							Y				
47	PLD	Y		Y		N	Y	Y	Y							Y				
48	Engineering Electrical	Y		Y		N	Y	Y	Y							Y				
49	Engineering wing	Y		Y		N	Y	Y	Y						Y					
50	Academic staff college	Y		Y		N	Y	Y	Y						Y					
51	Day care	Y		Y		N	Y	Y	N							Y				
52	Store I	Y		Y		N	Y	Y	Y											Y
53	Store II	Y		Y		N	Y	Y	Y							Y				
54	Garden	Y		Y		N	Y	Y	Y											Y

Figure 9. Segregation of waste

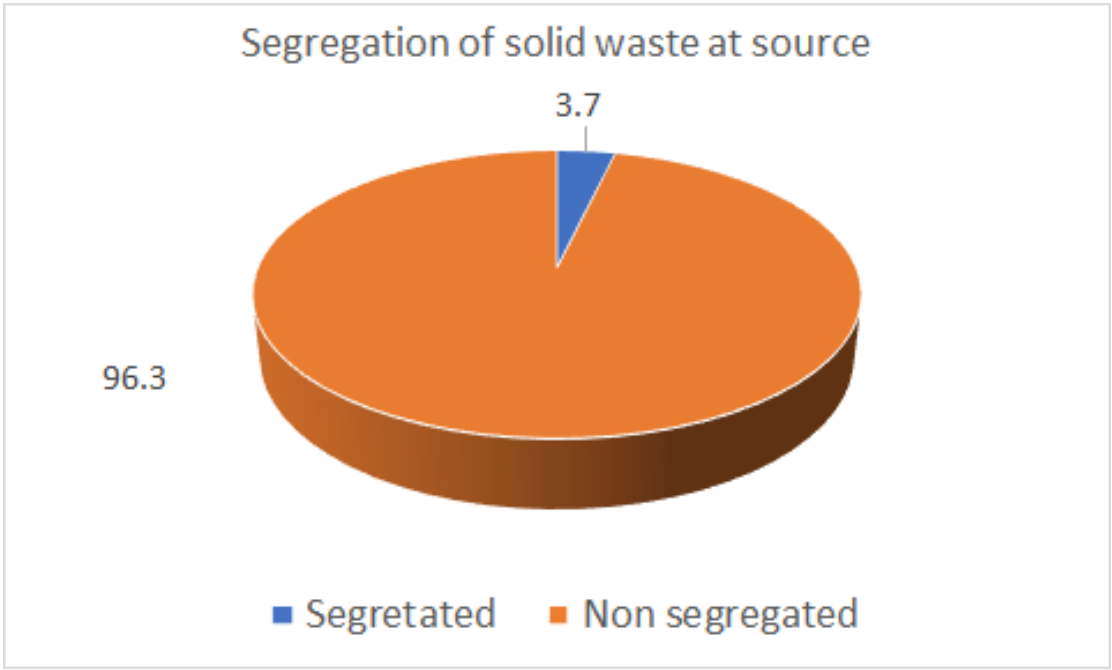


Figure 10 Solid waste management practices

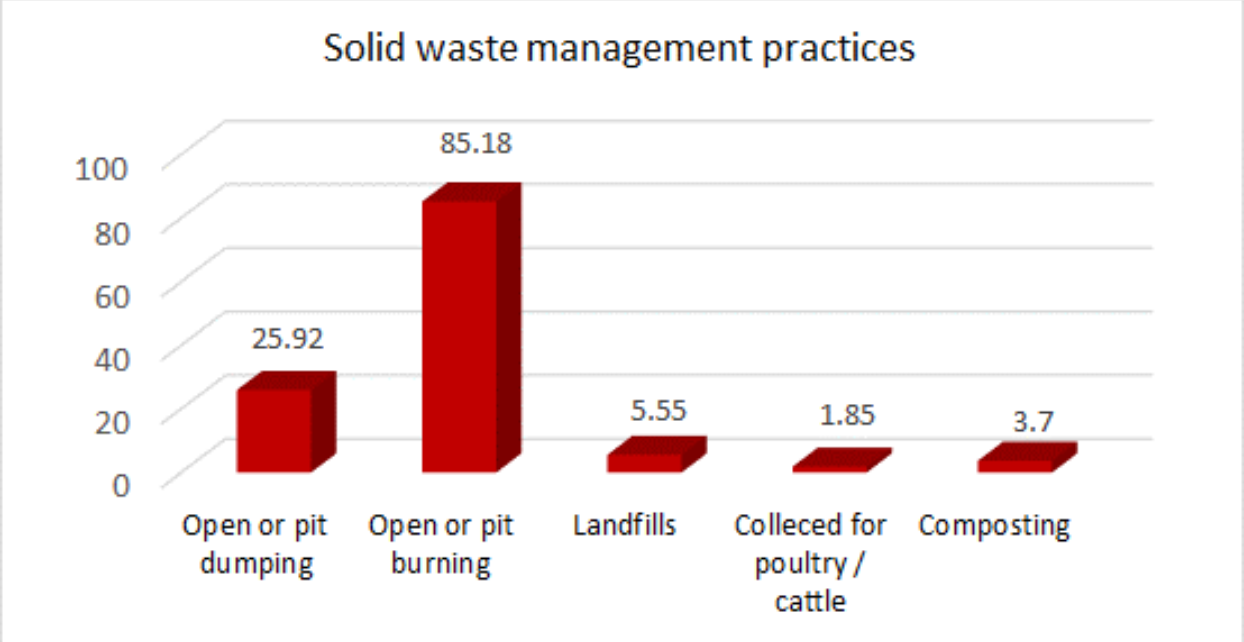


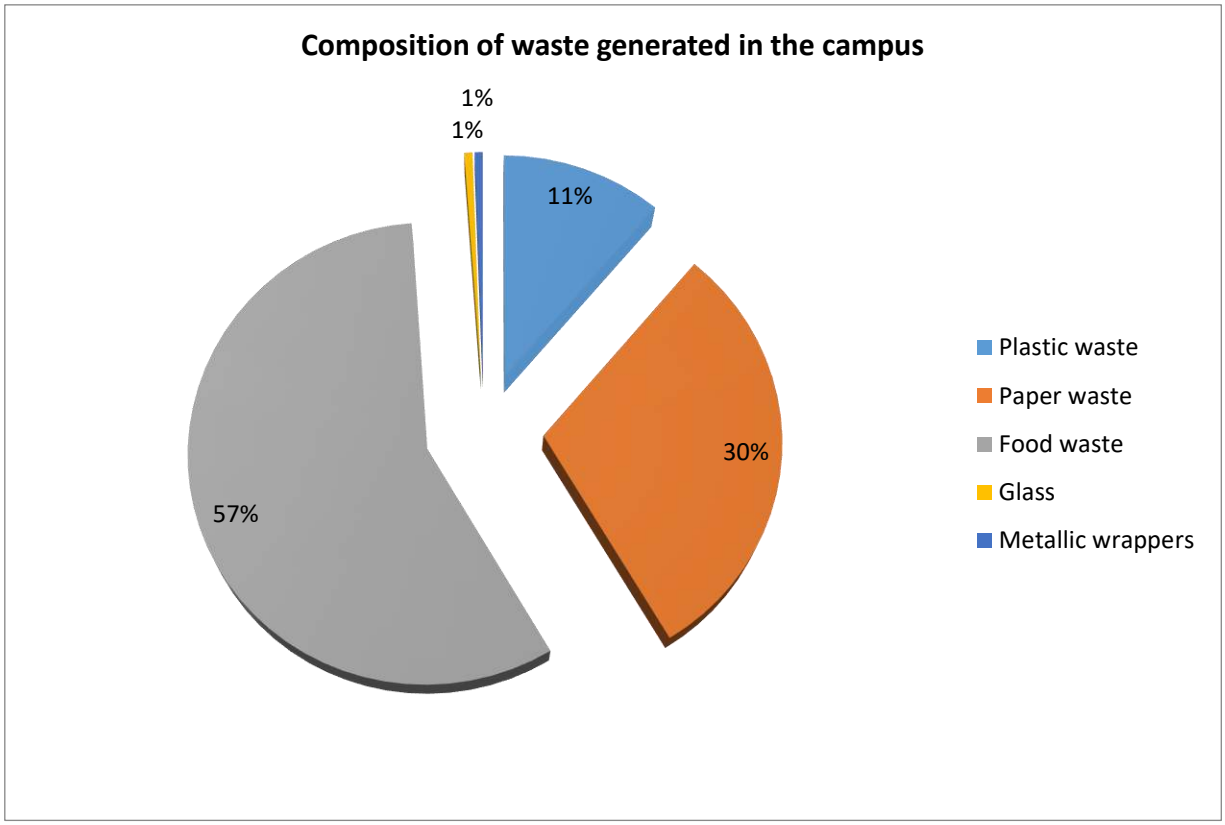
Table 29. Waste generation from various sections / Departments of the campus

