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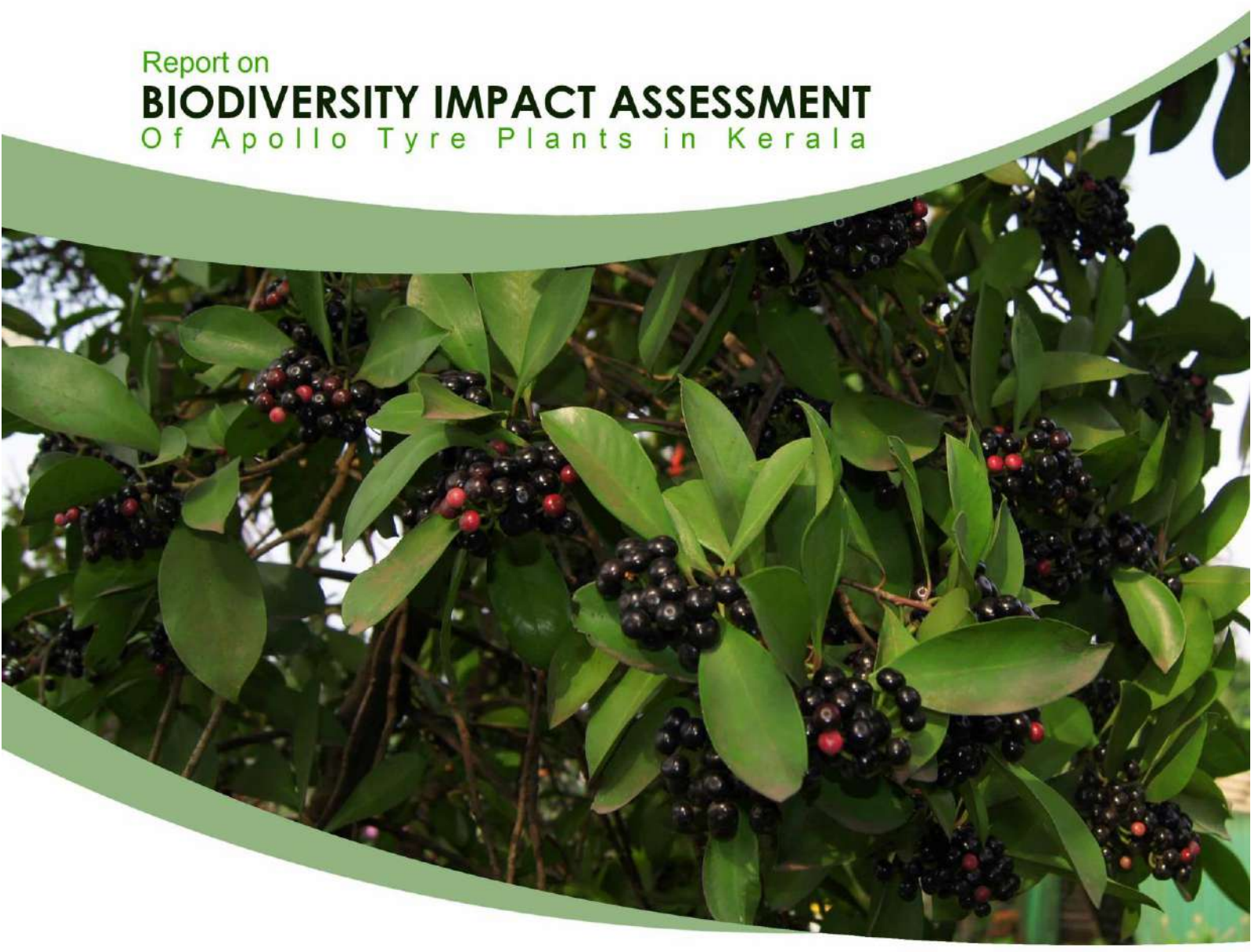
Report on

BIODIVERSITY IMPACT ASSESSMENT

Of Apollo Tyre Plants in Kerala



TIES TROPICAL INSTITUTE OF ECOLOGICAL SCIENCES
www.ties.org.in

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Biodiversity Impact Assessment

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APOLLO TYRE FOUNDATION

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Cover Photo: Miniature Jamun at Garden of Kalamassery Plant

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Preface

Every aspect of life is linked to biodiversity, and business is not detached from it. Since most of the businesses are heavily depended on biodiversity and ecosystem services for their raw materials and other needs, sustainability of biodiversity is of utmost important for the viability of corporate companies. Therefore, corporate companies have a responsibility to conserve the ecosystem and native biodiversity of the occupied sites and the surrounding areas. Hence, Corporate Social Responsibility (CSR) departments of many companies involve in various programs that improve and protect local biota. Similarly, CSR team of Apollo Tyres Limited, a leading global tyre dealer, fully understands the significance of biodiversity conservation and enhancement in their operating area. They approached Tropical Institute of Ecological Sciences (TIES), Kottayam, to perform a Biodiversity Impact Assessment and to propose specific biodiversity enhancement activities that will involve both the company and the neighbouring communities to ensure the sustainability and longevity of the local biodiversity. This report contains the status of currently existing biodiversity at both Cochin plants of Apollo Tyres Limited, and an attempt to re-track the past status of the local biodiversity. The result of the analysis of the data was used to propose several biodiversity enhancement programs for both the plants.

Acknowledgments

We would like to express our deepest gratitude to CSR team of Apollo Tyres Limited, for entrusting TIES with the responsibility of conducting Biodiversity Impact Assessment at Apollo Tyres Limited, Kalamassery and Perambra. TIES take this opportunity to individually thank Ms. Harshitha Pande, Head CSR, Ms. Kanika Pal, Manager CSR, Ms. Smitha R, Coordinator CSR of Apollo Tyres Limited, Cochin plants, for continuously providing official assistance in carrying out the assessment at Apollo Tyres Limited, Cochin plants. We convey our sincere gratitude to HR team, Security team, Quality Assurance team and Engineering Department of Apollo Tyres, especially Mr. Ravindhranadhan, Associate Manager Security and Mr. C. Venugopal, Manager of Productions and Mr. Kishor, gardener at Apollo Tyres Kalamassery and Mr. Venu, gardener at Apollo Tyres Perambra for helping us in data collection process inside the company. Also, we would like to acknowledge both unit heads for all the support and consideration of their team throughout the study period. Further, we appreciate the cooperation shown by Alur, Choornikkara, Kodakara, Mattathur and Muriyad Panchayaths, Chalakkudy, Kalamassery and Eloor Municipalities, Alur, Chalakkudy, Choornikkara, Eloor, Kalamassery, Kodakara, Mattathur and Muriyad Agriculture Offices, Ernakulum and Thrissur Pollution Control Boards, and Aluva and Chalakkudy PWD offices in providing us with secondary data documents that we have requested. Finally, we extent our gratitude to the community members of Kalamassery and Perambra region and senior staffs of Apollo's Cochin plants for their willingness to take part in the historical survey.

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Bonsai Garden at Kalamssery Plant

Introduction

1. INTRODUCTION

Biodiversity is fundamental to the existence of life on earth. It not only indicates the variety and richness of biotic factors of the earth, but also the interdependence of each organism with the other (Trowbridge, 2008). Thus it creates a tightly woven network of organisms and it is very crucial to have the presence of every single member of the network for its sustainable existence. The Convention of Biological Diversity (CBD) defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Bohn and Amundsen, nd)." Biodiversity supports many lives and livelihoods by providing harvestable goods and regulating natural processes. It is also linked to human wellbeing that includes basic materials for better life, health and social relations. Human activities can affect different aspects of ecosystem and biodiversity, and those impacts on biodiversity will have reverse effects on human activities and related wellbeing. Since human beings are also a member of this network, the biodiversity conservation is vital for the survival of human beings as well. To elaborate, the services provided by ecosystem are of high economical importance to human beings and provides employment, health and quality of life. Also, almost all the cultures have a root to the biological diversity. Therefore, biodiversity conservation and promotion of its sustainability is of utmost importance (IAIA, 2005).

1.1. Significance of Biodiversity Impact Assessment

Biodiversity Impact Assessment (BIA) is a technique that is used to assess the impact of certain projects or activities on the biodiversity and the ecosystem services of the area. It is an "integrated ecosystem approach" that assesses the healthy functioning of an ecosystem as people and biodiversity are interdependent. BIA provides an opportunity to have thorough insight to the dynamic nature of the biodiversity, thereby helping to take adaptive measures to deal with uncertainities and unpredictable natures of ecosystem functions, behaviours and responses. The type of approach taken in BIA is not only applicable to biodiversity rich ecosystems that are somewhat in its pristine forms, but is applicable in most urban systems as biodiversity plays a major role in the quality of people's lives. Therefore, BIA is the ideal technique to assess the biodiversity of any systems and to come up with sustainable enhancement practises.

1.2. Background Information on Apollo Tyres Limited

Apollo Tyres Ltd is a forerunner in India in manufacturing automobile tyres and tubes. It is also the first Indian company that has launched radial tyres for farm vehicles. Apollo Tyres has four units in India including the first plant of Apollo tyres at Perambra, Kerala. In Kerala, currently Apollo has two factories, which are at Perambra in Thrissur and Kalamassery in Ernakulam.

In the journey of three decades, it has grown immensely establishing its branches not only in the country, but also across the globe. Recently, this fast growing company has reached top

position in the production sector and second in market share beating out other tyre major manufactures. Over the last four decades Apollo expanded its corporate domain not only in India, but in other foreign nations such as South Africa, Netherlands and Zimbabwe. In addition to that, Apollo Tyres has been successful in its tyre dealership all over the world, with majority of its revenue obtaining from India, Europe and Africa.

Apollo Tyres Limited has started its corporate venture after commissioning its mother plant at Perambra, Kerala in 1976. It is situated in a rural area by occupying about 90.338 acres of land. Perambra plant is one of the major production units of Apollo Tyres and it currently employs about 2232 staffs and 849 contract workers.

The Kalamassery plant was established in 1962, and it was primarily owned by Desai Group and was named as Premier Tyres. In 1995, the company was taken over by Apollo Tyres. The Kalamassery plant is situated in an urban area and occupies almost 27 acres of land. Apollo Tyres produces about 110 tones of tyre daily in the Kalamassery plant, and has a workforce strength of 1412, which includes 100 management staff, 87 general staff, 775 workmen and 450 contract workers.

1.3. Significance of BIA for Apollo Tyres Limited, Perambra and Kalamassery

Apart from being a leading corporate company, Apollo is concerned about its impacts on environment and neighbouring communities. Therefore, the company established its Corporate Social Responsibility (CSR) Department in 2010. CSR has dedicatedly worked on minimizing the environmental issues that Apollo creates and reached out for the development of neighbouring communities.

Apollo Tyres Limited, Perambra is situated in the outskirts of a reserve forest (4 km away), while Apollo Tyres Limited, Kalamassery is established in the urban setting of Cochin city. In general both the plants have a good number of plant and animal species within their premises. However, it is unknown whether any changes occurred in the diversity and abundance of flora and fauna over the last 40 decades. Prior to implementing any activities on biodiversity conservation and enhancement, and the promotion of environmentalism, a proper assessment of the changing pattern of biodiversity has to be conducted at Apollo. By prioritising biodiversity, Apollo has decided to assess its impact on flora and fauna within the campus and its surrounding areas. For that, BIA is one of the best methods as it will give insight to the status of biodiversity in the past and present, and will come up with efficient suggestions for biodiversity enhancement that are feasible from the context of Apollo Tyres. Moreover, this study will help them to undertake effective mitigation and biodiversity enhancement programs at Apollo campus and its neighbouring communities, if there are any negative impacts. In case of no negative impacts, Apollo can proceed with biodiversity enhancement programs for improving the diversity and richness of flora and fauna inside and outside the campus. Therefore, Apollo CSR team approached Tropical Institute of Ecological Sciences (TIES), an environmental research organization based at Kottayam, Kerala. Apollo CSR team placed the following requirements to be met through a comprehensive project.

- Impact assessment of the biodiversity within the factory campuses and surrounding area in 2.5 km radius of Apollo campuses.
- Eco-restoration programme- enhancement of biodiversity within the factory campus.
- Environmental education programmes for promoting eco-friendly life style and to include community participation in biodiversity conservation projects.

1.4. Aim and Objectives

This study aims at assessing the impact on biodiversity inside the Apollo campus and a 2.5 km radius surrounding area in order to propose relevant biodiversity enhancement activities. The main objectives of this study are:

- To make a status report of the current biodiversity of the study area (company site and surrounding 2.5 km. radius)
- To assess the impact on the biodiversity by the company so far, through a historical survey and available secondary data
- To find out the avenues of restoration and biodiversity enhancement, and make a proposal for Biodiversity Enhancement Programme

1.5. Limitations of the study

First of all, this study is limited to assessing the existing impact on biodiversity by comparing the present status with available past data on biodiversity and its direct and indirect driving forces. The Biodiversity Impact Assessment is usually done in relation to a proposed project or future development plan by projecting 10 or 20 years to the future, and then assessing its impact on the biodiversity of the area. However, this assessment is not based on any project plans or technological changes, so there is no predictive component about biodiversity in this report. In addition, the impact of the plant on biodiversity will be continued as such, if there are no initiatives for implementing biodiversity enhancement programs.

Secondly, one of the techniques for finding the status of biodiversity during the establishment of Apollo campus is conducting a historical survey of the native households of the area. The drawback of this technique is that respondents' opinion will depend on their dependency and interest in the biodiversity components and their memory, but there are no other alternatives to find these data as no one has recorded the biodiversity of the study area previously.

Thirdly, the impact of Apollo Tyres on the biodiversity is assessed based on the status of biodiversity in the area during the establishment years of Apollo Tyres. However, the secondary data received from local offices does not date back to 4 decades. Since many of them were established after 1980, the oldest data available is that of 1980s. Therefore, benchmark years were considered to conduct the Biodiversty Impact Assessment. Besides, it is very difficult to alienate the impact of Apollo and other industries or in general the ongoing urbanisation trend on biodiversity.

Finally, short time period limits the study to estimation of biodiversity richness alone; besides, seasonal or temporal variations are not included in the study.

1.6. Scope of the study

Through the implementation of the biodiversity enhancement project the company will be able to establish a way to integrate biodiversity to the business, thereby providing a mechanism for improving Apollo's performance in relation to biodiversity and ecosystem services. It will also demonstrate the company's contribution to corporate responsibility and enhance Apollo's image in the community. It will improve Apollo's reputation as a multi-national tyre dealer that perform business in a greener way, thus differentiate Apollo's business tactics from other competitors.

Moreover, this study and the proposed suggestions will significantly improve the eco-friendliness of the company; provide more aesthetic appearance and prepare the campuses towards international biodiversity or green accreditations. It will make the company a Potentially Carbon Neutral Organization (by about 5 years), able to deliver Green Product & Services, and contribute significantly to the habitat through improved biodiversity.

Biodiversity accreditation agencies are very few internationally, and in India we have no such agencies or certificates. International Biodiversity Accreditation programmes are very specific and we need 5-6 years at least to set their bench mark standards. Therefore, by carrying out eco-friendly activities suggested later in the study, and increasing the commitment towards environment, Apollo can make the company eligible for applying for accreditations. However, each accreditations look for specific criteria prior to awarding the certification. A number of such accreditations and their criteria are enlisted below.

i. Green business certification

Green business certification is granted by Green Business Bureau. The agency look for following ten criteria before granting the certification to the organizations applied for it.

a. Solid waste reduction
b. Recycle or reuse materials
c. Reduced office waste
d. Purchase used or recycled content
e. Energy savings
f. Water conservation
g. Pollution prevention
h. Chemical reduction
i. Potential pollutants
j. Reduce vehicle emissions
k. Environmentally friendly purchasing (GBB, nd)

ii. Green Certificate

This certification is provided by Green Standard Certification Program (GSCP). It requires organization to follow a green approach for a safe, healthy and green environment so that it contributes to the sustainable business for delivering green products and services. GSCP requires the organizations applying for the certifications to be pioneering in the below mentioned areas.

a. Be a Potentially Carbon Neutral Organization
b. Deliver Green Product & Services
c. Maintain a Green Process to deliver Products or Services
d. Provide a Green System towards a Sustainable Business utmost (Green Standard Certification Program, nd)

iii. Wildlife Habitat Certificate

Wildlife Habitat Certificate is granted by National Wildlife Federation. This certification aims to improve the habitat of wildlife by providing food and shelter to them; hence, they collaborate with other organizations, institutions, and even households who succeed in providing habitat to the wildlife and certify them. The Wildlife Habitat Certificate demands these criteria:

a. Provide food for wildlife: Plant native herbs, shrubs and trees that provide foliage, nectar and fruit for fauna in the area
b. Supply water for wildlife: Provide natural or handmade water sources like ponds for wildlife to drink, bath and reproduce.
c. Create cover for wildlife: Supply place for wildlife to hide and to feel safe from humans
d. Give space for wild life to rear and care for their young ones (NWF, 2014)

TIES' Field investigators with a local man who is angling fishes at Peringankulam, Perambra

2 Methodology

2. METHODOLOGY

The methods adopted for carrying out this BIA is discussed below.

2.1. Screening and Scoping

To determine the possibility and level of assessment required to understand the impact on biodiversity due to Apollo Tyres, an expert team from TIES including a biodiversity expert had done an initial biodiversity assessment inside the Apollo campuses and surrounding area.

2.2. Study period

The study was conducted during the period 1st November 2013 to 31st January 2014.

2.3. Study area description

This study is conducted inside Cochin Plant campuses of Apollo and neighbouring communities of 2.5 Km radius around each campus. Apollo Tyres, Perambra is located in a rural setting with Kodassery reserve forest existing 4 km away from it (10°21′16″N 76°22′10″E). The plant located at Kodakara Panchayath of Thrissur district occupies about 90.388 acres of land and NH 47 passes right infront of the campus. The boundaries of the study area are marked by Kodakara and Mattathur Panchayaths in the North, Kodassery Panchayath in the East, Chalakkudy Municipality in the South and Alur and Muriyad Panchayaths in the West. In addition, the buffer zone of 2.5 km radial distance consisting of sub-urban and rural areas does not have any other large scale institutions apart from Apollo Tyres.

On the other hand, Kalamassery plant is located in the midst of an urban ecosystem with a land area of 117908 sq.m, in between NH47 and Railway line with the coordinates of 10°3′42″N 76°19′26″E. As Apollo Tyres outlines northern periphery of Kalamassery Municipality, the boundaries of the study area are located in Choornikara panchayat in the north, Eloor municipality in the west, and Kalamassery municipality in the south and east. In addition, the buffer zone of 2.5 km radial distance consists of urban, sub-urban, and rural areas with several large scale and small industries, IT companies and educational institutions.

2.4. Methods

2.4.1. Assessment of current biodiversity of Apollo campuses

Detailed resource map of the campuses were prepared based on the sketch of the campuses given by Apollo. One field investigator each was assigned to both campuses and the entire campus of both plants were investigated thoroughly. As it is a short term study the species richness and evenness alone were studied. The diversity of plants and animals were assessed by quadrate and transect studies. The field investigator spent specified time period in the campus during morning (till noon) and evening, three days a week for a period of one month. Data was recorded through direct observations. A group of taxonomists visited the campus twice and assisted scientific identification of fauna and flora.

2.4.2. Assessment of current biodiversity of the area surrounding Apollo campuses (2.5 km. radius)

A map of the study area covering 2.5 km. radius of Apollo campuses were prepared using IRS P6 (LISS III) image acquired on 19th February 2011. Forty five sampling spots were randomly selected inside the selected area by giving an almost equal representation to four sides (North, east, west and south). The details of the selected spots are given in Table 2.1 and 2.2 and Fig. 2.1 and 2.2. A field investigator visited each identified location and recorded the biodiversity of the locality, mainly plants, birds and mammals (100 m. Radius/ 50 cents) using the methodology described above. A group of taxonomists visited selected sample spots (<12) and given the scientific identification of doubtful cases. The collected data was tabulated and statistically analysed.