	Blocks	Plastic waste	Paper waste	Food waste	Glass	Metallic wrappers	Total
1	Tagore Nikethan	1.3	7.62	3.5		1.345	13.765
2	School of Distance Education	0.5	2.3	0.5			3.3
3	Offices / Depts. in Chenakal including ASC	0.82	1.81	1.61			4.24
4	DCMS	0.15	2.15				2.3
5	Health centre	10.75	1.775		3.25		15.775
6	Engineering wing	0.25	1	0.25			1.5
7	Pareeksha Bhavan	1.675	23.49	0.75		0.055	25.97
8	Cafeteria (PB premises)	0.52	2.03	11.3			13.85
9	Administrative Block	0.15	2.65	2			4.8
10	Guest house	0.2	1				1.2
11	Guest house canteen	0.956	1.3	14.5			16.756
12	Canteen (students trap)	0.5	4.5	*42.115			47.115
13	Science Block	3.25		72.5			72.5
14	Language block	2.03					0
15	Humanities block	0.225	37.75	12.5		1.75	55.25
16	Working women's Hostel	0.75 @0.31	19.97	9			31
17	Ladies Hostel	13.5	14	*24.025			38.25

		@5.8					
18	Men's hostel	2.3		0.575			1.325
19	Teacher' Flat	0.8					0.31
20	CHMK Library	0.64	14	5.6			33.1
21	USIC	0.3		55			60.8
22	Store	2.16	7.8	15.7			25.8
23	EMMRC	0.15	1	21			22.8
24	Officer's quarters including teachers hostel	12.8	1.85				2.49
	Total	62.786	168.315	319.725	3.25	3.15	557.226

*Kitchen processing waste; @ Sanitary napkin
Quantification only from point sources; Values average of 3 working days collection;
Littered waste has not been quantified

Figure 8. Composition of waste



Inference:

A physical assessment made in 2021 revealed that the total magnitude of solid waste generation in the campus on a working day is 557.226 kg. The segregation of waste revealed higher extent of food refuse (57%), followed by paper (30%), Plastic (11%), glass (1%) and metallic substances (1%). As compared to the previous environmental audit (2015 – 2016), waste generation in the

campus has showed a declining trend from 613.896 kg. The implementation of green protocol in the year 2017 and the Covid induced semi-lockdown situations might have attributed to a reduction in the magnitude of waste generation.

A survey conducted in connection with the solid waste management (2021) revealed that the daily cleaning and collection of waste is undertaken by all offices and departments through dust / waste bins kept at strategic locations. The university does not have a centralized system of daily waste collection and processing. At present, the wastes which are collected and segregated at the offices and departments are handed over to Haritha Karma Sena at regular intervals for further processing. However, the lack of a centralized waste collection and processing system in the campus and lack of regularity in the collection and removal of wastes by external agencies is putting offices and departments in trouble, which force them to adopt methods of their choice, which are mostly unscientific. This is evident in the survey that only 3.7% of the offices / departments are segregating the waste for further processing. Nearly 26% of the departments / offices are subjecting their wastes for either open or pit dumping. Around 85% of the departments are openly burning their waste. Nearly 5.5% of the centres are putting the waste for landfilling and composting of waste is performed only at 2 centres, out of the 54 centres surveyed (3.7%).