Table 2.1: Coordinates of Samples sites at Perambra

Sl. No	Locations	Coordinates
1	Panampilli Junction, Potta	10°19′56″N 76°19′15″E
2	Apollo Junction, Perambra	10°20′53″N 76°19′14″E
3	Alur-Irinjalakkuda Road	10°20′50″N 76°18′47″E
4	Chathanmash Road	10°21′8″N 76°18′53″E
5	Perambra Junction	10°21′2″N 76°19′0″E
6	Peringankulam	10°21′47″N 76°18′57″E
7	Azhakam Road, Kodakara	10°22′3″N 76°19′10″E

Table 2.2: Coordinates of sample sites at Kalamassery

Sl. No	Locations	Coordinates
1	South Kalamassery	10°3′5″N 76°19′2″E
2	Muttom	10°4′16″N 76°19′56″E
3	Eloor Road, North Kalamassery	10°4′2″N 76°19′27″E
4	Thoomangathodu road, North Kalamassery	10°3′42″N 76°19′50″E
5	Rajagiri road, North Kalamassery	10°3′17″N 76°19′11″E
6	Chenakala road, NAD,North Kalamassery	10°3′27″N 76°19′36″E
7	HMT Jn,North Kalamassery	10°3′13″N 76°19′22″E
8	Puthalam road, North Kalamassery	10°4′2″N 76°19′10″E
9	Ferry road, North Kalamassery	10°4′4″N 76°19′17″E
10	Karippai road, North Kalamassery	10°3′26″N 76°19′11″E

Fig. 2.1. Sample study locations in Permapra plant area

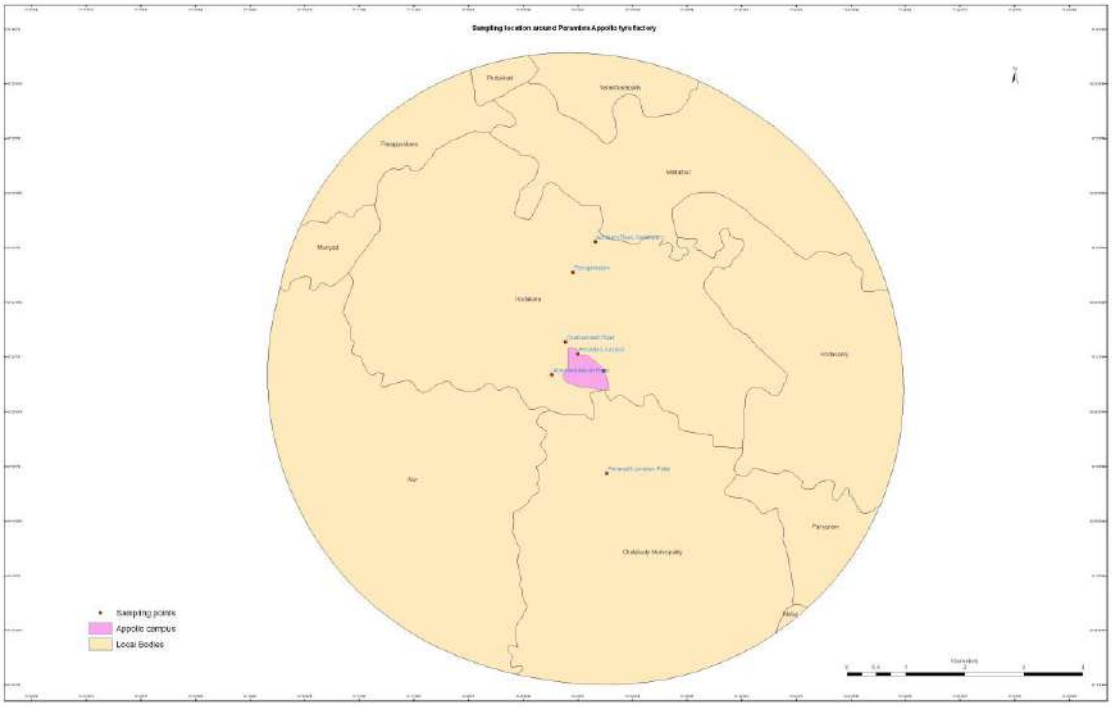
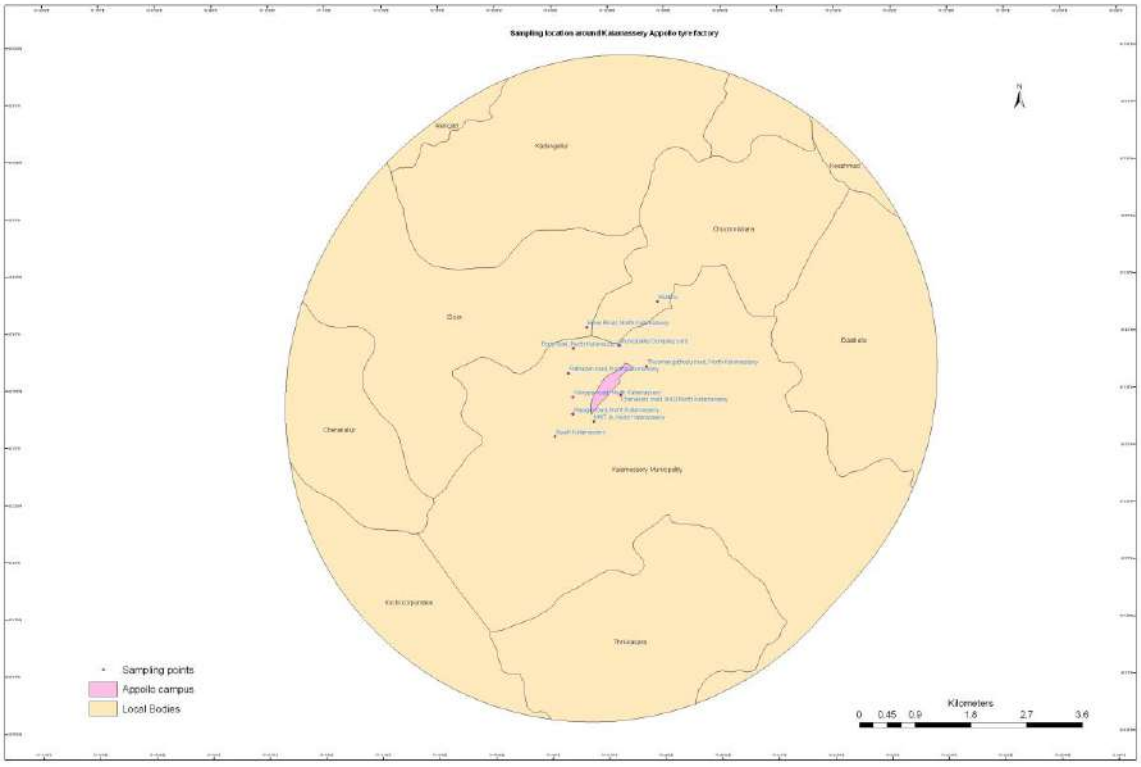


Fig. 2.2. Sample study locations in Kalamassery plant area



2.4.3. Assessment of past biodiversity of Apollo campuses (during 1975)

An attempt was made to find out the biodiversity status of the area during the period of about 30 years back by interviewing employees of Apollo Tyre Company who are working in the company for more than 30 years using a structured interview sheet (See Appendix I). 1/5th of the total number of senior employees at Perambra plant were selected for the interview. At the same time, 20 workmen out of the 34 senior employees were surveyed at Kalamassery plant.

2.4.4. Assessment of past biodiversity of area surrounding Apollo campuses (2.5 km radius) (during 1975)

Similar attempt was made to collect the biodiversity status of the surrounding area (2.5 Km. radius) of Apollo campuses by interviewing persons who are resident of the same locality for more than 30 years using a structured interview sheet (See Appendix –II). 45 people residing in the four sides of the campus were randomly selected and interviewed. The demography details of the samples are given in Table 2.3 and 2.4.

Table 2.3: Demography information of surveyed community members at Perambra

Categories		**Percentage (%)**
Survey Respondents	Male	44
	Female	56
Age	40-50	11
	51-60	36
	61-70	31
	71-80	20
	81-90	2
Average year of residence at the area	30-50	51
	51-70	38
	71-90	11
Ancestral History	0-1 generation	18
	2-3 generations	73
	4-5 generations	4
	6-7 generations	2
	7-8 generations	2
Occupation	Apollo Employee	22
	Housewife	27
	Farmer	13
	Business	2
	Teacher	11
	Others	24

Table 2.4: Demography information of surveyed community members of Kalamassery

Categories		Percentage (%)
Survey Respondents	Male	33
	Female	67
Age	50-60	31
	61-70	49
	71-80	16
	81-90	4
Average year of residence	30-50	78
	51-70	18
	71-90	4
Ancestral History	0-1 generation	49
	2-3 generations	47
	4-5 generations	4
Occupation	Apollo Employee	2
	Other company employee	27
	Housewife	38
	Farmer	7
	Business	4
	Teacher	2
	Others	20

2.4.5. Land use and land cover changes using Remote Sensing & Geographical Information System (RS & GIS) tools.

Data sets used

The 5 km buffer area of Kalamassery and Perambra Apollo tyre companies are completely covered on the Survey of India Toposheet 58 B/8 and 58 B/7 (1:50000 scale) surveyed on 1967- 1969 and is used to create the land use maps and thematic layers (roads, places, river and drainages) of the area. (At this resolution it is difficult to represent the details of topography and other land use aspects of 2.5 km radius area, hence 5 km area was selected for analysis).

LANDSAT MSS (Multi-Spectral Scanner) image acquired on 24th January 1971 and IRS P6 (LISS III) image acquired on 19th February 2011 are the satellite data used for the study to create the land use maps and Normalized Difference Vegetation Index (NDVI) of the area.

Software used

Arc GIS 9.3 version, a software package generated and marketed by Environmental System and Research Institute (ESRI), California, composed of Arc GIS desktop, Arc GIS gateway and Arc GIS IMS software were used to perform GIS tasks. ERDAS (Earth resource Data Analysis

system) Imagine 9.1 version generated and marketed by ESRI, California and was used to perform both image processing and GIS analysis.

2.4.6. Analysis

Land use/ Land cover change analysis

Feature class for land use/ land cover was generated from geometrically corrected toposheets and satellite imageries. The land use classes were represented multihued with all map elements. The geographical area of different land use classes was statistically summarized using the software.

Normalised Difference Vegetation Index (NDVI) analysis

The Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to assess whether the target being observed contains live green vegetation or not. A Normalized Difference Vegetation Index (NDVI) is an equation that takes into account the amount of infrared reflected by plants. Live green plants absorb solar radiation, which they use as a source of energy in the process of photosynthesis. The reason NDVI is related to vegetation is that healthy vegetation reflects very well in the near-infrared part of the electromagnetic spectrum.

Green leaves have a reflectance of 20% or less in the 0.5 to 0.7 micron range (green to red) and about 60% in the 0.7 to 1.3 micron range (near-infrared). These spectral reflectances are themselves ratios of the reflected over the incoming radiation in each spectral band individually; hence, they take on values between 0.0 and 1.0. Thus, the NDVI itself varies between -1.0 and +1.0.

Negative values of NDVI (values approaching -1) correspond to deep water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1). The typical range is between about -0.1 (for a not very green area) to 0.6 (for a very green area). Overall, NDVI provides a crude estimate of vegetation health and a means of monitoring changes in vegetation over time, and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data.

The NDVI ratio is calculated by dividing the difference in the near-infrared (NIR) and red color bands by the sum of the NIR and red colors bands for each pixel in the image as follows:

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{RED})}{(\mathrm{NIR} + \mathrm{RED})}$$

2.4.7. Drivers of change identification

Direct drivers of change, which can be identified and measured, include the following groupings: (i) changes in land use and land cover, (ii) industrialization (iii) infrastructural developments and (iv) pollution .Indirect drivers of change which can in turn influence the

direct drivers, include: (i) demographic, (ii) socio-economic and cultural factors (iii) change in agricultural pattern and (iv) urbanization

Both the direct and indirect drivers of changes are identified through evaluation of data from direct observation, GIS & RS study, historical data and heavily based on secondary data collected from Apollo Tyres Ltd., local body offices (municipality & panchayaths), agricultural offices, Kerala State Pollution Control Board and State PWD offices. Request letters demanding specified information as per Right to Information Act (2005) was submitted to concerned offices at the beginning of the study period itself and data were collected completing all formalities. Census data of 2011 and various studies available are also taken into consideration.

Secondary succession of trees and weeds at the fringe area of lorry parking ground at perampra

Honey bee collecting nectar from a flower at Perambra campus (near coal storage yard)

3 Results : Perambra

3.1. Status of biodiversity in the study area

The status of biodiversity collected through direct observation (present status) and participatory research method are enlisted under this section. In order to make it more clear, the total biodiversity are categorized separately as biodiversity inside the campus and biodiversity outside the campus.

3.1.1. Status of biodiversity inside Apollo campus

Apollo Tyres occupies about 90 acres of land. Through a general observation it was noticed that the company has a moderately rich biodiversity inside its campus, but the evenness of the flora is low. Since the distribution of fauna is heavily depended on flora, faunal evenness inside the campus also follows the same pattern as that of flora. The status of the floral and faunal diversity inside the campus at present and in the past was prepared in order to take necessary steps for the biodiversity enhancement at Apollo.

3.1.1.1. Flora

Through the direct observation, it was recorded that there are 189 species of flora inside the campus at present (Table 3.1). Among them the majority are trees, herbs and shrubs, comprising 33%, 27% and 22% respectively of the total flora population (Fig. 3.1). One of the important features of the floral biodiversity inside the campus is that the natural succession is completely vanished from the campus during the initial construction period. Therefore, a major portion of flora currently existing inside the campus is newly introduced as ornamental plants, and the rest came into existence during the following secondary growth period due to lack of human intervention. Since most of the current flora inside the campus is not original vegetation, a significant portion of them are exotic. For instance, 71% of the garden plant diversity inside the campus is exotic, which represent 28% of the total floral diversity at Apollo. Consequently, the diversity and abundance of the faunal population has decreased drastically due to the inability of foreign flora to support native fauna. A list of the existing flora inside the campus is given below, and an attempt was made to track down the flora existed inside the campus during the pioneering years of Apollo's establishment through historical survey of the senior employees of the company (Tables 3.2). Since this type of data collection is based on the memory of a person, it only includes the major tree species existed in the campus at the time as the interviewee recalls. Therefore, it is not an ideal list, but it gives a glimpse to the major tree species of the time period 1975-85 at Apollo campus.

Table 3.1: Flora present inside Apollo campus in 2014

Sl. No.	Malayalam Name	Common Name	*Scientific Name*	Category
1	Kurumulaku	Pepper	*Piper nigrum*	Climber
2	Valaripayar	Garden Pea	*Pisum sativum*	Climber
3	Money plant	Money plant	*Epipremnum aureum*	Climber
4	John Creeper	John Creeper	*Podranea ricasoliana*	Climber
5	Kattu munthiri	Grape glory	*Merremia vitifolia*	Climber
6	Kattupaval	Spiny gourd	*Momordica dioica*	Climber
7	Kattupeechinga	Ridge gourd	*Luffa acutangula*	Climber
8	Shangupushpam	Butterfly bean	*Clitoria ternatea*	Climber
9	Vayara	Bitter Vine	*Mikania micrantha*	Climber
10	Uzhinja	Balloon vine	*Cardiospermum halicacabum*	Climber
11	Pudapazham	Wild Maracuja	*Passiflora foetida*	Climber
12	Pullanji	Ukshi	*Calycopteris floribunda*	Climber
13	Bridal Boquet	Bridal Boquet	*Plumeria pudica*	Climber
14	Kumbalam	Ash guard	*Benincasa hispida*	Creeper
15	Parpatakapullu	Chayroot	*Oldenlandia corymbosa*	Creeper
16	Puliyarila	Indian sorrel	*Oxalis corniculata*	Creeper
17	Pannal chedi	Pteridophytes	*Pteridophyta*	Fern
18	Pannal chedi	Fern	*Pyrrosia lanceolata*	Fern
19	Inchapullu	Chinese grass	*Miscanthus sinensis*	Grass
20	Chinese bamboo	Chinese bamboo	*Bambuseae*	Grass
21	Muthanga	Nut grass	*Cyperus rotundus*	Grass
22	Karuka	Dhub grass	*Cynodon dactylon*	Grass
23	Pothappullu	Potha grass	*Themeda cymbaria Hack*	Grass
24	Mula	Green bamboo	*Bambuseae sp.*	Grass
25	Poochavalanpullu	Kyasuwa grass	*Pennisettum pedicillatum*	Grass
26	Karimuttan	Common Nut Sedge	*Cyperus cephalotes*	Grass
27	Switchgrass	Switchgrass	*Arundinella leptochloa*	Grass
28	Kaalappullu	Blanket grass	*Axonopus compressus*	Grass
29	Love grass	Love grass	*Eragrostis viscosa*	Grass
30	Velutta nirvasi	White Water Sedge	*Kyllinga nemoralis*	Grass
31	Pullu	Indian Murainagrass	*Ischaemum indicum*	Grass
32	Vaazha	Banana	*Musa sp.*	Herb
33	Mulaku	Ghost chilli	*Capsicum annum*	Herb
34	Kanthari	Bird's Eye Chilli	*Capsicum annum*	Herb
35	Murikku	Indian coral tree	*Erythrina variegata*	Herb
36	Orchid	Vanda	*Vanda denisoniana*	
37		Suplera	*Suplera sp.*	Herb

38	Desert rose	Adenium rose	*Adenium sp.*	Herb
39		Samia cycas	*cycas sp.*	Herb
40	May flower	May flower	*Epigaea repens*	Herb
41	White grass	Silver grass	*Leersia virginica*	Grass
42	Green grass	Maiden grass	*Miscanthus sinensis*	Grass
43	Cheera	Amaranthus	*Amaranthus sp.*	Herb
44	Orchids	Dendrobium	*Dendrobium sp.*	Herb
45	Dracaena	Dracaena	*Dracaenae sp.*	Herb
46	Cabbage	Cabbage	*Brassica oleracea*	Herb
47	Cauli flower	Cauli flower	*Brassica oleracea*	Herb
48	Euphorbia	Euphorbia	*Euphorbia milii*	Herb
49	Vazhappovu	Heliconia	*Heliconia*	Herb
50	Naalumani chedi	Table rose	*Portulaca grandiflora*	Herb
51	Anthoorium	Anthoorium	*Anthurium andraeanum*	Herb
53	Jamanthi/Banthi	Marigold	*Calendula officianalis*	Herb
54	Kodiveli	Leadwort	*Plumbago rosea Linn.*	Herb
55	Muriyan pacha	Goat weed	*Ageratum conyzoides Linn*	Herb
56	Choriyanam	Canchorie root-plant	*Tragia involucrata Linn*	Herb
57	Kayyonni	Marsh Daisy	*Eclipta alba*	Herb
58	Muyalcheviyan	Consumption weed	*Emilia sonchifolia*	Herb
59	Keezhar nelli	Hazarmani	*Phyllanthus amarus*	Herb
60	Kurumthotti	Common Wireweed/ Indian hemp	*Sida rhombifolia*	Herb
61	Thottavadi	Touch me not	*Mimosa pudica*	Herb
62	Naivela	Common Spider Flower	*Cleome burmanni*	Herb
63	Aatunarivela	Yellow spider flower	*Cleome viscosa*	Herb
64	Chembu	Taro	*Colocasia esculenta*	Herb
65	Begonia	Begonia	*Begonia sp.*	Herb
66	Queen's tears	Billbergia	*Billbergia nutans var. schimperiana*	Herb
67	Balsam	Balsam	*Impatiens balsamina*	Herb
68	Astra	Ballon flower	*Platycodon grandiflorus*	Herb
69	Seeniya	Zinnia	*Zinnia peruviana*	Herb
70	Vellai-ooral	Grape leaved mallow	*Kosteletzkya vitifolia*	Herb
71	Nilappala	Thyme-leaf spurge	*Euphorbia thymifolia*	Herb
72	Anachuvadi	Elephant's Foot	*Elephantopus scaber*	Herb
73	Palluvedanachedi	Tooth ache plant	*Acmella sp.*	Herb
74	Vellachampa	Malabar plum	*Syzuygium jambos*	
75	Odiyancheera	Coat Buttons	*Tridax procumbens*	Herb
76	Garudapacha	Blue Snakeweed	*Stachytarpheta cayennensis*	Herb
77	Mashitandu chedi	Shining bush plant	*Peperomia pellucida*	Herb

78	Tapaskaya	Britton's Wild Petunia	*Ruellia tweediana*	Herb
79	Anakaita	American Century Plant	*Agave americana*	Herb
80	Shavamnari	Periwinkle	*Catharanthus rosea*	Herb
81	Chemparathi	Hibiscus	*Hibiscus rosasinensis*	Shrub
82	Kongini	Lantana	*Lantana camera*	Shrub
83	Mussanda	Mussanda	*Cestrum nocternum*	Shrub
84	Thakkara	Ceylon Senna	*Cassia roxburghii*	Shrub
85	Swarnathali	Gold spot	Euonymus japonicus	Shrub
86	Manja Arali	Yellow Oleander	*Cascabela thevetia*	Shrub
87	Chethi	Ixora	*Ixora coccinia*	Shrub
88	Kanakamparam	Fire cracker flower	*Crossandra infundibuliformis.*	Shrub
89	Velichedi	Mouse tail Plant	*Phyllanthus myrtifolia*	Shrub
90	Tulsi	Basil	*Ocimum basilicum*	Shrub
91	Garden croton	Garden croton	*Codiaeum variegatum*	Shrub
92	Rosa	Rose	*Rosa sp.*	Shrub
93	Kadalasu poovu	Bougainvillea	*Bougainvillea glabra*	Shrub
94	Nanthyarvattam	East India Rosebay	*Tabernaemontana divaricata*	Shrub
95	Aralia	Ming Aralia	*Polyscias fruticosa*	Shrub
96	Durantha	White sky flower/ Golden dew drop	*Duranta erecta*	Shrub
97	Sreelankan Jasmine	Sreelankan Jasmine	*Jasminum sp.*	Shrub
98	Mulla	Jasmine	*Jasminum sombac*	Shrub
99	Kallimulchedi	Cactus	*Cactaceae sp.*	Shrub
100	Aralia	Aralia	*Polyscias sp*	Shrub
101	Finger Palm	Finger Palm	*Rhapis multifida*	Shrub
102	Table palm	Table palm	*Chamaedorea elegans*	Shrub
103	Karivepila	Curry leaf tree	*Murraya koenigii*	Shrub
104	Communist pacha	Siam weed	*Chromolaena odorata*	Shrub
105	Thakkali	Tomato	*Solanum lycopersicum*	Shrub
106	Buddha	Buddha belly plant	*Jatropha podagrica*	Shrub
107	Eriku	Giant Milkweed	*Calotropis gigantea*	Shrub
108	Ithikkanni	Mistletoe	*Dendrophthoe falcata*	Shrub
109	Aavanakku	Castor	*Ricinus communis Linn.*	Shrub
110	Chempakam	Frangipani	*Plumeria alba*	Shrub
111	Cherru-pullate	Birdsville Indigo	*Indigofera linnaei*	Shrub
112	Kallurukki	Graceful Pouzolz's Bush	*Pouzolzia zeylanica*	Shrub
113	Thanka arali	Yellow oleander	*Tecoma stans*	Shrub
114	Chempakam	Frangipani	*Plumeria obtusa*	Shrub
115	Adenium	Desert Rose	*Adenium obesum*	Shrub
116	Morning glory	Morning glory	*Ipomoea nil*	Shrub
117	Kolambi	Violet Alamanda	*Allamanda blanchetti*	Shrub

118	Manja Kolambi	Golden trumpet	*Allamanda cathartica*	Shrub
119	Koonampala	Nag kuda	*Tabernaemontana alternifolia*	Shrub
120	Pavizhamulla	Night-flowering Jasmine	*Nyctanthes arbor-tristis*	Shrub
121	Arali	Nerium	*Nerium oleander*	Shrub
122	Mysore Mailanchi		*Lawsonia inermisLinn.*	Shrub
123	Thonti	Indian gum tragacanth	*Sterculia urens*	Shrub
124	Pana	Bottle palm	*Hyophorbe lagenicaulis*	Shrub
125	Thengu	Coconut Tree	*Cocos nucifera*	Shrub
126	Vaka	Flamboyant	*Delonix regia*	Tree
127	Pancharamaram	Indian Charcoal Tree	*Trema orientalis*	Tree
128	Aranamaram	Indian Mast Tree	*Polyalthia longifolia*	Tree
129	Pana	Palmyra Palm	*Borassus flabellifer*	Tree
130	Poomaruthu	Queen's Crape-myrtle	*Lagerstroemia speciosa*	Tree
131	Sheema Konna	Gliricidia	*Gliricidia sepium*	Tree
132	Pera	Guava	*Psidium guajava*	Tree
133	Vattamaram	Chandada	*Macaranga peltata*	Tree
134	Rubber	Rubber Tree	*Hevea brasiliensis*	Tree
135	Plavu	Jack Fruit Tree	*Artocarpus heterophyllus*	Tree
136	Arayal	Peepal Tree	*Ficus religiosa*	Tree
137	Kappalam	Pappaya	*Carica papaya*	Tree
138	Mahogany	Mahogany	*Swietenia mahagoni*	Tree
139	Mavu	Mango Tree	*Mangifera indica*	Tree
140	Choondappana	Fishtail Palm	*Caryota urens*	Tree
141	Karash/ Otiyan-maram	Indian Ash Tree	*Lannea coromandelica*	Tree
142	Pathimukham	Sappan	*Caesalpinia sappan*	Tree
143	Kariveetti	Indian Rosewood	*Dalbergia latifolia*	Tree
144	Manja vaka	Copper-pod	*Peltophorum pterocarpum*	Tree
145	Chempakam	yellow jade orchid tree	*Michelia champaca*	Tree
146	Mazhamaram/ Urakamthoongi maram	Rain Tree	*Albizia saman*	Tree
147	Christmas tree	Arcaria	*Pseudotsuga menzietii'*	Tree
148	Unnamurika	Silk-cotton Tree	*Ceiba pentandra*	Tree
149	Chuvanna pana	Red palm	*Acanthophoenix rubra*	Tree
150	Sampirani	Coast Sheoak	*Casuarina equisetifolia*	Tree
152	Aatha	Custard Apple	*Annona muricata*	Tree
153	Ungu	Indian beech tree	*Pongamia pinnata*	Tree
154	Cypress	Cypress	*Cupressus macrocarpa*	Tree
155	Pana	Yellow palm	*Dypsis lutescens*	Tree
157	Karimaram	Green Ebony	*Diospyros buxifolia*	Tree
158	Kumbil/Kumizhu	Beechwood	*Gmelina arborea*	Tree

159	Ezhillam pala	Devil Tree	*Alstonia scholaris*	Tree
160		Tea tree	*Melaleuca bracteata*	Tree
161	Bottle brush	Bottle brush	*Callistemon citrinus*	Tree
162	Thekku	Teak	*Tectona grandis*	Tree
163	Cypress	Golden cyprus	*Cupressus sp.*	Tree
164	Rambutan	Rambutan	*Nephelium lappaceum*	Tree
165	Nellikka	Indian Gooseberry	*Emblica officinalis*	Tree
166	Ficus	Golden Fig	*Ficus benjamina*	Tree
167	Champa	Rose Apple	*Syzygium jambolanum*	Tree
168	Thuja	Thuja	*Thuja occidentalis*	Tree
169	Cherry	Cherry	*Prunus avium*	Tree
170	Panji maram	White silk cotton tree	*Bombax pentandrum Linn*	Tree
171	Pana	Foxtail palm	*Wodyetia bifurcata*	Tree
172	Mangosteen	Mangosteen	*Garcinia mangostana*	Tree
173	Motta pazham	Egg Fruit	*Pouteria campechiana*	Tree
174	Kattu Rubber	Jungle Rubber	*Hevea brasiliensis*	Tree
175	Chempakam	Frangipani	*Alpha Plumeria*	Tree
177	Unnam	Grewia	*Grewia microcos*	Tree
178	Seethappazham	Sugar apple	*Annona squamosa*	Tree
179	Njaval	black plum	*Syzygium cumini*	Tree
180	Kamuku	Arecanut	*Areca catechu*	Tree
181	Mangium	Mangium	*Acacia mangium*	Tree
182	Aryavep	Neem	*Azadirachta indica*	Tree
184	Peral	Banyan Tree	*Ficus benghalensis*	Tree
185	Manchadi	Indian Coral Nut Tree	*Adenanthera pavonina*	Tree
186	Acasia	Acasia	*Acasia acasia*	Tree
187	Chandanam	Sandalwood tree	*Santalum album Lin*	Tree
188		Watery Rose Apple	*Syzegium malaccensis*	Tree
189	Pancharapazham	Chinese cherry	*Muntingia calabura*	Tree
190	Perumaram	White palle	*Ailanthus triphysa*	Tree
186	Vatta	Gum Plant	*Macaronga indica*	Tree
187	Ippil /Subabul	Mimosoid tree	*Leucaena leucocephala*	Tree
188	Plum	Drupe fruit	*Prunus cultivar*	Tree
189	Avocado	Avocado	*Persea americana*	Tree

Figure 3.1: Floral strength inside the campus in 2014

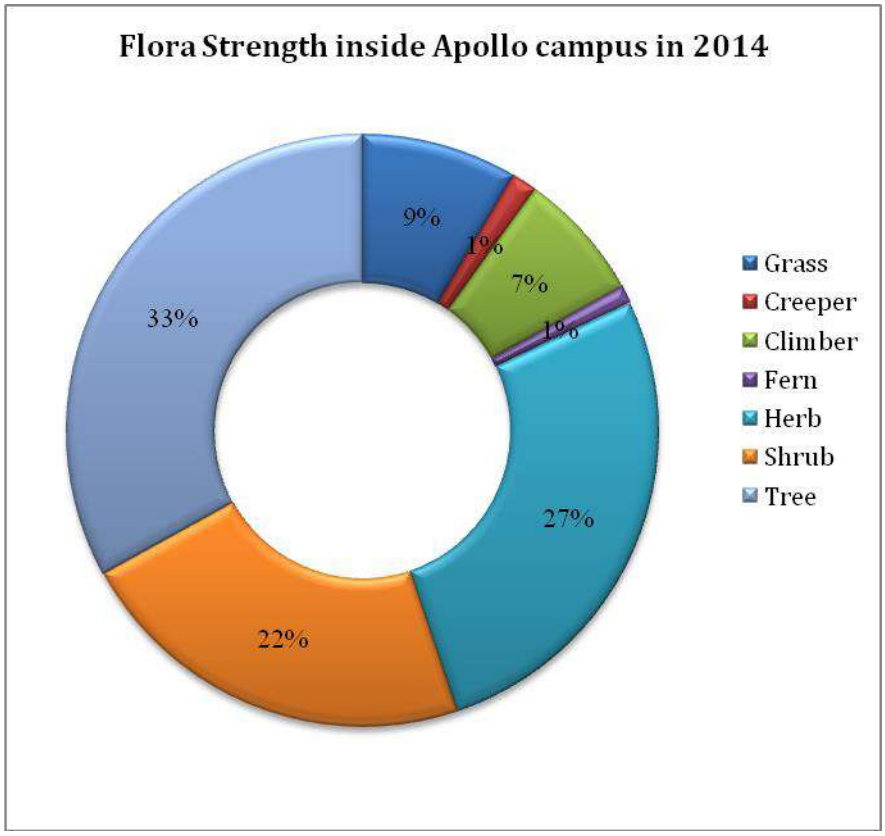
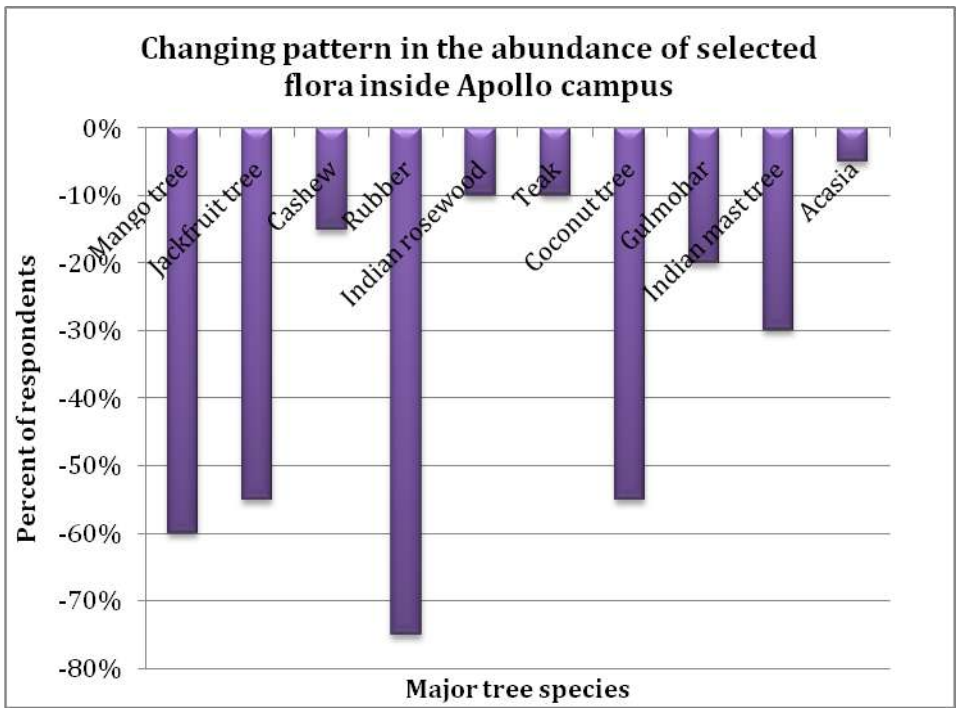


Table 3.2: List of flora inside the campus in 1975-85

Sl. No.	Malayalam Name	Common Name	*Scientific Name*	Category
1	Mavu	Mango tree	*Mangifera indica*	Tree
2	Rubber	Rubber	*Hevea brasiliensis*	Tree
3	Thengu	Coconut tree	*Cocos nucifera*	Tree
4	Aranamaram	Indian Mast Tree	*Polyalthia longifolia*	Tree
5	Vaka	Gulmohar	*Delonix regia*	Tree
6	Plavu	Jackfruit tree	*Artocarpus heterophyllus*	Tree
7	Thekku	Teak	*Tectona grandis*	Tree
8	Eetti	Indian Rose Wood	*Dalbergia latifolia*	Tree
9	Pathimukham	Sappan	*Prunus cerasoides*	Tree
10	Kashumavu	Cashew nut	*Anacardium oxydental lin*	Tree
11	Pana	Palmyra Palm	*Borassus flabellifer*	Tree
12	Anjili	Wild jack	*Artocarpus hirsutus*	Tree
13	Acasia	Acasia	*Acacia acasia*	Tree

Though not much data on the actual status of the flora in the past was known, surveyed employees were asked about the change in abundance of the major trees species of Apollo campus over the past 4 decades. According to the responses received, Rubber tree (75% respondents) is the species that is significantly affected by construction and other activities inside the campus. Also, mango tree (60%), jackfruit tree (55%) and coconut tree (55%) were also greately affected (Fig.3.2). The reduction in the abundance of native trees and the fact that there were no attempts have taken place to replace the clear cut floral wealth indicates that the company was least concerned about the native biodiversity conservation inside the campus.

Fig. 3.2: Changing pattern in the abundance of selected trees inside Apollo campus over the last four decades



3.1.1.2. Fauna

According to the field visit, the total faunal species strength inside the campus is recorded to be 118 (Table 3.3). Out of which, birds comprises 31%, and butterflies and dragonflies constitute about 24% and 26% respectively. From a general analysis it can be noticed that only 41% of the total faunal population consists animals that are not insects, indicating moderate biodiversity strength inside the campus. This data underlines the fact that native flora only can support native fauna. The reason for having less faunal diversity inside the campus is that the number of exotic flora species outweighs the number of native flora species.

Table 3.3: List of fauna inside Apollo campus in 2014

BIRDS				
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***	**Status**
1	Mothiravalayan Thatha	Rose-ringed Parakeet	*Pscittakula krameri*	Occasional
2	Kakkathampuratti	Black Drongo	*Dicruruss admilis*	Common
3	Meenkothi chathan	White throated Kingfisher	*Halcyon smyrnensis*	Common
4	Olenjali	Rufous Tree Pie	*Dendrocitta vagabunda*	Common
5	Kavathi kakka	House Crow	*corvus splendens*	Common
6	Velli Eriyan	Black Winged Kite	*Elanus Careleus*	Occasional
7	Mada Pravu	Blue Rock Pigeon	*Columba elphinstonii*	Common
8	Nattumaina	Common Myna	*Acridotheres tristis*	Common
9	Perumundi	Great Egret	*Ardea alba*	Common
10	Chinnamundi	Little Egret	*Egretta garzetta*	Common
11	Kula Mundi	Indian Pond Heron	*Ardeola grayii*	Common
12	Chempoth	Greater Coucal	*Centropus sinensis*	Common
13	Chenkanni Thithiri	Redwattled Lapwing	*Vanellus indicus*	Common
14	Thavidan Kathrika	Dusky Crag Martin	*Ptynoprogne concolor*	Common
15	Kariyilakkili	Jungle babbler	*Turdoides striatus*	Common
16	Indian Manjakkili	Golden Oriole	*Oriolus kundoo*	Common
18	Kuyil	Asian Koel	*Eudynamys scolopacea*	Occasional
19	Chinnakkutturuvan	White cheeked Barbet	*Megalaima viridis*	Common
20	Nattu Maramkothi	Blackrumbed Flameback	*Dinopium bengalensis*	Common
21	Mannathippullu	Oriental Magpie-Robbin	*Copsychus saularis*	Common
22	Angadi kuruvi	House Sparrow	*Passer domesticus*	Common
23	Kakka maramkothi	White bellied Woodpecker	*Dryocopus javensis*	Rare
24	Chakkipparunthu	Black Kite	*Milvus migrans*	Rare
25	Moonga	Mottled Wood Owl	*Strix ocellata*	Rare
26	Chenkannan theepporichathan	Water cock/Kora	*Gallicrex cinerea*	Rare
27	Chenkokkan Ithikkannikkuruvi	Tickl'es Flowerpecker	*Diaceum erythrorhynchos*	Common
28	Karinchundan Ithikkannikkuruvi	Nilgiri Flowerpecker	*Dicaeum concolor*	Common
29	Chutteenthal Kili	Pied Bush Chat	*Saxicola caprata*	Common
30	Karuppan Thenkili	Purple Sunbird	*Nectarinia asiatica*	Common
31	Naattu Bulbul	Red vented Bulbul	*Pycnonotus cafer*	Common
32	Kalmannaathi	Indian Robin	*Saxicoloides fulicata*	Occasional
33	Pullinathu	Spotted Owlet	*Athene brama*	Rare
34	Cheruthenkili	Small sunbird	*Nectarinia minima*	Occasional
35	Kakkathampuran	Ashy Drongo	*Dicrurus leucophaeus*	Common

MAMMALS				
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***	**Status**
1	Annan	Three striped palm Squirrel	*Funambulus palmarum*	Common
2	Keeri	Common Mongoose	*Herpestes edwardsii*	Rare
3	Panniyeli	Larger Bandicoot rat	*Bandicota indica*	Occasional
4	Poocha	Domestic cat	*Felis catus*	Common
REPTILES				
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***	**Status**
1	Moorkhan	Spectacled cobra	*Naja Naja*	Common
2	Anali/Chenathandan	Russel's Viper	*Daboiea russeli*	Common
3	Shankuvarayan/Vellikkettan	Common Krait	*Bungarus coeruleus*	Common
4	Valavalappan	Indian Wolf Snake	*Lycodon aulicus*	Common
5	Chera	Rat snake	*Ptyas mucosa*	Common
6	Arana	Brahminy Skink	*Mabuya carinata*	Common
7	Onthu	Common Garden Lizard	*Calotes versicolor*	Common
8	Palli	House Gecko	*Hemidactylus frenatus*	Common
AMPHIBIANS				
Sl.No.	**Malayalam Name**	**Common Name**	***Scientific Name***	**Status**
1	Marathavala	Golden Treefrog	*Rana aurantiaca*	Rare
INSECTS				
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***	
1	Pachakkala/ Vittle	Grass Hoper	*Caelifera* sp.	
2	Vettile	Beetle	*Coleoptera* sp.	
3		Praying Mantis	*Stagmantis religiosa*	
4	Ettukali	Spider		
5	Theneecha	Honey bee	*Apis* sp.	
6	Urumpu	Ant	*Formicidae* sp.	
7	Eecha	House fly	*Musca domestica*	
8	Kadannal	Wasp	*Hymnoptera* sp.	
9	Kaduvakkothuku	Tiger Mosquito	*Aedes albopictus*	
10	Nettiyeppottan	Yellow fever mosquito	*Aedes aegypty*	
BUTTERFLIES				
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***	
1	Vazhanappoompata	Common Mime	*Papilio clytia*	
2	Manjatharakamuthi	Common Emigrant	*Catopsilia pomona*	
3	Viravalan	Tailed Jay	*Graphium longifolia*	
4		Spotted small flat	*Sarangesa purendra*	
5	Pullivalan	Malabar Banded Swallowtail	*Papilio liomedon*	
6	Thakaramuthi	Mottled Emigrant	*Catopsilia pyranthe*	

7	Pulitheyan	Common Leopard	*Phalanta phalanta*
8	Pottuvellatti	Psyche	*Leptosia nina*
9	Neelakkaduva	Blue Tiger	*Tirumala limniace*
10	Manjapappathi	Common Grass Yellow	*Eurema hecabe*
11	Varnaparappan	Tricolour Pied Flat	*Coledenia indrani*
12		Chocolate albatross	*Chocolate albatross*
13	Aranalishalabham	Common Indian Crow	*Euploea core*
14	Chocolate shalabham	Chocolate pancy	*Junonia iphita*
15	Neelakudukka	Common Blue Bottle	*Graphium sarpedon*
16	Payar Neei	Gram Blue	*Euchrysops cnejus*
18	Narakakkali	Common Mormone	*Papilio polytes*
19	Panchanethri	Common Five-ring	*Ypthima baldus*
20	Mayilkkanni	Peacock Pansy	*Junonia almana*
21	Krishnashalabham	Blue Mormon	*Papilio polymnestor*
22	Thavidan	Common Bush Brown	*Mycalesis perseus*
23	Theechirakan	Tawny coster	*Arcaea violae*
24	Oalakkandan	Common Palmfly	*Elymnias hypermnestra*
25	Erikkuthappi	Plain Tiger	*Dancaus chrysippus*
26	Ponthachuttan	Common Sailer	*Neptis hylas*
27	Narakashalabham	Lime Butterfly	*Papilio demoleus*
28	Chenchirakan	Great Orange Tip	*Hebomoia glaucippe*
29	Vilasini	Common Jezebel	*Delias eucharis*

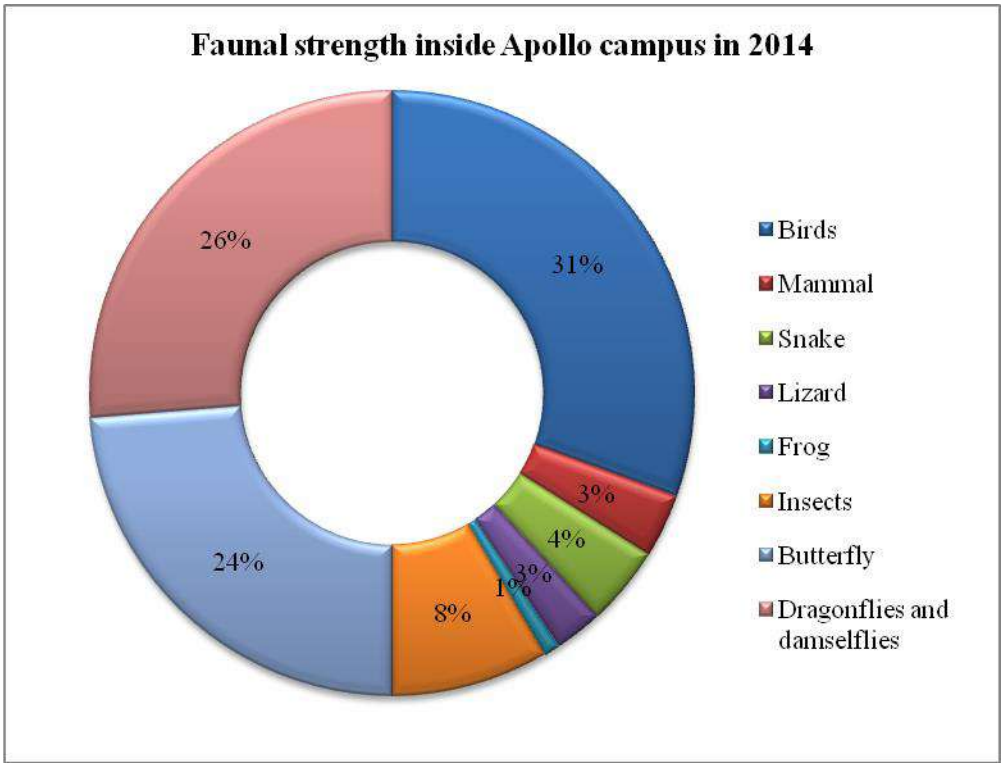
DRAGONFLIES AND DAMSELFLIES

Sl No	Malayalam Name	Common Name	*Scientific Name*
1	Chengali Palthumpi	Blue Bush Dart	*Copera Vittata*
2	Manjakkali palthumpi	Yellow Feather Leg	*Copera marginipes*
3	Ennakkaruppan	Marsh Dancer/Black Marsh Dart	*Onychargia atrocyana*
4	Aruvithumpi	Blue-banded Longtail	*Archibasis oscillans*
5	Neela pulmanikyan	Common Bluetail/Senegal Golden Dartlet	*Ischnura Senegalensis*
6	Thavidan Cherachirakan	Brown Spreadwing	*Lestes Umbrinus*
7	Ilaneeli Poothali	Green Stripped Grass Dartlet/Azure Sprite	*Pseudagrion decorum*
8	Karinchempan mulavalan	Black bambootail/Red Stripped threadtail	*Prodasineura verticalis*
9	Chuttichirakan mulavalan	Black tipped bambootail	*Disparoneura apicalis*
10	Pathi pulchinnan	Kerala wisp/kerala dartlet	*Agriocnemis keralensis*
11	Vella pulchinnan	White wisp/White dartlet	*Agriocnemis pieris*
12	Pokkan kaduva	Fraser's Clubtail	*Acrogomphus fraseri*
13	Thekkan Komaram	Travancore Shadow Dancer	*Idionyx travencorensis*
14	Thurumpan chathan	Vagrant Emperor	*Hemianax ephippiger*

15	Thavittu venneeran	Greater Grey Skimmer	*Brachydiplax chalybea*
16	Theekkarimuthan	Scarlet Marsh Hawk	*Aethriamanta brevipennis*
17	Changathithumpi	Asian Groundling	*Brachythemis contaminata*
18	Swamithumpi	Pied Paddy Skimmer/Pied Parcher/Blackspot Widow	*Neurothemis tullia*
19	Thrivarnnan vyali	Marsh skimmer	*Orthetrum luzonicum*
20	Puzhakkaduva	South River Clubtail	*Goniphidia kodaguensis*
21	Thurumpan rajan	Australasian Dusk Hawker/Dusty Darner	*Anaciaeschna jaspidea*
22	Nattukaduva	Asian Tiger/Tapacious flangetail/Common Clubtail	*Ictinogomphus rapax*
23	Pachavyali	Green Skimmer/ Green Marsh Hawk	*Orthetrum Sabina*
24	Pullivalam cholakkaduva	Long legged clubtail	*Merogomphus longistigma*
25	Shalabhathumpi	Common Picturewing	*Rhyothemis variegata*
26	Makudivalan thumpi	Asian Pintail/Bulb-bodied skimmer/Trumpet-Tail	*Acisoma panorpoides*
27	Karimpan charalmuthi	Light tipped Demon/Black scrub glider	*Indothemis carnatica*
28	Mathil thumpi	Indian Rockdweller/ Granite ghost	*Bradinopyga geminata*
29	Pozhithumpi	Coastal glider/ Cora's pendant/ Estuarine skimmer	*macrodiplax cora*
30	Pulthurumpan	Paddy field parasol/ pale yellow widow/ ruddy meadow skimmer	*Neurothemis intermedia*
31	Vayalthumpi	Oriental Scarlet/ Ruddy Marsh Skimmer	*Crocothemis servilia*

Moreover, the waste water drainage and the effluent settling tank have found to be the major breeding ground for many dragonflies and damselflies, especially *Brachythemis contaminata* which is an indicator of water pollution. Similarly, the water logged inside the tyres stored in the ground breeds a large mosquitoe population, especially vector species like *Aedes albopectus* and *Aedes aegypty*.