Similarly, there are issues of other wastes like chemical wastes, biomedical wastes and electronic wastes. About 8 science departments are producing chemical wastes. The University at present is having only facility for the collection of chemical wastes, but has to develop protocols for its management. Electronic wastes are generated by almost all offices / departments and at present, University is having a system of collection and disposal of electronic waste through the University Science Instrumentation Center (USIC). The biomedical waste is associated only with the University Health Centre and is processed scientifically. Generation of liquid wastes, especially sewage is associated with canteens and guest houses. At present, they are being released openly, without any scientific means of treatment.

A survey on the field noticed careless disposal of solid wastes at various location of the campus. The travelers, local populace and small business venturers are found to dispose their wastes in remote areas of the campus, which are having vehicular access. The gravity of such issues is more in Chettiyarmad and Kohinoor regions of the Campus.

Suggestions and recommendations

The present survey (2021) estimated the total magnitude (minimum) of solid waste generation in the campus to a tune of 557.226 kg. on a working day. The segregation of waste revealed higher extent of food refuse (57%), followed by paper (30%), plastic (11%), glass (1%) and metallic substances (1%). The reduction in the extent of waste generation from 613.896 kg./day (2016) can be attributed to the Covid imposed semi lockdown situations. The higher extent of degradable organic components in waste is indicative of the effectiveness of its management with a recovery of manure, energy etc.

The implementation of Green Protocol in the campus in 2017 has help to reduce the magnitude of waste generation, especially of plastic, to a certain extent. Most of the departments are following green charter with a ban on flex banners and plastic carry bags and cups for social functions and academic programmes. However, lack of a centralized system of waste collection, segregation, processing and management is putting offices and departments in trouble, which force them to adopt methods of their choice, which in most cases are not falling within the scope of the green protocol. The following suggestions and recommendations are placed in this perspective.

Offices and departments are to adhere more to the policies of Green Protocol, implemented in the University. They should adopt to various practices of` least waste generation. Adequate awareness initiatives and action programmes can be undertaken by offices and departments in this regard. Adequate administrative and financial services are to be mobilized by the University in this regard.

A centralized system of waste collection, processing and management needs to be developed by the University. Presently the offices and departments are constrained to retain the non-degradable wastes (plastics and other materials) and to process the degradable wastes collected by them at their centres, due to space requirements and technical constraints. The services by *Haritha Karma Sena* are not adequate in this perspective. A centralized facility for the collection of segregated wastes from offices and departments by the University will overcome the burden of individual offices / departments from processing their wastes using unscientific methods. Adequate manpower and infrastructure (including vehicles) under a House Keeping Department can be arranged by the University in this regard. There can be a central waste processing units in the campus with incineration, compost, biogas and recycling facilities set at strategic locations. However, quarters and residential areas are to be insisted to manage household wastes, other than plastics by scientific mechanisms. There should also be efforts for the management of sewage generated by hostels and canteens. A detailed study is warranted in this direction.

Presently biomedical waste management is undertaken by the Health Sciences Department of the University. Similarly, management of e-waste is through the University Science Instrumentation Centre (USIC), which collects and dispose the waste to outside recognized agencies. The present systems followed by them can be streamlined for better efficiency. However, with regard to chemical wastes, the University has to develop protocols for its effective disposal, apart from their collection and storage.

There is high extent of littering and waste disposal in this campus from outside. The local populace and commercial centres need to be informed of this matter through offices of local governance. Travelers are also involved in littering and waste disposal. Adequate sign boards and surveillance facility needs to be arranged by the University in this regard. There can have a greater number of properly functioning waste bins at strategic locations of the campus to control littering.

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