Fig. 3.3: Faunal strength inside Apollo campus in 2014

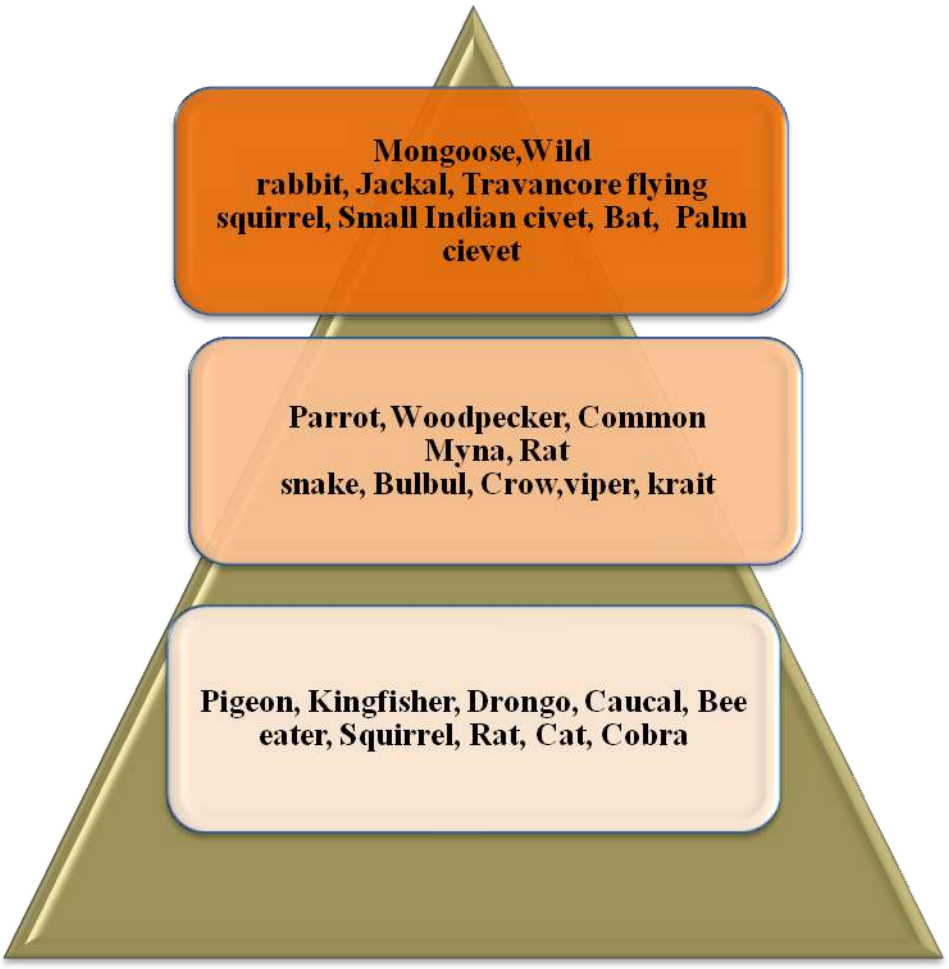


Similar to that of past flora inside Apollo campus, the surveyed employees were enquired about the past status of fauna inside the campus. The overall opinion is that the fauna species has drastically reduced due to the clearing of plant cover for different infrastructure developmental activities. As mentioned before, the compiled list does not fully represent the past status of fauna as a surveyee could only recall whether they have noticed the fauna 3 to 4 decades ago and it also depends on their memory. Therefore, it totally depends on the interest of the surveyee and how much he or she remembers it. However, it can be noticed that the bigger animal species like Jackal, Palm civet, Small Indian civet and Travancore flying squirrel does not exist at the campus at present (Table 3.3 and 3.4). The reason for these species evacuating the company premise is because of the loss of habitat, especially big trees, as many of them depend on trees. Also, increase in the anthropogenic activities also contributes to the disappearance of bigger mammals from Apollo. Therefore, planting native trees and other plants inside the campus is inevitable for enhancing faunal diversity.

Table 3.4: List of fauna at Apollo campus in 1975-85 (Based on company survey)

BIRDS				
Sl No	**Malayalam Name**	**Common Name**	**Scientific Name**	**Category**
1	Mothiravalayan Thatha	Rose-ringed Parakeet	*Pscittakula krameri*	Bird
2	Kakkathampuratti	Black Drongo	*Dicruruss admilis*	Bird
3	Ponman	White Breasted Kingfisher	*Halcyon smyrnensis*	Bird
4	Attakkili	Baya Weaver	*Ploceus philippinus*	Bird
5	Kavathi kakka	House Crow	*corvus splendens*	Bird
6	Chempoth	Greater Coucal	*Centropus sinensis*	Bird
7	Mada Pravu	Blue Rock Pigeon	*Columba elphinstonii*	Bird
8	Kavalam Kili	Common Myna	*Acridotheres tristis*	Bird
9	Irattathalachi	Redwhiskered bulbul	*Pycnonotus jocosus*	Bird
10	Thenkuruvi	Loten's sunbird	*Cinnyris lotenius*	Bird
11	Valiya Ponni Maramkothi	Blackrumbed Flameback	*Dinopium benghalense*	Bird
12	Angadikkuruvi	House Sparrow	*Passer domesticus*	Bird
MAMMALS				
Sl No	**Malayalam Name**	**Common Name**	**Scientific Name**	**Category**
1	Keeri	Common Mongoose	*Herpestes edwardsii*	Mammal
2	Marappatti	Palm civet	*Paradoxurus jerdonii*	Mammal
3	Kurukkan	Jackal	*Canis aureus*	Mammal
4	Malayannan	Travancor Flying Squirrel	*Petinomys fuscocapillus*	Mammal
5	Veetteli	House Rat	*Rattus rattus*	Mammal
6	Annan	Three striped palm Squirrel	*Funambulus palmarum*	Mammal
7	Veruk	Small Indian Civet	*Viverricula indica*	Mammal
8	Vavval	Bat	*Chiroptera*	Mammal
9	Poocha	Domestic cat	*Felis catus*	Mammal
REPTILES				
Sl No	**Malayalam Name**	**Common Name**	**Scientific Name**	**Category**
1	Moorkhan	Indian Spectacled Cobra	*Naja naja*	Snake
2	Shankuvarayan/Vellikkettan	Krait	*Bungarus coeruleus*	Snake
3	Anali/Chenathandan	Russel's Viper	*Daboiea russeli*	Snake
4	Chera	Rat snake	*Ptyas mucosa*	Snake

Figure 3.4: Changing pattern of selected flora inside campus between 1975-85 and 2014



According to the responses received from the company survey, Fig. 3.4 has been prepared which indicate the severity of the impact on the population of fauna species. The animals that are in the pointed end of the pyramid are the severely affected ones such that they are disappeared from the campus. As mentioned before, the increasing infrastructure development and consequent habitat loss resulted in their evacuation. The second box indicates the organisms that are moderately affected; hence, their number has reduced drastically. On the other hand, the lowest box indicates the fauna species that are not affected at all or the ones whose population increased inside the campus.

3.1.2. Biodiversity outside Apollo campus

The biodiversity indicates the soundness of ecosystem and ecosystem services. As Apollo Tyres is the only large company in the area, the company may have significant impacts on the biodiversity of the surrounding areas. During the field visits, a good biodiversity strength and abundance was noticed in the study area. As the households in the area are heavily depended on the ecosystem services, somewhat the soundness of ecosystem is maintained. Similar to the previous sections, flora and fauna are categorized separately.

3.1.2.1. Flora

Through the biodiversity status assessment in seven sample spots covering 45 sample units in the study area, 139 flora species were identified. This floral wealth consists of 14 creeper and climber, 4 grass, 39 herbs, 24 shrubs and 58 tree species (Table 3.5). The distinguishing feature of the flora of the area surrounding Apollo campus is that the proportion of exotic species is below 10%, indicating the potential of the outside flora to support native fauna. Therefore, in comparison to the inside campus, the surrounding areas have a much better native floral diversity.

Table 3.5: List of flora in the surrounding areas of Apollo Campus in 2014

Sl No	Malayalam Name	Common Name	*Scientific Name*	Category
1	Akashavellari	Giant Passion Fruit	*Passiflora quadrangularis*	Climber
2	Paval	Bitter Gourd	*Momordica charantia*	Climber
3	Ever green	Ever green	*Asparagus racemosus*	Climber
4	Kachil	Asiatic Yam	*Dioscorea alata*	Climber
5	Koval	Ivy gourd	*Coccinia grandis*	Climber
6	Money plant	Money plant	*Epipremnum aureum*	Climber
7	Nakshathramulla	Cypress vine	*Ipomoea quamoclit*	Climber
8	Payar	Yard Long Beans	*Vigna unguiculata sesquipedalis*	Climber
9	Kurumulaku	Pepper	*Piper nigrum*	Climber
10	Shankhupushpam	Butterfly pea	*Clitoria ternatea*	Climber
11	Padavalam	Snake gaurd	*Trichosanthes cucumerina*	Climber
12	Bridal Boquet	Bridal Boquet	*Plumeria pudica*	Climber
13	Shathavari	Wild asparagus	*Asparagus recemosus Wild.*	Creeper
14	Kumbalam	White ash guard	*Benincasa hispida*	Creeper
15	Mula	Bamboo	*Bambuseae*	Grass
16	Green grass	Maiden grass	*Miscanthus sinensus 'Gracillimus'*	Grass
17	Pothappullu	Potha grass	*Themeda cymbaria Hack*	Grass
18	White grass	Variegated Silver Grass	*Miscanthus sinensis*	Grass
19	Anthurium	Anthurium	*Anthurium andraeanum*	Herb
20	Bandi	Marigold	*Calendula officianalis*	Herb
21	Thulsi	Basil	*Oscimum sanctum*	Herb
22	Balsam	Balsam	*Impatiens balsamina*	Herb
23	Vazhuthana	Brinjal	*Solanum melongena*	Herb
24	Communist pacha	Eupatorium	*Chromolaena odorata King*	Herb
25	Dahlia	Dahlia	*Dahlia hortensis*	Herb
26	Euphorbia	Euphorbia	*Euphorbia milii*	Herb
27	Mulaku	Ghost chilli	*Capsicum annum*	Herb
28	Inji	Ginger	*Cingiber officinelrex*	Herb

29	Pachamulaku	Green chilly	*Capsicum annum*	Herb
30	Cheera	green spinach	*Amaranthus sp.*	Herb
31	Vaazhachedi	Heliconia	*Heliconia rostrata*	Herb
32	Jamanthi	Marigold	*Chrysanthemum indicum*	Herb
33	Mulla	Jasmine	*Jasminum grandiflorum*	Herb
34	kammal poovu	Singapore Daizy	*Melambodium leuchanthum*	Herb
35	kanakamparam	Fire cracker flower	*Crossandra infundibuliformi*	Herb
36	koorkka	Chinese potato	*Solenostemon rotundifolius*	Herb
37	kuppacheera	Spinach	*Amaranthus sp.*	Herb
38	Venda	Lady's Finger	*Abelmoschus esculentus*	Herb
39	lilly	Lilly	*Lilium*	Herb
40	Malli	Coriander	*Coriandrum sativum*	Herb
41	Mysore cheera	Spinach	*Amaranthus sp.*	Herb
42	Naalumani chedi	Table Rose	*Mirabilis Jalapa*	Herb
43	Nishaganthi	Queen of the night	*Epiphyllum oxypetalum*	Herb
44	Orchids	Orchids	*Orchidaceae*	Herb
45	Nellu	Paddy	*Oryza sativa*	Herb
46	Panikkoorkka	Indian Rock foil	*Plectranthus amboinicus*	Herb
47	Cheera	Red spinach	*Amaranthus sp.*	Herb
48	Thiruhridya chedi	Sacred heart	*Lamiaceae sp.*	Herb
49	Seeniya	Zinnia	*Zinnia peruviana*	Herb
50	Shavanari poovu	Vinca	*Catharanthus Roseus*	Herb
51	Chembu	Taro	*Colocasia esculenta*	Herb
52	Thakkali	Tomato	*Solanum lycopersicum*	Herb
53	Thottavadi	Touch me not	*Mimosa pudica*	Herb
54	Manjal	Turmeric	*Curcuma longa*	Herb
55	Vadamulla	Globe amaranth	*Gomphrena globosa*	Herb
56	Chena	Yam	*Amorphophallus cam panulatus*	Herb
57	kadali	Malabar Black Mouth	*Melastoma malabathricum*	Herb
58	Kolambi	Alamanda	*Thevasia iverifolia*	Shrub
59	Vaazha	Plantain	*Musa sp.*	Shrub
60	Kadalasupoovu	Bougainvillea	*Bougainvillea glabra*	Shrub
61	Kallimulchedi	Cactus	*Cactaceae*	Shrub
62	Chethi	Ixora	*Ixora coccinia*	Shrub
63	Kappi	Coffee	*Coffee arabica linn*	Shrub
64	Garden croton	Garden croton	*Codiaeum variegatum*	Shrub
65	Kariveppila	Curry leaves	*Murraya koenigii*	Shrub
66	Erikku	Giant milkweed	*Calotropis gigantia*	Shrub
67	Finger Palm	Finger Palm	*Rhapis multifida*	Shrub
68	Gandharajan	White emetic nut	*Gardenia gummifera Linn*	Shrub
69	Mylanchi	Henna	*Lawsonia inermisLinn.*	Shrub

70	Chembarathi	Hibiscus	*Hibiscus roosasinensis*	Shrub
71	Kongini	Lantana camara	*Linum usitatissimum*	Shrub
72	Kozhivalan	mountain cypress	*Celosia nodiflora*	Shrub
73	Kudampuli	Malabar Black Tamarind	*Garcinia cambogia*	Shrub
74	Mussanda	Mussanda	*Cestrum nocternum*	Shrub
75	Mysore mailanchi		*Lawsonia inermisLinn.*	Shrub
76	Nanthyarvattam	East India Rosebay	*Tabernaemontana divaricata*	Shrub
77	Neela amari	Indian indigo	*Indigofera tinctora*	Shrub
78	Parijatham	Night-flowering Jasmine	*Nyctanthes arbor-tristis*	Shrub
79	Rosa	Rose	*Rosa sp.*	Shrub
80	Kappa	Tapioca	*Manihot esculenta*	Shrub
81	Tulsi	Basil	*Ocimum basilicum*	Shrub
82	Cheru narakom	Lemon	*Citrus aurantifolia*	Tree
83	Bottle brush	Bottle brush	*Callistemon lanceolatus*	Tree
84	Chempakam	Golenchi	*Plumeria rubra acutifolia*	Tree
85	Arali	Nerium	*Nerium oleander*	Tree
86	Mantharam	White orchid tree	*Bauhinia tomentosa*	Tree
87	Jathi	Nut mug tree	*Myristica fragrans*	Tree
88	Panineer champa	Rose Apple	*Syzygium jambolanum*	Tree
89	Cypress	Golden Cyprus	*Cupressus sp.*	Tree
90	Irimpan puli	Bilimbi	*Averrhoa bilimbi*	Tree
91	Thonti	Indian gum tragacanth	*Sterculia urens*	Tree
92	Aavanakku	Castor oil plant	*Ricinus communis Linn.*	Tree
93	Acasia	Acasia	*Acasia acasia*	Tree
94	Aryavep	Neem	*Azadirachta indica*	Tree
95	Arana maram	Indian Mast Tree	*Polyalthia longifolia*	Tree
96	Kamuk	Arecanut	*Areca catechu*	Tree
97	Arayal	Banyan tree	*Ficus religiosa*	Tree
98	Kashumaavu	Cashew tree	*Anacardium occidentale*	Tree
99	Thakara	Wild Senna	*Cassia tora L.*	Tree
100	Champa	Rose Apple	*Syzygium Samarangense*	Tree
101	Choondappana	Fishtail Palm	*Caryota urens*	Tree
102	Christmas tree	Pine tree	*Pseudotsuga menzietii'*	Tree
103	Thengu	Coconut tree	*Cocos nucifera*	Tree
104	Aatha	Custard apple	*Anona squamosa*	Tree
105	Cypress	Pencil pine	*Cupressus sempervirens*	Tree
106	Dividivi	Dividivi	*Caesalpinia coriaria*	Tree
107	Muringa	Drum stick plant	*Moringa oleifera*	Tree
108	Nelli	Gooseberry	*Phyllanthus emblica*	Tree
109	Pera	Guava	*Psidium gavjava*	Tree
110	Vaaka	Gulmohar	*Delonix regia*	Tree

111	Ilanji	Bullet wood tree	*Mimusops elengi*	Tree
112	Ilavu	Red Cotton Tree	*Bombax ceiba L.*	Tree
113	Plavu	Jack Fruit Tree	*Artocarpus heterophyllus*	Tree
114	kambili naranga	Pomelo	*Citrus maxima*	Tree
115	kanikkonna	Indian lebornam	*Cassia fistula*	Tree
116	Karuva	Cinnamon	*Cinnamomum verum*	Tree
117	kudappana	Palm tree	*Borassus sp.*	Tree
118	Manchadi	Indian coral nut tree	*Adenanthera pavonina*	Tree
119	Mavu	Mango tree	*Mangifera indica*	Tree
120	Murikku	Indian coral tree	*Erythrina variegate*	Tree
121	Panji maram	Cotton plant	*Boombax seiba*	Tree
122	Kappalam	Pappaya	*Carica papaya*	Tree
123	Weeping fig	Golden fig	*Ficus benjamina*	Tree
124	Mathala naranga	Pomegranate	*Punica granatum*	Tree
125	Potama	Indian charcoal tree	*Trema orientalis*	Tree
126	Mazhamaram	Rain Tree	*Albizia saman*	Tree
127	Rambutan	Rambutan	*Nephelium lappaceum*	Tree
128	Red palm	Red palm	*Acanthophoenix rubra*	Tree
129	Peringalam	Clerodendrum	*Clerodendrum infortunatum*	Tree
130	Rubber	Rubber	*Hevea brasiliensis*	Tree
131	Sappotta	Sapodilla	*Manilkara zapota*	Tree
132	Sarvasuganthi	Allspice	*Pimenta dioica*	Tree
133	Valan puli	Tamarind	*Tamarindus indica*	Tree
134	Thekku	Teak	*Tectona grandis*	Tree
135	Thuja	Thuja	*Thuja occidentalis*	Tree
136	Vatta	Gum Plant	*Macaronga indica*	Tree
137	vellachampa	Rose apple	*Syzygium malaccense*	Tree
138	Yakshi pala	Devil tree	*Alstonia scholaris*	Tree
139	Karash/ Otiyan-maram	Indian Ash Tree	*Lannea coromandelica*	Tree

Also, the baseline data prepared through the discussion with the surveyed community members is given in Table 3.6. Collectively, the respondents were able to recall 45 flora species that were present in the past. The compiled list is also not a good indicator of the total flora present in the time period 1975-85 because a closer look indicates that more than 40 among them were food crops that people of the community heavily depended on. It points out that, people could only recall the crops of food dependency, and other trees and plants are not included in the list.

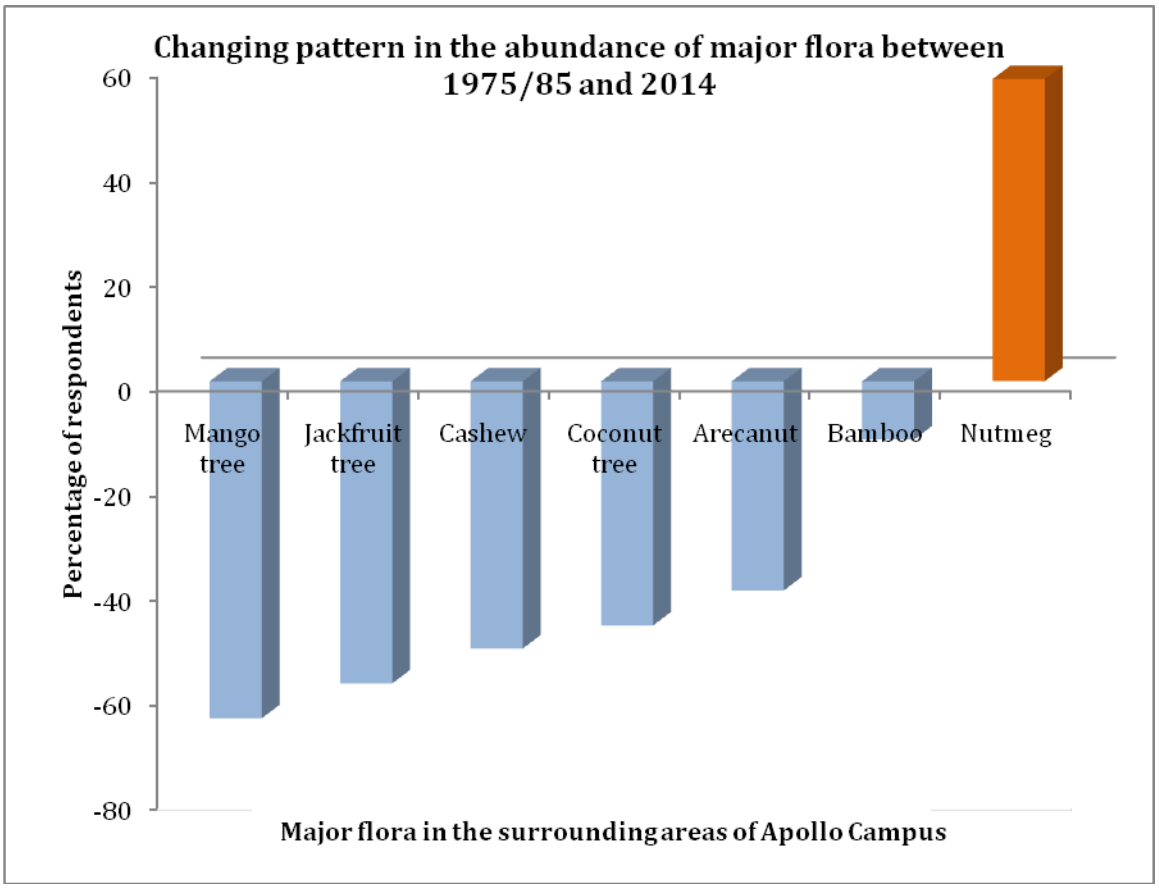
Table 3.6: List of flora in the surrounding areas of Apollo campus in 1975-85 (Based on historical survey)

Sl No	Local Name	English Name	Scientific Name	Category
1	Kurumulaku	Black pepper	*Piper nigrum*	Climber
2	Payar	Peas	Vigna sp.	Climber
3	Paval	Bitter guard	*Momordica charantia*	Climber
4	Mathan	Pumpkin	*Cucurbita maxima*	Climber
5	Kachil	Greater yam	*Dioscorea alata*	Climber
6	Padavalam	Snake guard	*Trichosanthes cucumerina*	Climber
7	Cheenikkizhangu	Sweet potato	*Ipomoea batatas*	Climber
8	Koval	Ivy guard	*Coccinia grandis*	Climber
9	Kumbalam	White ash guard	*Benincasa hispida*	Creeper
10	Vellari	Cucumber	*Cucumis sativus*	Creeper
11	Illi	Bamboo	*Bambuseae*	Grass
12	Pullu	Raggy	Poaceae	Grass
13	Vazha	Banana	Musa sp.	Herb
14	Chena	Yam	*Amorphophallus cam panulatus*	Herb
15	Chempu	Taro	*Colocasia esculenta*	Herb
16	Venda	Ladies finger	*Abelmoschus esculentus*	Herb
17	Vazhuthana	Brinjal	*Solanum melongena*	Herb
18	Inchi	Ginger	*Zingiber officinale*	Herb
19	Pachamulaku	Green chilly	*Capsicum annum*	Herb
20	Nellu	Rice	*Oryza sativa*	Herb
21	Cholam	Corn	Zea mays	Herb
22	Nilakkadala	Ground nut	Arachis hypogaea	Herb
23	Manjal	Turmeric	*Curcuma longa*	Herb
24	Cheera	Spinach	*Amaranthus sp.*	Herb
25	Kokko	Cocoa	Theobroma cacao	Shrub
26	Chemparathi	Hibiscus	*Hibiscus rosasinensis*	Shrub
27	Kariveppu	Curry leaf	*Murraya koenigii*	Shrub
28	Kappa	Tapioca	*Manihot esculenta*	Shrub
29	Rubber	Rubber	*Hevea brasiliensis*	Tree
30	Mavu	Mango tree	*Mangifera indica*	Tree
31	Plavu	Jackfruit tree	*Artocarpus heterophyllus*	Tree
32	Kashumavu	Cashew	*Anacardium oxydental lin*	Tree
33	Thekku	Teak	*Tectona grandis*	Tree
34	Kamuku	Arecanut	*Areca catechu*	Tree
35	Acasia	Acacia	Acacia sp.	Tree
36	Eucalyptus	Eucalyptus	*Eucalyptus globules*	Tree
37	Valan puli	Tamarind	*Tamarindus indica*	Tree
38	Eetti	Indian Rose Wood	*Dalbergia latifolia*	Tree

39	Kattadimaram	Pine	*Pinus*	Tree
40	Ariveppu	Neem	*Azadirachta indica*	Tree
41	Atha	Custard apple	*Annona muricata*	Tree
42	Pera	Guava	*Psidium guajava*	Tree
43	Narakam	Lemon	*Citrus aurantifolia*	Tree
44	Jathi	Nutmeg	*Myristica fragrans*	Tree
45	Muringa	Drum stick	*Moringa oleifera*	Tree

Also, the samples were asked about the changing pattern in the abundance of selected tree species of the area and the result is shown in Fig. 3.5. The negative y-axis consists of tree species that were very common in the past in the study area, but drastically decreased over the recent decades. On the other hand, positive y-axis displays the plant species that have spontaneously increased in the area in the near decades.

Figure 3.5: Changing pattern in the abundance of selected flora in the surrounding areas of Apollo Tyres between 1975-85 and 2014 (Based on historical data)



As Fig. 3.5 points out, about 50% of the samples commented that mango tree, jackfruit tree, cashew and coconut tree were the major trees of the area and their number has decreased tremendously. One of the key features of the decreased species is that except for cashew and areca nut, people of the past heavily depended on the rest of the decreased plant species for

the purpose of their sustenance. Since the area was financially backward 40 years ago, families had mostly depended on the food crops or trees grown in their own yards. A change in the dependency on these crops resulted due to the simultaneous occurring of three factors; changing occupational pattern, emergence of consumerist mentality and development.
First of all, increasing awareness about education resulted in the increasing number of educated people in the area. These educated people became employed in various private and government institutions and companies like Apollo Tyres, and the income flow to the area and individual families increased. Due to the lack of time for the employed people and the improved financial condition, people started to buy more food items from the market. Thus, change in occupation pattern coupled with change in the lifestyles of people of the area lead to the second factor which is the emergence consumerist mentality.

A shift towards a consumerist culture might have resulted in the rise of market, and improved market lead to the high demand for cash crops. Thus, the priority has changed from cultivating trees of food crop to cash crops. Thus, cocoa and nutmeg were introduced to the area and the subsequent widespread cultivation. However, demand for cocoa has reduced later in the market; hence, it is no longer a major crop in the study area. On the other hand, nutmeg remains as the major crop in the area as it still has high market value. Though nutmeg maintains the green cover in the area, it is a plant that demand more care than any other species. Its high requirement for light, water and space eliminates other species from the area.

Third and the most important reason for the reduction in the number of common trees is the infrastructural development occurred because of NH and the increased job opportunity due to the execution of Apollo Tyres Limited in the area. Due to the development and job opportunities, town settlement to the area increased, thereby rocketing demand and price for the land. Thus, land owners started to divide and sell the plots to the new comers for building houses. During the house construction, the trees were cut down due to lack of space and to get timber. Therefore, the number of native trees in the area started to reduce rapidly. Though mango tree, jackfruit tree, coconut tree and areca nut are less in number in comparison to the past, they still exist in the area. However, cashew and bamboo have almost completely washed out from the area.

3.1.2.2. Fauna

The fauna of the surrounding areas of Apollo Tyres was found out through direct observation and discussion with surveyed community members. At present, there are about 55 species recorded, out of which about 26 are birds and 12 are bigger animals (Table 3.7). A list of fauna present in the past that the respondents could remember is given in Table 3.8 though it is not complete as they cannot recall every single one of the animals present at the time. However, it could be comprehended that there are bigger sized animals in the outside both in the past and present due to the availability of food and shelter. This clearly reflects the impact on the faunal diversity due to the floral diversity.

Table 3.7: List of fauna present in the surrounding area of Apollo campus in 2014 (Based on direct observation and historical survey)

BIRDS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Mothiravalayan Thatha	Rose-ringed Parakeet	*Pscittakula krameri*
2	Kakkathampuratti	Black Drongo	*Dicruruss admilis*
3	Meenkothi chathan	White Breasted Kingfisher	*Halcyon smyrnensis*
4	Olenjali	Rufous Tree Pie	*Dendrocitta vagabunda*
5	Kavathi kakka	House Crow	*corvus splendens*
6	Moonga	Mottled Wood Owl	*Strix ocellata*
7	Mada Pravu	Blue Rock Pigeon	*Columba elphinstonii*
8	Kavalam Kili	Common Myna	*Acridotheres tristis*
9	Perumundi	Great Egret	*Ardea alba*
10	Chinnamundi	Little Egret	*Egretta garzetta*
11	Kula Mundi	Indian Pond Heron	*Ardeola grayii*
12	Chempoth	Greater Coucal	*Centropus sinensis*
13	Chenkannan theepporichathan	Water cock/Kora	*Gallicrex cinerea*
14	Kutturuvan	White Cheeked Barbet	*Megalaima virdis*
15	Irattathalachi	Redwhiskered bulbul	*Pycnonotus jocosus*
16	Thenkuruvi	Loten's sunbird	*Cinnyris lotenius*
17	Mayil	Indian Peafowl	*Pavo cristatus*
18	Kariyilakkili	Jungle babbler	*Turdoides striatus*
19	Kuyil	Asian Koel	*Eudynamys scolopacea*
20	Nattu Maramkothi	Blackrumped Flameback	*Dinopium benghalense*
21	Mannathi	Oriental Magpie-Robbin	*Copsychus saularis*
22	Karikilappida	Grey babbler	*Turdoides striatus*
23	Angadikkuruvi	House Sparrow	*Passer domesticus*
24	Chakkipparunthu	Pariah Kite	*Milvus migrans*
25	Tharavu	Domestic Duck	*Anas Sp.*
26	Kozhi	Domestic fowl	*Gallus domesticus*
MAMMALS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Patti	Dog	*Canis lupus*
2	Pashu	Cow	*Bos sp.*
3	Poocha	Domestic cat	*Felis catus*
4	Aadu	Domestic Goat	*Capra aegagrus*
5	Eruma	Buffalo	*Bubalus bubalis*
6	Kattumuyal	Blacknaped Hare	*Lepus nigricollis*
7	Keeri	Common Mongoose	*Herpestes edwardsii*
8	Kattu poocha	Jungle cat	*Felis chaus*
9	Kurukkan	Jackal	*Canis aureus*
10	Kattupanni	Wild boar	*Sus scrofa*
11	Veetteli	House Rat	*Rattus rattus*
12	Annan	Three striped palm Squirrel	*Funambulus palmarum*

REPTILES			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Moorkhan	Indian Spectacled Cobra	*Naja naja*
2	Peumpampu	Indian Python	*Python molurus*
3	Anali/Chenathandan	Russel's Viper	*Daboiea russeli*
4	Shankuvarayan/Vellikkettan	Krait	*Bungarus coeruleus*
5	Valavalappan	Indian Wolf Snake	*Lycodon aulicus*
6	Neerkkoli	Checkered Keel Back	*Natrix sp.*
7	Chera	Rat snake	*Ptyas mucosa*
AMPHIBIANS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Marathavala	Golden Treefrog	*Rana aurantiaca*
INSECTS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Vazhanappoompata	Common Mime	*Papilio clytia*
2	Manjatharakamuthi	Common Emigrant	*Catopsilia pomona*
3	Thakaramuthi	Mottled Emigrant	*Catopsilia pyranthe*
4	Pulitheyan	Common Leopard	*Phalanta phalanta*
5	Pottuvellatti	Psyche	*Leptosia nina*
6	Payar Neei	Gram Blue	*Euchrysops cnejus*
7	Narakakkali	Common Mormone	*Papilio polytes*
8	Thavidan	Common Bush Brown	*Mycalesis perseus*
9	Theechirakan	Tawny coster	*Arcaea violae*
BIRDS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Mothiravalayan Thatha	Rose-ringed Parakeet	*Pscittakula krameri*
2	Kakkathampuratti	Black Drongo	*Dicruruss admilis*
3	Meenkothi chathan	White Breasted Kingfisher	*Halcyon smyrnensis*
4	Olenjali	Rufous Tree Pie	*Dendrocitta vagabunda*
5	Kavathi kakka	House Crow	*corvus splendens*
6	Moonga	Mottled Wood Owl	*Strix ocellata*
7	Mada Pravu	Blue Rock Pigeon	*Columba elphinstonii*
8	Kavalam Kili	Common Myna	*Acridotheres tristis*
9	Perumundi	Great Egret	*Ardea alba*
10	Chinnamundi	Little Egret	*Egretta garzetta*
11	Kula Mundi	Indian Pond Heron	*Ardeola grayii*
12	Chempoth	Greater Coucal	*Centropus sinensis*
13	Chenkannan theepporichathan	Water cock/Kora	*Gallicrex cinerea*
14	Kutturuvan	White Cheeked Barbet	*Megalaima virdis*
15	Irattathalachi	Redwhiskered bulbul	*Pycnonotus jocosus*
16	Thenkuruvi	Loten's sunbird	*Cinnyris lotenius*
17	Mayil	Indian Peafowl	*Pavo cristatus*
18	Kariyilakkili	Jungle babbler	*Turdoides striatus*
19	Kuyil	Asian Koel	*Eudynamys scolopacea*
20	Nattu Maramkothi	Blackrumped Flameback	*Dinopium benghalense*

21	Mannathi	Oriental Magpie-Robbin	*Copsychus saularis*
22	Karikilappida	Grey babbler	*Turdoides striatus*
23	Angadikkuruvi	House Sparrow	*Passer domesticus*
24	Chakkipparunthu	Pariah Kite	*Milvus migrans*
25	Tharavu	Domestic Duck	*Anas Sp.*
26	Kozhi	Domestic fowl	*Gallus domesticus*
MAMMALS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Patti	Dog	*Canis lupus*
2	Pashu	Cow	*Bos sp.*
3	Poocha	Domestic cat	*Felis catus*
4	Aadu	Domestic Goat	*Capra aegagrus*
5	Eruma	Buffalo	*Bubalus bubalis*
6	Kattumuyal	Blacknaped Hare	*Lepus nigricollis*
7	Keeri	Common Mongoose	*Herpestes edwardsii*
8	Kattu poocha	Jungle cat	*Felis chaus*
9	Kurukkan	Jackal	*Canis aureus*
10	Kattupanni	Wild boar	*Sus scrofa*
11	Veetteli	House Rat	*Rattus rattus*
12	Annan	Three striped palm Squirrel	*Funambulus palmarum*
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2	Peumpampu	Indian Python	*Python molurus*
3	Anali/Chenathandan	Russel's Viper	*Daboiea russeli*
4	Shankuvarayan/Vellikkettan	Krait	*Bungarus coeruleus*
5	Valavalappan	Indian Wolf Snake	*Lycodon aulicus*
6	Neerkkoli	Checkered Keel Back	*Natrix sp.*
7	Chera	Rat snake	*Ptyas mucosa*
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4	Pulitheyan	Common Leopard	*Phalanta phalanta*
5	Pottuvellatti	Psyche	*Leptosia nina*
6	Payar Neei	Gram Blue	*Euchrysops cnejus*
7	Narakakkali	Common Mormone	*Papilio polytes*
8	Thavidan	Common Bush Brown	*Mycalesis perseus*
9	Theechirakan	Tawny coster	*Arcaea violae*

Table 3.8: List of fauna in the surrounding areas of Apollo campus in 1975-85 (Adapted from historical survey)

BIRDS			
Sl No	**Malayalam Name**	**Common Name**	**Scientific Name**
1	Mothiravalayan Thatha	Rose-ringed Parakeet	*Pscittakula krameri*
2	Kakkathampuratti	Black Drongo	*Dicruruss admilis*
3	Ponman	White Breasted Kingfisher	*Halcyon smyrnensis*
4	Olenjali	Rufous Tree Pie	*Dendrocitta vagabunda*
5	Kavathi kakka	House Crow	*corvus splendens*
6	Moonga	Mottled Wood Owl	*Strix ocellata*
7	Mada Pravu	Blue Rock Pigeon	*Columba elphinstonii*
8	Kavalam Kili	Common Myna	*Acridotheres tristis*
9	Perumundi	Great Egret	*Ardea alba*
10	Cherumundi	Little Egret	*Egretta garzetta*
11	Kula Mundi	Indian Pond Heron	*Ardeola grayii*
12	Chempoth	Greater Coucal	*Centropus sinensis*
13	Chenkannan theepporichathan	Water cock/Kora	*Gallicrex cinerea*
14	Kutturuvan	White Cheeked Barbet	*Megalaima virdis*
15	Irattathalachi	Redwhiskered bulbul	*Pycnonotus jocosus*
16	Thenkuruvi	Loten's sunbird	*Cinnyris lotenius*
17	Mayil	Indian Peafowl	*Pavo cristatus*
18	Kariyilakkili	Grey babbler	*Turdoides striatus*
19	Kuyil	Asian Koel	*Eudynamys scolopacea*
20	Valiya Ponni Maramkothi	Blackrumped Flameback	*Dinopium benghalense*
21	Mannathi	Magpie-Robbin	*Copsychus saularis*
22	Karikilappida	Grey babbler	*Turdoides striatus*
23	Angadikkuruvi	House Sparrow	*Passer domesticus*
24	Chakkipparunthu	Pariah Kite	*Milvus migrans*
25	Tharavu	Duck	*Anas Sp.*
26	Kozhi	Domestic chicken	*Gallus domesticus*
MAMMALS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
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2	Pashu	Cow	*Bos sp.*
3	Poocha	Domestic cat	*Felis catus*
4	Aadu	Domestic Goat	*Capra aegagrus*
5	Eruma	Buffalo	*Bubalus bubalis*
6	Kattumuyal	Black naped hare	Lepus nigricollis
7	Keeri	Common Mongoose	*Herpestes edwardsii*
8	Kattu poocha	Jungle cat	*Felis chaus*
9	Kurukkan	Jackal	*Canis aureus*
10	Kattupanni	Wild boar	*Sus scrofa*
11	Veetteli	House Rat	*Rattus rattus*
12	Annan	Three striped palm Squirrel	*Funambulus palmarum*

REPTILES			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
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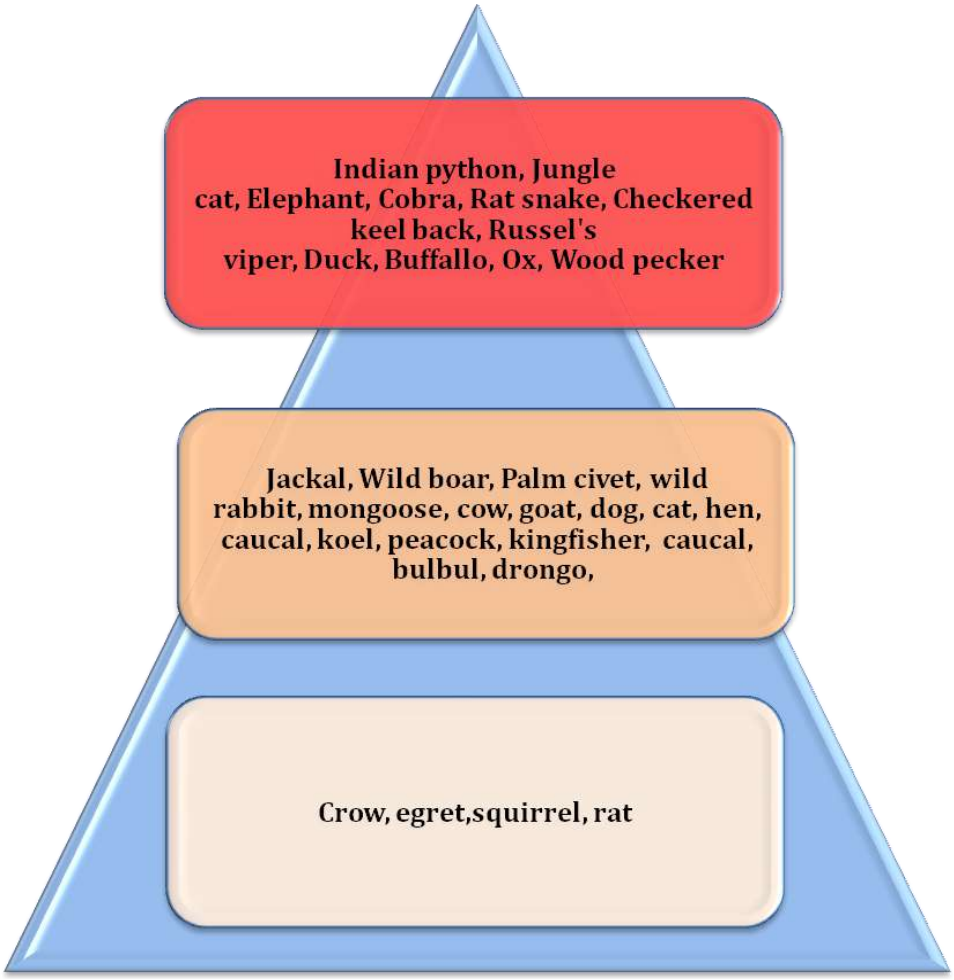
3	Anali/Chenathandan	Russel's Viper	*Daboiea russeli*
4	Shankuvarayan/Vellikkettan	Krait	*Bungarus coeruleus*
5	Valavalappan	Indian Wolf Snake	*Lycodon aulicus*
6	Neerkkoli	Checkered Keel Back	*Natrix sp.*
7	Chera	Rat snake	*Ptyas mucosa*
AMPHIBIANS			
Sl No	**Malayalam Name**	**Common Name**	***Scientific Name***
1	Marathavala	Golden Treefrog	*Rana aurantiaca*

Figure 3.6: Changing pattern in the faunal diversity at the surrounding areas of Apollo campus from 1975/85 to 2014 (Based on historical survey)



An assessment of the changing pattern of faunal biodiversity in the surrounding areas of Apollo Tyres was done and the result is shown in Fig 3.6. The most severely affected fauna are given in the upper part and least severely affected are given in the lower part of the pyramid.

Fig 3.6 indicates that bigger animals like elephants are completely evacuated from the area. Though moderately affected, some of the wild animals still exist in the campus. The reason for the reduction in the population of these animals is the loss of habitat. Since Apollo campus and the surrounding areas were rubber estates and sparsely populated scrub jungles in the past, frequent sighting of jackal, palm civet and wild rabbits and occasional sightings of elephants and wild boars occurred in the area. Moreover, the area had good bird diversity as well. Additionally, most houses were heavily depedent on domestic animals like cow, goat, buffalo and ox. The change in the lifestyle of the people from high rate of dependency to less dependency on agriculture resulted in reduction of diversity and abundance of farm animals in the area. Also, cutting down trees and jungles resulted in the loss of habitat of wild animals in the area and they might have been forced to shift to nearby forest areas like Kanakamala.

3.2. Drivers of Change in Biodiversity

As part of assessing the impacts on biodiversity in 2.5 km radius of Apollo campus, drivers of changes in biodiversity and ecosystem were considered. These drivers could interact with the biodiversity of the study area spatially and temporally, and could lead to biodiversity loss or significant alterations in the ecosystem pattern. In order to clearly assess the impact of various drivers in the loss of biodiversity, these have been categorized into direct and indirect drivers of change.

3.2.1. Direct Drivers of Change

The direct drivers of change are the human induced activities that were initiated with the aim of improving the quality of life, but eventually resulted in affecting the biodiversity of the area negatively (MEPA, Undated). These explicitly influence the biodiversity and result in biodiversity loss and interfere with the ecosystem services (Treat and Callahan, 2008). In the context of this study, the direct drivers of change are land use pattern, infrastructure developments, industrialization and pollution.

3.2.1.1. Land Use Pattern

Land use pattern is an important factor that elicits significant changes in biodiversity in any area. For instance, change in agricultural crop lands to township will result in the habitat loss of the native plant and animal species that were dependent on the agriculture for their food and shelter. Also, it may or may not introduce new species that co-habit with humans in populated areas. Since Apollo Tyres had taken over a significant land mass in order to execute its mother plant in Perambra, it is very crucial to study the change in land use pattern and associated habitat loss occurred in the area in the last four decades.

The change in land use and land cover pattern of the surrounding area of Apollo Tyres was studied by comparing the GIS map of 5 km radius area in 1967 and 2011 (Fig.3.7, 3.8 and 3.9 and Table 3.9). Apart from mixed crop with housing area occupying more than 80% of the land area in both the cases, some distinguishing features were noticed. Firstly, total area covered by crop land has become half in size. Though crop lands still exist in the area, almost 100% of the agricultural crop lands of the past have disappeared and the existing crop lands

are newly emerged ones. However, the newly emerged croplands are not of the same kind as of the past. For example, when almost all of the old crop lands consisted of rice and vegetable cultivation, most of the existing croplands and mixed agriculture with housing area consist of cash crops like nutmeg, coconut, rubber and some vegetables. Therefore, it could have huge impact on the diversity and abundance of native flora and fauna by changing the availability and type of food. Secondly, the area consisted of zero industrial area in the past, whereas the establishment of Apollo campus added up this new category to the area. Also, it can be clearly seen from Table 11 that mixed cropping with housing area has increased, indicating increase in the human settlement in the area. Similarly, areas of town settlement have increased in comparison to the past and it also corraborate the fact that human settlement increased. One of the reasons for the increase in the human settlement in the area could be the relocation by Apollo employees. Therefore, Apollo directly impacts the biodiversity of the buffer zone. Moreover, decrease in the area occupied by the water bodies also points out a possible decrease in the biodiversity richness and abundance as water bodies play a major role in the existence of organisms.

Fig. 3.7: Land use pattern of the study area in 1967 (Adapted through GIS maping)

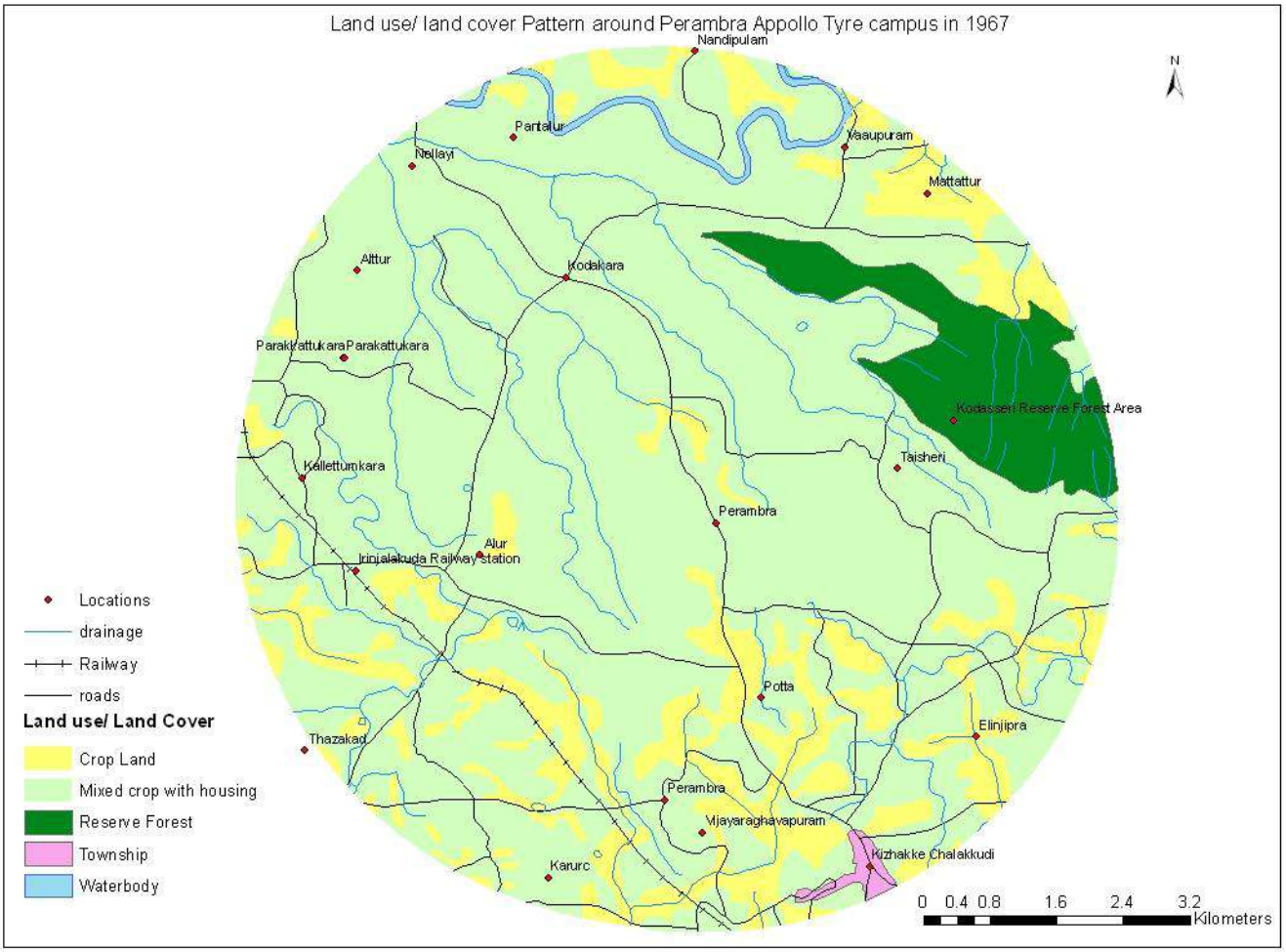


Fig. 3.8: Land use pattern in the study area in 2014 (Adapted from GIS mapping)

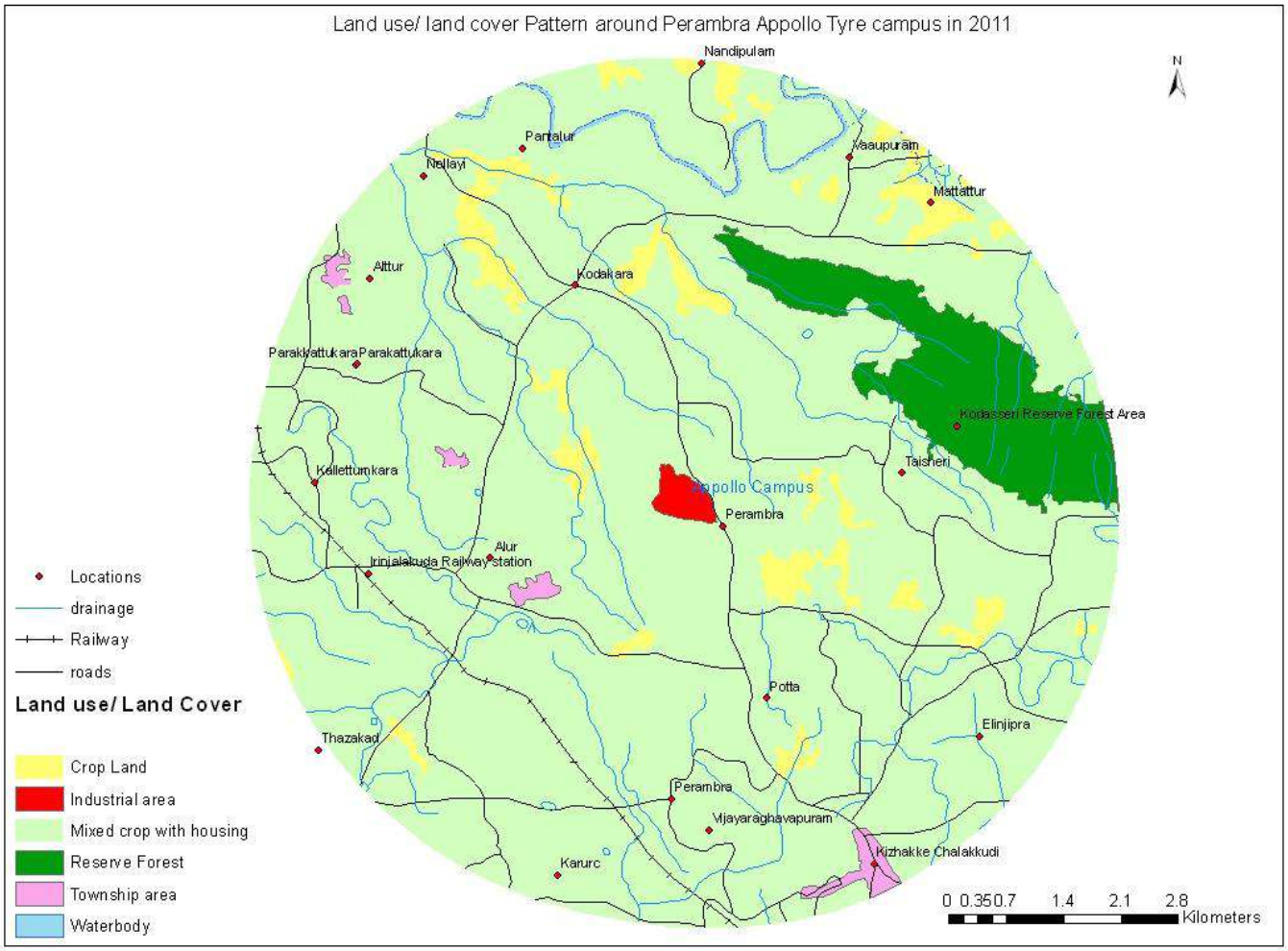
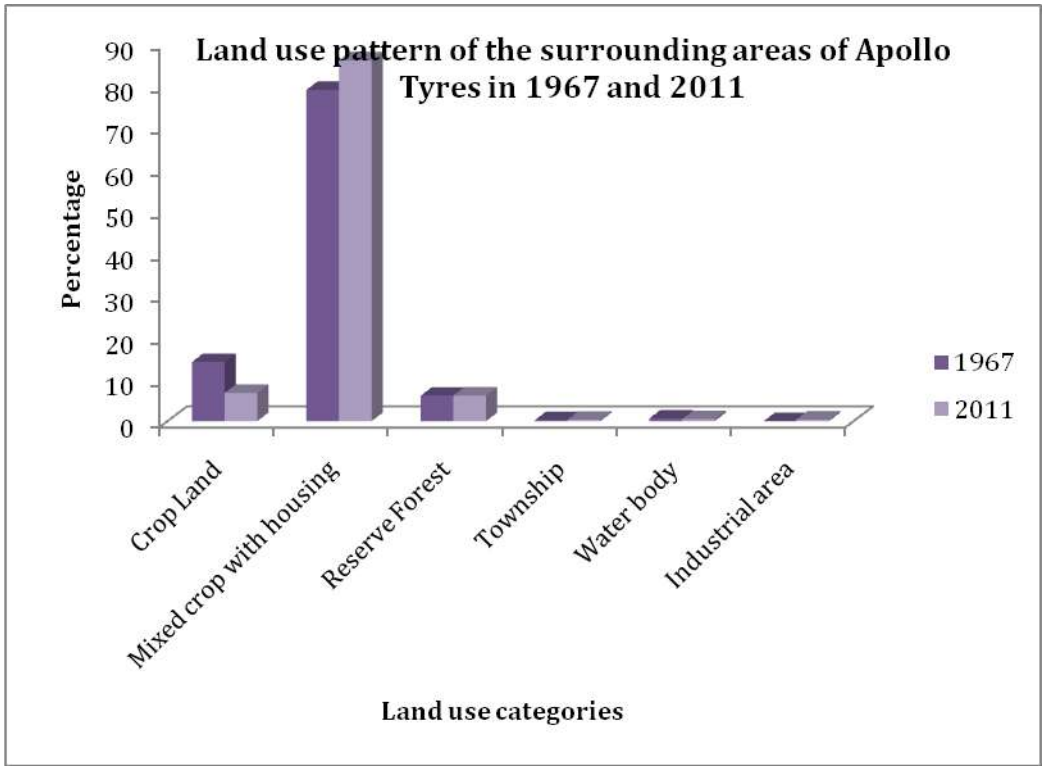


Table 3.9: Changing pattern in the land use pattern in the study area between 1967 and 2014 (Adapted from GIS mapping)

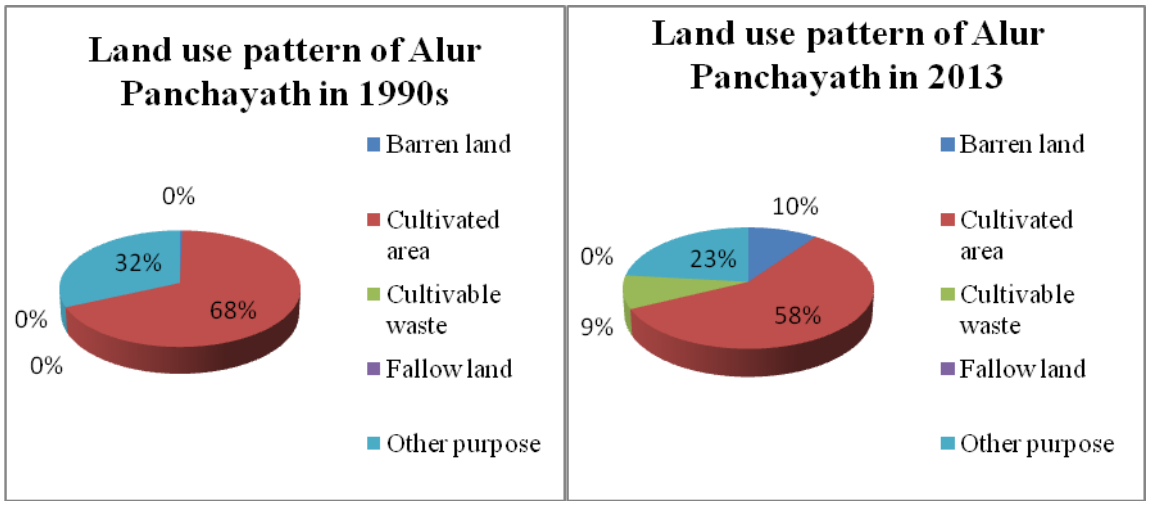
SI No	Land use type	1967 (km^2)	2014 (km^2)
1	Crop Land	12.579	5.9914
2	Mixed crop with housing	70.3631	76.296
3	Reserve Forest	5.4	5.4368
4	Township	0.2513	0.67
5	Water body	0.5832	0.4427
6	Industrial area	0	0.3395
Total Area		**89.1766**	

Fig. 3.9: Change in the land use pattern in the study area between 1967 and 2014 (Adapted from GIS mapping)



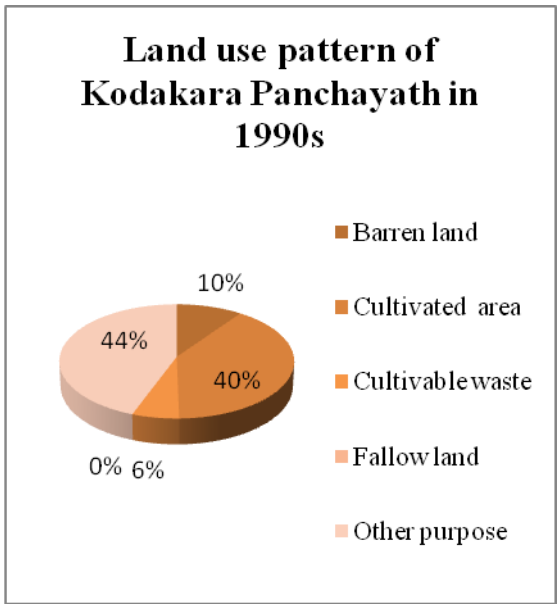
In order to ensure the accuracy of the data acquired from GIS, secondary data on land use pattern in the neighbouring areas of Apollo Tyres were collected from the concerned Agriculture Offices. The data received from Alur Agriculture Office and Kodakara Agricultural Office is given below, and there was no data on land use pattern was available at Chalakkudy Agriculture Office. Due to the importance given to the agriculture, the categorization done in the data received from Agricultural Offices are different from GIS data. However, it can be comprehended that overall cropland has decreased over the years. It is a clear indication of decrease in the agricultural flora and subsequent reduction in the dependent fauna (Fig. 3.10). Therefore, change in land use pattern from traditional uses such as cropping to townships grately reduces the biodiverisy richness of the area.

Figure 3.10: a) Land use pattern of Alur Panchayath in 1990s, b) Land use pattern of Alur Panchayath in 2013, c) Land use pattern of Kodakara Panchayath in 1990s, d) Land use pattern of Kodakara Panchayath in 2013 (Adapted from Baseline data of Alur Panchayath 2013 and Baseline data of Kodakara Panchayath 2013)

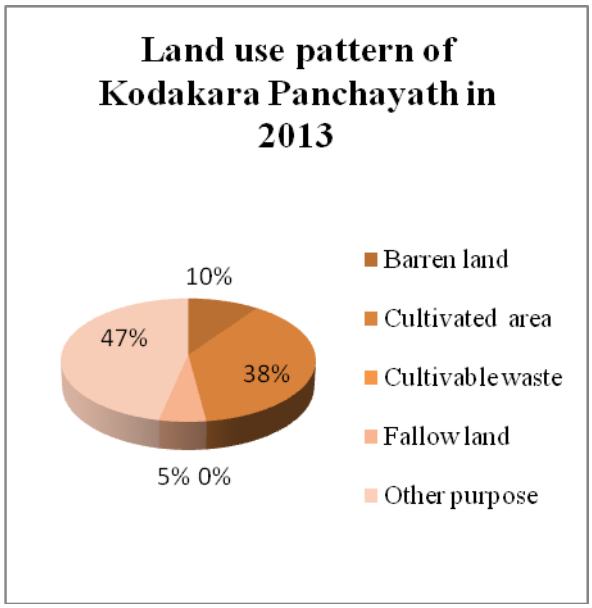


10 a)

10 b)



10 c)



10 d)

Also changing pattern in the richness of flora in the study area was assessed through NDVI mapping and the results are given in Fig. 3.11 and 3.12 and Table 3.10. The very low vegetation vigor category indicates that there is no vegetation in the area and such areas represents buildings, establishments, houses, roads, water bodies, rocky area and other barren areas. Low and medium category indicated vegetations including herbs, shrubs and woody tree area with housing and any other manmade structures. The moderately high vegetation vigor indicates the continuous patch of trees with understory vegetations.

Figure 3.11: NDVI of the study area in 1971 (Adapted from NDVI mapping)

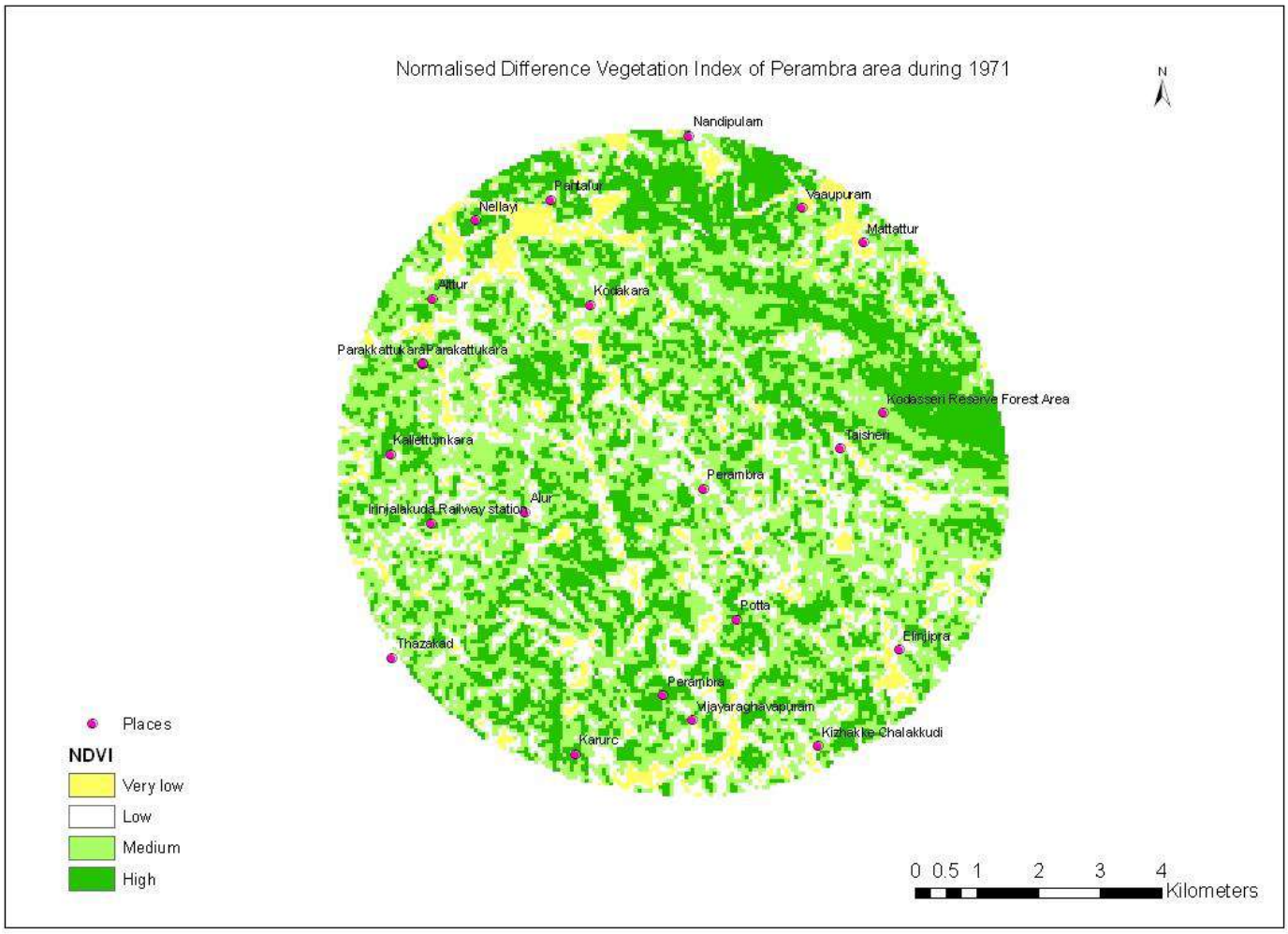


Fig 3.12: NDVI map of the study area in 2011 (Adapted from NDVI mapping)

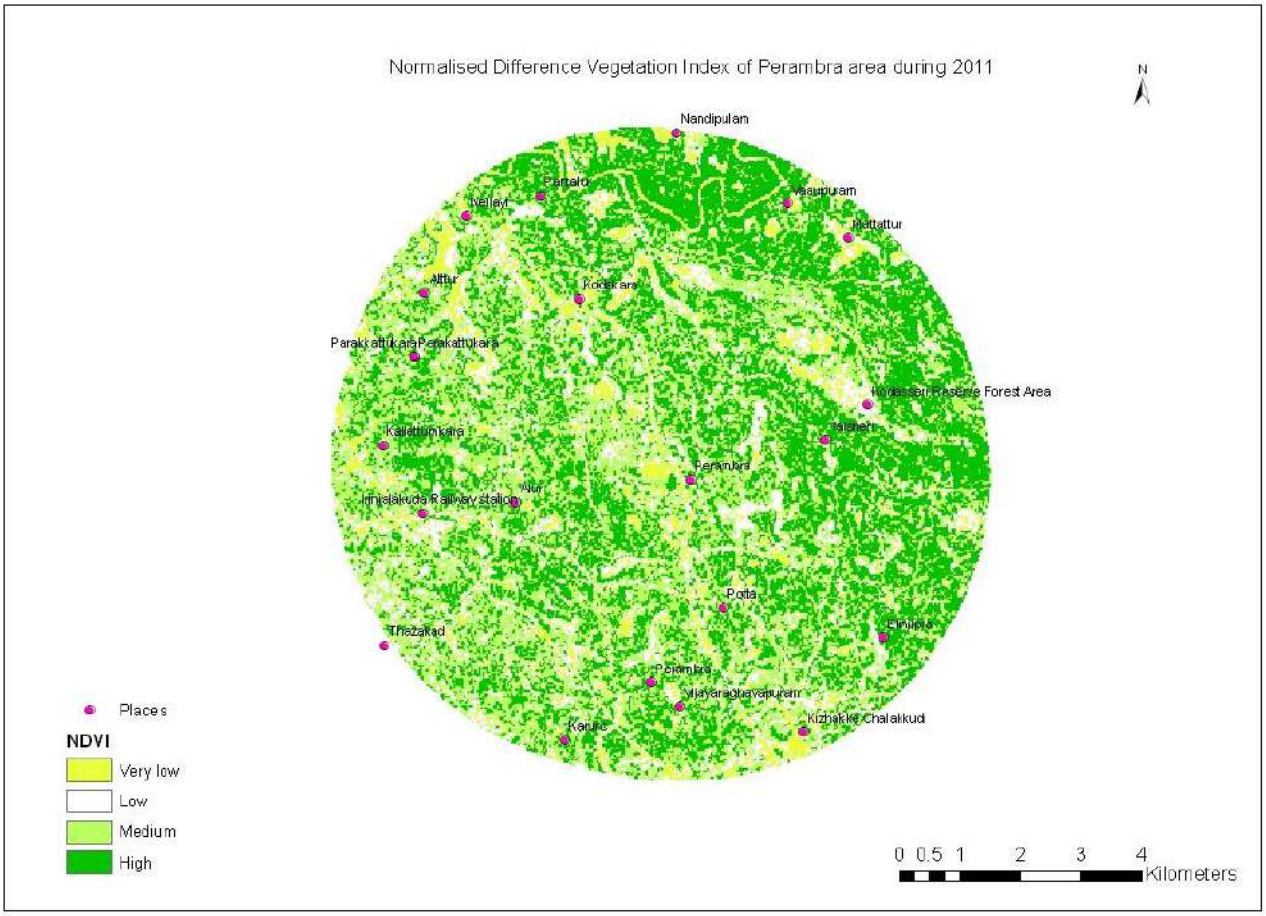


Table 3.10: Change in Normalized difference Vegetation Index of 5 km radius area around Apollo Tyres, Perambra between 1971 and 2011

Vegetation vigor	Year	
	1971	2011
Very Low	4.263	4.713
Low	27.630	29.623
Medium	37.336	32.928
Moderately High	19.944	21.911
Total area	**89.176**	**89.176**

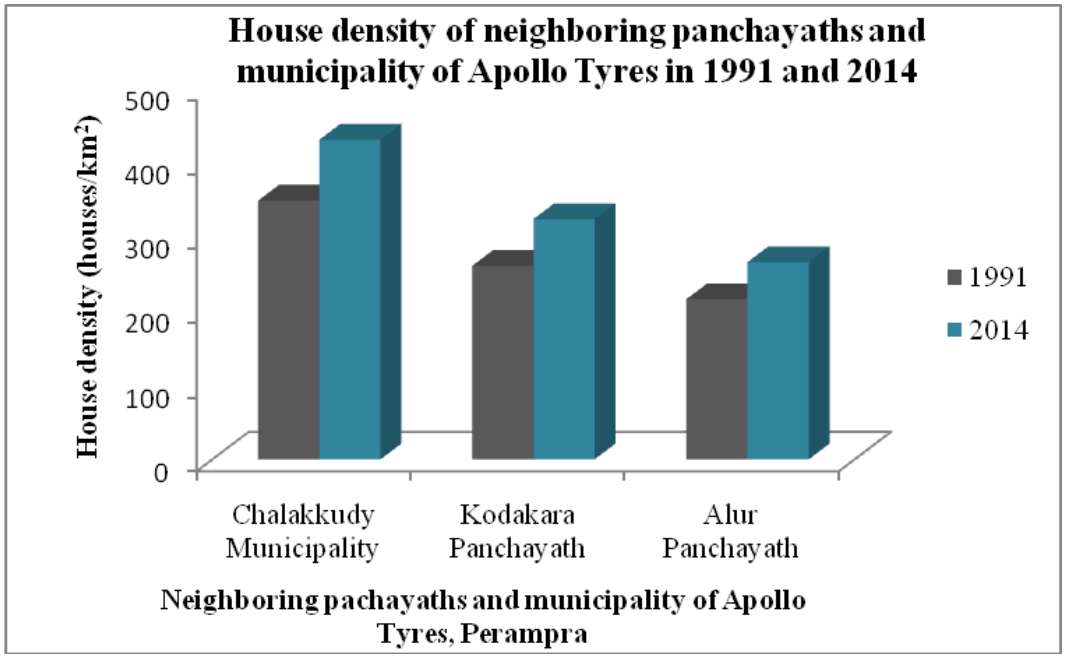
The comparison of Fig. 3.11 and 3.12 and Table 3.10 does not point out any significant changes in vegetation vigor in the study area, even though increase in very low and low categories is observed. Also, vegetation vigor in the Kodassery Reserve forest has decreased which might be due to the increase in anthropogenic interference in the area. The increase in moderately high vegetation category inferences the change in cultivation practices to monoculture plantations such as rubber and nutmeg. In addition, weed prolifereation in the

unused fields that were once cultivated with crops like paddy could also be the reason for increase in vegetation vigor. Though weed proliferation certainly increases the green cover, it may not contribute to the support of fauna population, especially birds and mammals. However, any increase in vegetation vigor in an industrial area can be considered as increase in carbon sink. Therefore, there is an indirect increase in the carbon sink over the last four decades.

3.2.1.2. Infrastructure in the study area

Physical, residential and institutional infrastructural development is an unavoidable factor that accompanies socio-economic development in any area. Since major socio-economic advancement has occurred in the study area over the past decades due to the establishment of various businesses, the rate of infrastructural development has increased noticeably. For instance, establishment of Apollo Tyres in Perambra increased the town settlement in the neighbouring regions as it attracted more people. A closer look at the change in house density between 1991 and 2014 indicates a noticeable increase in the number of houses in Chalakkudy Municipality, Kodakara Panchayath and Alur Panchayath (Fig. 3.13).

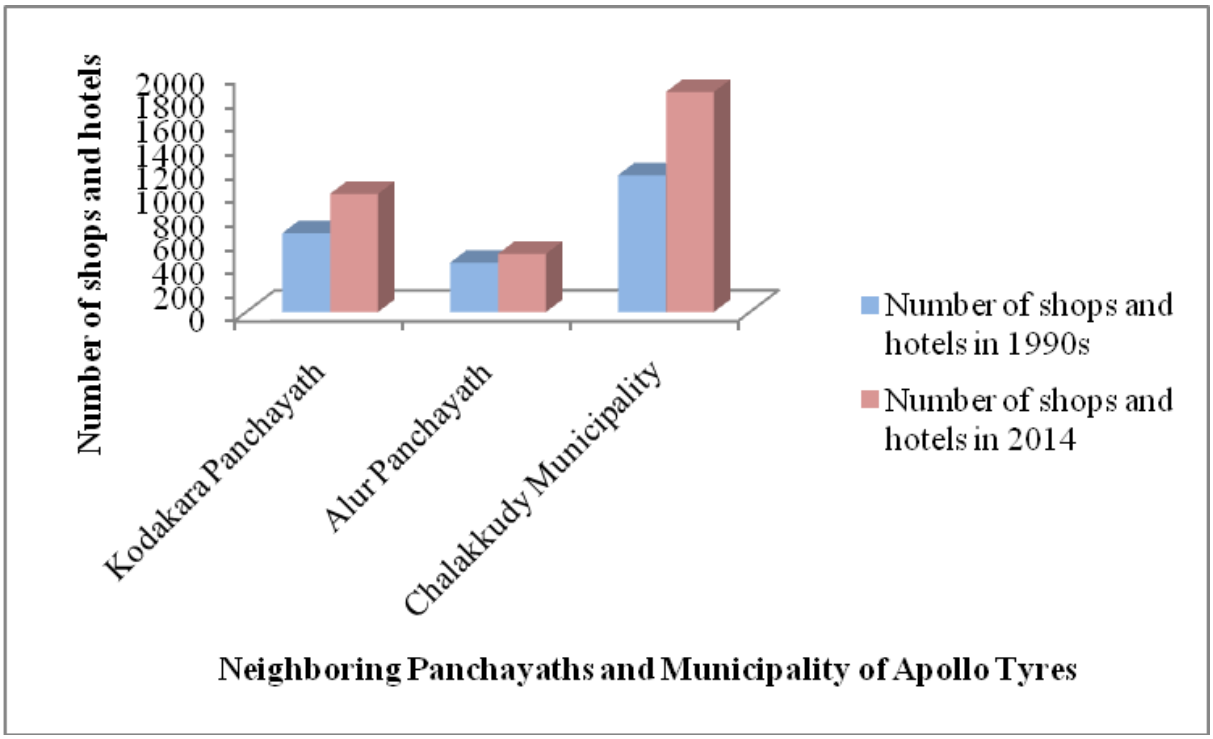
Figure 3.13: Change in house density in the surrounding areas of Apollo campus between 1991 and 2014 (Adapted from *Vikasanarekha 1991 and 2014,* Chalakkudy Municipality, *Vikasanarekha 1991 and 2014,* Kodakara Panchayath and *Vikasanarekha 1991 and 2014,* Alur Panchayath)



The town settlement coupled with development of National Highway resulted in the increase in number of shops, hotels and commercial settings in the area. Though a major turnover of 50% increase in the number of shops occurred in Kodakara Panchayath and Chalakkudy Municipality, not much change can be noticed in Alur Panchayath (Fig. 3.14). From this, it can

be concluded that development of major business ventures due to highway development and other large scale businesses like Apollo Tyres is concentrated in Kodakara Panchayath and Chalakkudy Muncipality. Also, from the direct observation of the study area and opinion of the surveyed community members it was noticed that contrary to the common pattern of commercial setting development in the very near areas of large business enterprises, the business development in the Perambra region is almost negligible. Though a large number of people are working at Apollo, they do not stay much longer in the neighbouring areas of the company before and after their shift time as Apollo provides bus services to different parts of the districts. Therefore, most of the small scale and medium scale business ventures in the area were closed down due to lack of profit. For instance, South Indian Bank has started a new branch in the area by aiming for profit from cash dealings with Apollo employees, but they had to close it down due to lack of profit. On the other hand, the business development in two neighbouring towns of Apollo, Kodakara in North and Chalakkudy in the south, had tremendously improved after the establishment of Apollo Tyres at Perambra.

Fig. 3.14: Changing pattern in the number of shops and hotels in the neighbouring areas of Apollo Tyres between 1990s and 2014 (Adapted from *Vikasanarekha* 1990 and 2014, Kodakara Panchayath, Vikasanarekha 1990 and 2014, Chalakkudy Municipality and Vikasanarekha 1991 and 2014, Alur Panchayath)

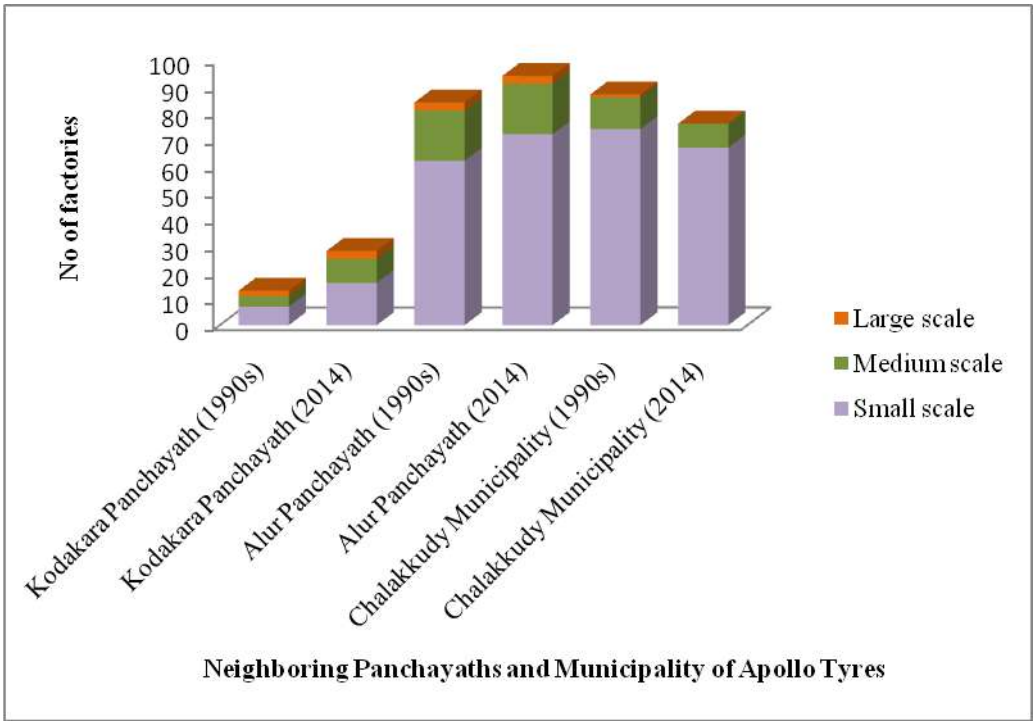


3.2.1.3. Industrialization

Industrialization is an important direct driver of change as it induces biodiversity loss due to the resulting air, water, land and noise pollution. Therefore, during any biodiversity impact assessment the industrial development in the area has to be considered. For that data on

pattern in the number and type of industries in the surrounding areas of Apollo campus was collected. According to Fig. 3.15, Alur Pachayath comprises of maximum number of industries in the past and the present, closely followed by Chalakkudy Panchayath. In all three regions, the majority of the industries are small scale and the number of large scale industries is negligible, especially in Chalakkudy Municipality. Among all the industries in the area, Apollo Tyres is the largest business institutions and hence the major contributor of economy to the region. Since Apollo is the largest production unit in the area, any major impact on biodiversity change due to industrialization would be imparted by Apollo Tyres. Therefore, it plays a major role in biodiversity change in the study area.

Fig. 3.15: Changing pattern in the number of industries in the surrounding areas of Apollo Tyres in 1990s and 2014 (Adapted from Institutional licence register 1990 and 2014, Kodakara Panchayath, Institutional licence register 1990 and 2014, Alur Panchayath and Institutional licence register 1990 and 2014, Chalakkudy Municipality)



3.2.1.4. Pollution

Pollution by altering the air, water and land quality and soundness, destructs the habitat of the organisms living in the area. Therefore, it either hamper the biodiversity, especially highly sensitive organisms like butterflies and birds, and force them to shift towards other safe environments, thereby damaging ecosystem of the region. In order to determine the occurrence of pollution and major polluters of the area, surveyed samples were asked about it. As per the opinion of the samples, three major sources of pollution in the area were air pollution and water pollution from Apollo and air pollution from NH and metal crushers. Out

of the three, pollution problems from Apollo have reduced moderately, indicating the effectiveness of pollution mitigation strategies undertaken by Apollo like increasing the smoke stack and commissioning effluent treatment plants. However, out of the four direct drivers of change in biodiversity pollution affects the biodiversity of the study area the most.

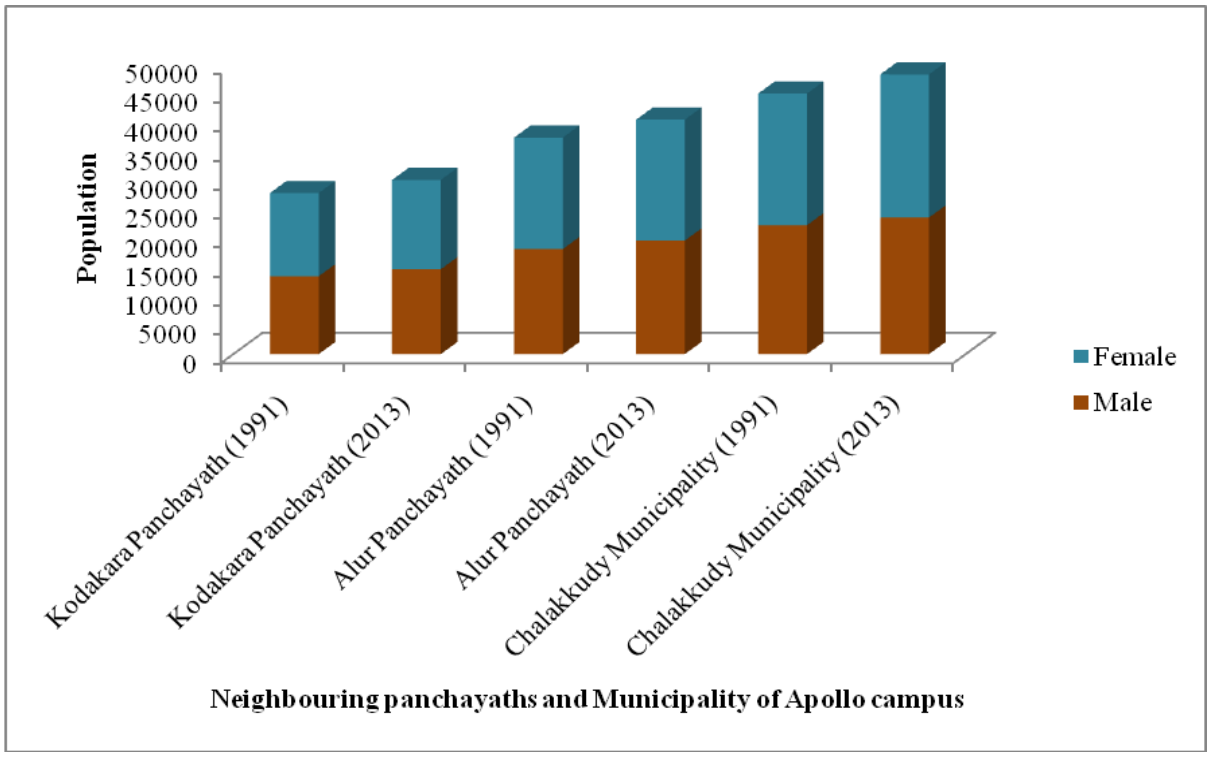
3.2.2. Indirect Drivers of Change

Indirect drivers of change are the factors that do not directly interfere in the biodiversity or ecosystem services, but will influence the rate at which direct factors affect the biodiversity. Therefore, indirect drivers speed up the effect of direct drivers, and accelerate biodiversity loss and hamper associated ecosystem services. Demography, socio-economic and cultural changes, urbanization and change in agricultural pattern are the indirect drivers of change in biodiversity considered in the perspective of this study.

3.2.2.1. Demography

Demography is a good indicator of anthropogenic activities in an area as larger populations occupy more land and consumes more resources. To determine the change in human influence in the area and the resulting biodiversity change, population data was collected from Kodakara Panchayath, Alur Panchayath and Chalakkudy Municipality. The result indicates a similar pattern of increase in population in all three regions with a decadal growth ranging from 7% to 10%, and it is much higher than the current decadal growth of host state Kerala's population which is 4.9% (Census India Organization, 2011). Since, Apollo Tyres is one of the major institutions in the area that provides job opportunities and hence attracts a large number of people to the area; it is an important contributor to the population growth in the area. The population growth and increasing human activities exert pressure on biodiversity, thereby significantly affecting the flora and fauna of the study area. For instance, increasing population occupies more land area as dwelling place, and they are forced to cut down trees in order to find space for house construction. Due to this, the habitat and food source of many birds and animals that are dependent on the tree are lost, and it pressurise them to find new habitat. Thus, increase in demography status will indirectly decrease the biodiverisy of the area. From the context of the study area, there is not much change occurred in terms of population. Therefore, biodiversity of the study area is least affected by demography in comparison to all other indirect drivers.

Fig. 3.18: Trend in demography in the neighboring local offices of Apollo Tyres between 1991 and 2013 (Adapted from Vikasanarekha 1990 and 2014, Kodakara Panchayath, Vikasanarekha 1990 and 2014, Chalakkudy Municipality and Vikasanarekha 1991 and 2014, Alur Panchayath)



3.2.2.2. Socio-economic and cultural changes

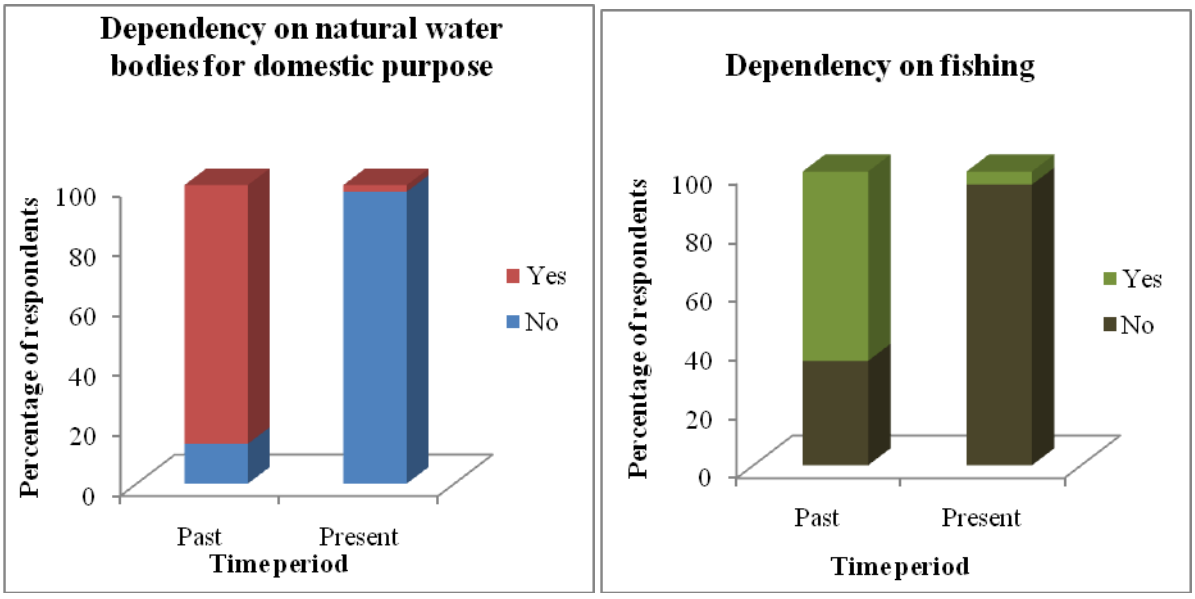
Socio-economic and cultural structures play a major role in promoting consumerist mentality among the people of a community and put little value on biodiversity preservation and enhancement. In most of the cases, socio-economic development is associated with development activities which often provide an incentive. This incentive is often attractive enough that there is not much concern among people on the over exploitation of the natural resources and the resulting pressure exerted on the biodiversity. Since most of the past socio-economic development and cultural activities have not included ensuring sustainability as an important fact, environment, biodiversity and ecosystem services had been considered as limitless and permanently available sources of resources (Stedman-Edwards, 1997). Therefore, being ignorant of the future implications of unrestricted consumerism has proven to be one of the key factors for the change in biodiversity. However, the resource exploitation among the rural communities is not as destructive as that of technologically advanced urban communities. Since they are heavily dependent on the nature and biodiversity, sustainability is somewhat maintained. For instance, majority of the rural families are agro- based and hence the destruction of the biodiversity will directly or indirectly affect their livelihood. This collective concern to an extent helps in the preservation of biodiversity and ecosystem services.

The neighbouring communities of Apollo campus come to the level of any other rural communities in terms of its dependency on agriculture and biodiversity. However, the level of change occurred in terms of the biodiversity dependency is not understandable just through general observation. Hence, respondents of the historical survey were asked whether they were dependent on natural water bodies for of domestic use and fishing and dependency on domestic animals in the past and present.

The most drastic change has been noticed in the use of water resources used for the domestic purpose. When about 86% of the people used public water bodies like ponds, streams and rivers for domestic uses like bathing, washing, cleaning and irrigation, it has reduced to only 2% over the last 30 years (Fig. 3.19a). According to the opinion of the people, the main reason for this is the change in lifestyle of the people, availability of facilities in each house hold and deterioration of the quality of water in the water sources due to pollution and careless handling and management of the natural resources. Also, some people said that loss of moral values in people compared to the past force them to use home facilities to ensure the personal safety.

Similar to the pattern of dependency on natural water bodies, the trend of fishing habits among the community members has indicated a reduction in the dependency on biodiversity. When more than 2/3rd of the respondents fished in the past as a pass time and as a source osf nutrition, currently only 4% of them does it (Fig. 3.19b). This cultural transformation is due to the change in lifestyle, lack of time and the improvement in the socio-economic condition of the people. In addition, the lack of proper management of the water bodies resulted in the pollution, thereby resulting in the reduction of fish diversity and population in the locality.

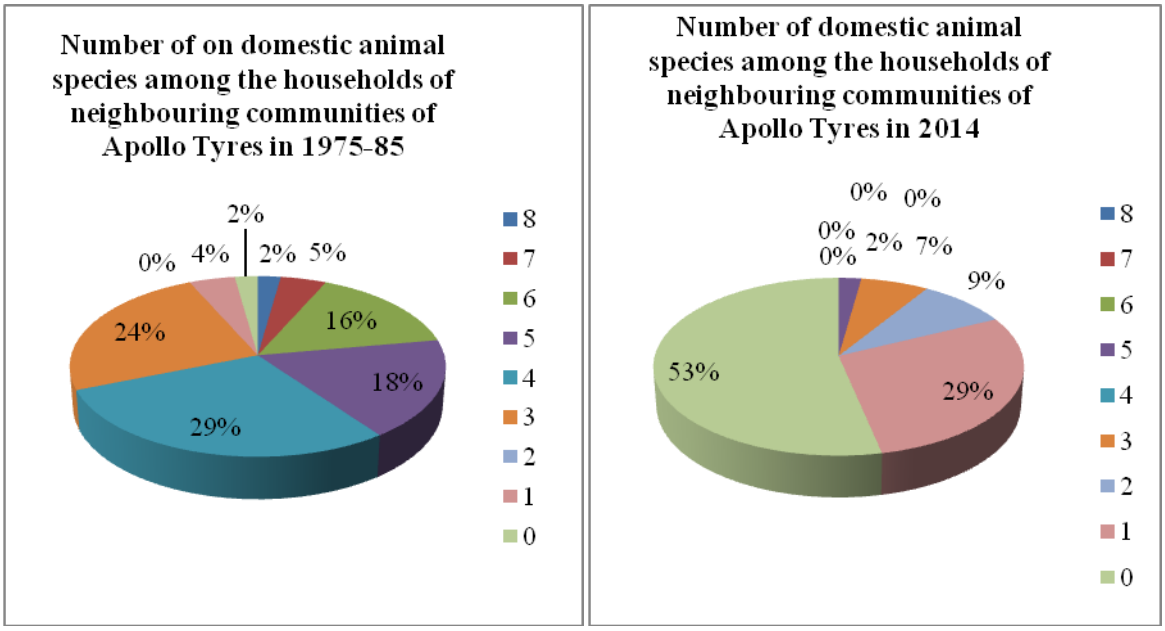
Fig. 3.19: a) Change in dependency on natural water bodies for domestic purpose and b) Change in fishing habits of people at surrounding areas of Apollo Tyres (Based on historical survey)



a) b)

According to the respondents, the number of domesticated animal species each household had for food and monetary benefit has changed. A species count of domestic animals in the households in the past and the present was taken in order to compare the dependency in both time periods. While average number of species in 1975-85 is 5, in the recent years the average number has reduced to 2. In 1975-85, about 29% of the households had 4 species of animals, while about 1/4th of the households had 3 species. On the other hand, more than half of the households have no domestic animals today, and about 29% has one animal species in their home (Fig. 3.20 a and b). It indicates that due to the changes in socio-economic pattern, change in lifestyle and cultural values the dependency of people on biodiversity has drastically decreased in the study area over the last 3-4 decades. Though it does not directly affect biodiversity, reduced dependency on the ecosystem services creates somewhat ignorant mentality among people about biodiversity. Therefore, indirectly it results in the biodiversity loss.

Figure 3.20: Change in the number of domestic animals among the households of surrounding areas in a) 1975-85 and b) 2014



a) b)

3.2.2.3. Change in Crop Pattern

Agriculture is a significant factor that plays a major role in biodiversity loss in various ways. First of all, depletion of agricultural lands affects the population of organisms that are dependent on them for food and habitat. Secondly, introduction of farming to a land that is used for other purposes also affect the biodiversity that is adapted to that particular environment in the locality. Thirdly, the introduction of new and exotic plant species also disturbs the ecosystem of the area. For example, converting paddy field to nutmeg plantation will affect species like paddy pippet, parrot, myna, frog and other animals depended on the

environment. Therefore, any alteration occurred in the agriculture will greatly affect the biodiversity in the area.

In order to determine the role of agriculture on the biodiversity of the study area, the data of major crops and land occupied in the past and present were collected from Chalakkudy Municipality, Alur Panchayath and Kodakara Panchayath. According to the data received, coconut is the major crop in all three regions at present. When coconut was the major crop in the past in both Kodakara and Alur Panchayath, both coconut and paddy were the major crop types in Chalakkudy Municipality. When the cultivation of most of the crop types increased at Kodakara and Alur, a significant reduction in the land occupied by each crop can be noticed at Chalakkudy (Fig. 3.21, 3.22 and 3.23). The alterations in the agricultural pattern in all three regions points out their role in changing biodiversity of the area. From the context of the study area, the only crop type that shows a consistant increase is coconut, but coconut cannot provide food for many birds and animals. Also, most of the coconut plantation was created in the fields used for the cultivation of other crops like rice, banana and vegetables. Hence, animals that are depended on these crops for their sustenance will be greately affected, thereby drastically reducing the biodiversity in the area.

Figure 3.21: Change in crop pattern at Alur Panchayath in 1998-99 and 2012-13 (Adapted from Baseline data, Agricultural Agricultural Office)

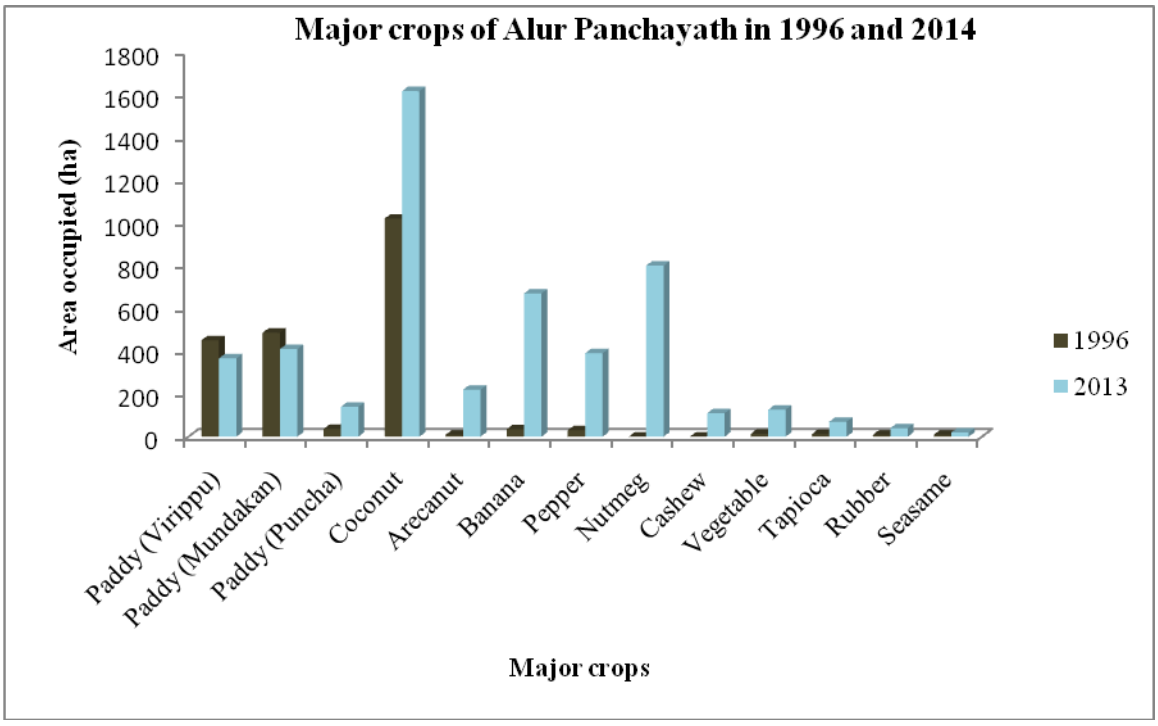


Figure 3.22: Change in crop pattern at Kodakara Panchayath in 1996 and 2013 (Adapted from Basic data, Kodakara Agricultural office)

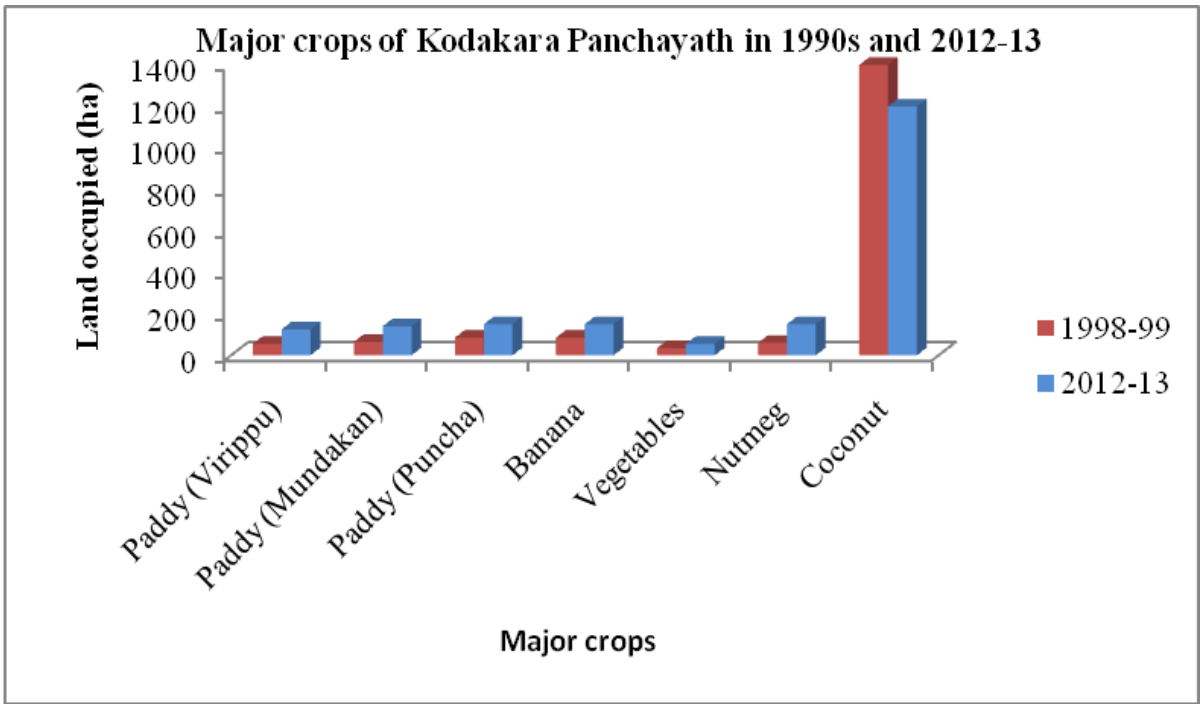
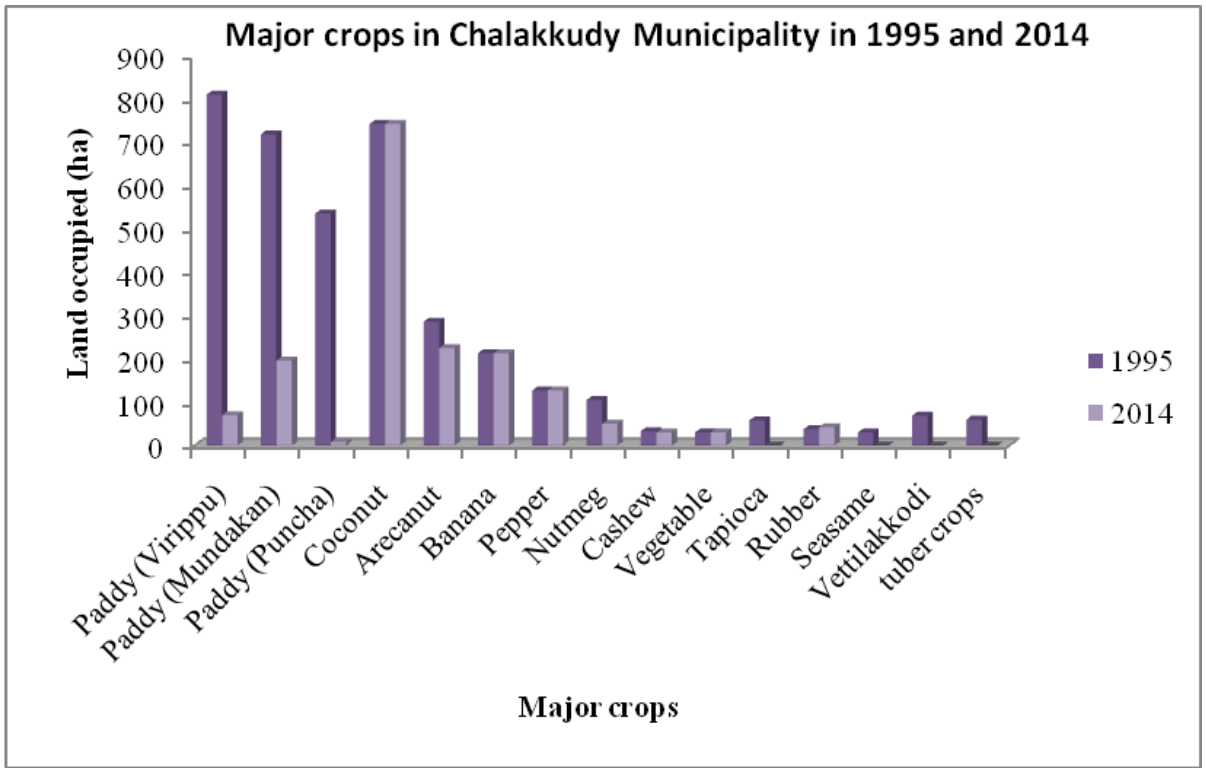


Fig. 3.23: Change in crop pattern at Chalakkudy Municipality in 1995 and 2014 (Adapted from Basic data, Chalakkudy Agriculture office)



3.2.2.4. Urbanization

Urbanization is one of the factors that create a change in the pattern of biodiversity as it may eliminate the species that are adapted to the village settings and replace them with new species that can successfully cohabit with humanbeings. However, in the area surrounding Apollo Tyres, Perambra is not much affected by urbanization. As mentioned before, despite having the largest corporate company exists in the area and NH47 passing through right infront of the company, the town settlement and small and medium scale business ventures are established in Kodakara and Chalakkudy. Therefore, biodiversity of the area is not much affected by urbanization.

A summary of the impacts of the above mentioned drivers of change is indicated in Figure 24. As the cycle events goes, direct drivers causes biodiversity loss and indirect drivers increases the rate at which direct drivers impact the biodiversity. Among direct drivers pollution highly exacerbates the biodiversity loss in the area. On the other hand, industrialization by Apollo and landuse pattern moderately impacts the biodiversity while it is least affected by infrastructure developments. On the other hand, socio-economic and cultural factors and change in agricultural pattern greately impacts biodiversity, whereas demography and urbanization minimally affect the biodiversity.

Also, biodiversity loss results in the changing pattern in indirect drivers. Figure 24 indicates interconnectness of direct to direct drivers, indirect to indirect drivers, indirect to direct drivers, and vice versa. Firstly, land use pattern can be created by demography, urbanization and socio-economic and cultural factors. Secondly, industrialization and urbanization mutually affects each other. Moreover, urbanization results in infrastructural developments and pollution. Also, industrialization results in both alterations in agricultural pattern, and socio-economic and cultural factors while infrastructural developments reduce agricultural crop area.

Fish culture in an abandoned quarry at Perambra

3.3. Analysis of Apollo's effect on change in biodiversity

Apollo Tyres Limited is the only large scale corporate company in the study area. Therefore, Apollo Tyres can be the major driver for change in biodiversity in the locality. In order to measure Apollo's impact on the local biodiversity and the ecosystem, factors related to the quality assurance, employee strength and Apollo's prioritization on environment protection were assessed.

3.3.1. Quality Assurance

Under quality assurance of factors of environmental significance, Apollo's air and effluent emissions, chemicals used and noise generated were considered. These factors were already quantified by Apollo Tyres' quality assurance team from 2005 onwards. The available data were collected and compiled in this section. Also, effluent quality analysis done by Pollution Control Board of Thrissur District is also enlisted below. All the data collected from Apollo Tyres' Annual Environmental and Monitoring Report indicates that quantity of quality assurance parameters are well below the regulatory limit of India.

3.3.1.1. Air Emission

Ambient air quality measurement is an important step in determining the impact of air pollution in the biodiversity and associated ecosystem in any environment. Since air pollutants interfere with the biogeochemical cycling and interact with members of ecosystem (Lovett *et al*, 2009), it is very significant to consider the air quality of an environment when studying the changes occurred to its biodiversity. Therefore, ambient air quality data of Apollo Tyres' periphery and inside the factory are enlisted below (Table 3.11 and 3.12). The comparison of ambient air quality inside the plant and outside the plant points out that effective air quality enhancement steps are undertaken prior to the release of emissions. However, the effect of air emissions from Apollo Tyres on the biodiversity cannot be predicted without studying this aspect of air emission.

3.3.1.2. Effluents

Apollo Tyres is a company that consumes about 1.8 million litres of water daily from Chalakkudy River. Since the production of tyre involves many harmful and non-harmful chemicals, Apollo Tyres has taken initiatives in treating their effluents prior to releasing out. The quality of the effluents is collected from quality assurance team of Apollo and Pollution Control Board. These data are given in Table 3.13 and Table 3.14.

3.3.1.3. Noise

Noise pollution is an increasing problem in both terrestrial as well as aquatic environments. Study of noise pollution is very crucial as it affects the behaviour, physiology and development of individual organisms (DEFRA, 2012). For instance, one of the Apollo employees said that one of the major reasons for reduction in bird population in the area is the increasing noise in the area after the recent development of roads. Hence, studying noise level in the company is very important for understanding its impact on biodiversity. The available data is given in Table 3.15.

Table 3.11: Ambient air quality data of Apollo's periphery from 2005 to 2013 (Adapted from Annual Environmental and Social Monitoring Report, Apollo Tyres Perambra)

Sl .no	Parameter	Host Country Regulatory Limit	Main gate								North Compound Wall								West Compound Wall							
			2005	2006	2008	2009	2010	2011	2012	2013	2005	2006	2008	2009	2010	2011	2012	2013	2005	2006	2008	2009	2010	2011	2012	2013
1	Sulphur Dioxide (SO2) (µg/m3)	17.2	17.2	16.5	17	16	15.5	15.2	18.6	17.8	15.4	16.1	17.3	16	16.4	14.8	17.4	17.4	16.1	16.5	15.9	15.5	37.6	15.1	15	16.6
2	Nitrogen Dioxide (NO2) (µg/m3)	22.6	22.6	22.4	17.3	16.1	16.5	16.8	16.8	19.6	19.8	18.6	18.3	16.1	17.5	16.6	18.1	19.2	21.2	17.8	16.7	16.8	16.5	16.4	18.4	19.2
3	Particulate matter (PM 10) (µg/m3)	60	46.5	43.6	40.1	37.6	37.1	25.3	23.1	25.3	44.1	44.3	43.1	37.6	43.6	27	25.4	27.4	43.4	44.8	38.6	37.4	37.6	23.7	22.7	25.5
4	Particulate matter (size less than 2.5) (µg/m3)	40	-	-	-	-	-	6.27	7.68	8.85	-	-	-	-	-	6.83	6.83	7.52	-	-		-	-	6.4	7.35	8.13
5	Lead (Pb) (µg/m3)	0.5	-	-	-	-	BDL	BDL	BDL	BDL	-	-	-	-	-	BDL	BDL	BDL	-	-		-	-	BDL	BDL	BDL
6	Carbon Monoxide (CO) (mg/m3)	2	-	-	-	-	-	1.06	1.1	1.1	-	-	-	-	-	0.9	1	1	-	-		-	-	1	1.1	1.1
7	Ammonia (NH3) (µg/m3)	100	-	-	-	-	-	25	27	27.8	-	-	-	-	-	27	30	37.5	-	-		-	-	25	26	27.3
8	VOC		-	-	-	-	-	6.7	7.43	7.53	-	-	-	-	-	6.37	8.1	7.7	-	-		-	-	6.83	7.83	7.2
9	Benzene (C6H6) (µg/m3)	5	-	-	-	-	-	-	BDL	BDL	-	-	-	-	-	-	BDL	BDL	-	-		-	-	-	BDL	BDL
10	Benzo (a)Pyrene (ng/m3)	1	-	-	-	-	-	-	BDL	BDL	-	-	-	-	-	-	BDL	BDL	-	-		-	-	-	BDL	BDL

Table 3.12: Annual air quality inside the factory from 2005 to 2013 (Adapted from Annual Environmental and Social Monitoring Report, Apollo Tyres Perambra)

Srl. No	Parameters	Banbury							Curing area							Tyre Building						
		2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013
1	Particulate matter (mg/m3)	1.12	0.08	0.07	0.07	0.07	0.06	0.07	0.99	0.07	0.06	0.06	0.07	0.08	0.07	1.09	0.08	0.07	0.07	0.07	0.07	0.08
2	VOC (mg/m3)	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	-	0.01	0.01	0.02	0.01	0.01	0.01	0.01	-	0.01
3	SO2 (mg/m3)	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.04	0.02	0.02	0.02	0.02	-	0.02
4	Nox (mg/m3)	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	-	0.02

Table 3.13: Effluent quality at Apollo campus from 2005 to 2013 (Annual Environmental and Social Monitoring Report, Apollo Perambra)

Sl no	Parameters	ETP outlet X1							ETP outlet X2						
		2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013
1	pH	7.02	7.12	7.18	7.16	7.19	7.27	7.22	7.06	7.19	7.21	7.28	7.29	7.34	7.37
2	BOD (mg/L)	3.12	12.4	15.6	14.9	16.6	20.7	19.9	28.5	20.5	22.5	23.1	23.4	23.6	22.9
3	COD (mg/L)	9.8	32	54	56.2		103	85.6	128	68	80		122	115	121
4	Oil and grease (mg/L)	0.07	0.2	0.5	0.64	0.73	0.67	0.77	0.76	0.72	0.9	1.34	1.12	1.06	1.7
5	Total suspended solids(mg/L)	26	12.4	14.7	15.7	17.1	24.2	23.2	24.2	18.8	17.3	22	21.2	28.4	29.2
6	Total coli form bacteria	280	<0.3	<0.3	<0.3	<0.3	<2.0	<2.0	360	<0.3	<0.3	<0.3	<0.3	<2.0	<2.0
7	Heavy metals	0.62	0.41	0.33	0.41	0.26	0.89	0.35	0.84	0.54	0.48	0.6	0.41	0.96	0.49

Table 3.14: Effluent quality at Apollo campus from 2000 to 2012 (Adapted from Effluent Quality Register, Pollution Control Board, Thrissur

Year	pH	BOD	COD	SS	Oil and greese	TDS	Zinc	Phosphates	Free ammonia	Total Kjedal's Nitrogen	Ammi Nitrogen	Phenolic compounds
2000	6.1	136	-	694	18.9	-	-	-	-	-	-	-
2001	6.1	27	-	88	18.9	1495	-	-	-	-	-	-
2002	6.7	40	-	135	13	2500	-	-	-	-	-	-
2003	7.2	126	-	390.8	3	836.8	-	-	-	-	-	-
2004	7.2	38	-	99	-	509.4	-	-	-	-	-	-
2008	7.7	412.1	978.7	52.5	BDL	-	BDL	6.3	0.5	2.9	1.3	BDL
2009	7.1	18.7	186	13	BDL	570	BDL	-	-	-	-	-
2010	6.9	7.5	-	10.3	BDL	BDL	-	-	-	-	-	-
2012	6.8	4.2	-	13.6	BDL	-	-	-	-	-	-	-

Table 3.15: Annual Ambient noise level at Apollo campus from 2005 to 2013 (Adapted from Annual Environmental and Social Monitoring Report, Apollo Tyres Perambra)

Parameters	Host country Regulatory Limit	East							West									South								North			
		2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013	2005	2006	2009	2010	2011	2012	2013
Residential, institutional, educational receptors (Day time) (db(A))	55	53.8	53.1	53.3	52.8	52.1	52.2	51.7	55	53.3	52.8	52.9	51.7	50.8	51.4	54	52.9	53.5	53.2	50.9	51.9	51.9	52.5	52.9	53.3	52.3	52.7		51.6
Residential, institutional, educational receptors (Night time) (db(A))	45	44.5	44.2	43.5	42.7	41.6	43.1	42		44.1	43.1	43.5	41.4	43.1	42	43.6	43.8	43.8		42.9	43.1	42.5	43.1	43.6	43.4	42.8	41.9		42.6

3.3.2. Chemicals used

In order to understand the type of chemicals that Apollo is using in their production process, and to ensure that the type of chemicals used is not hazardous, the list of chemicals Apollo using is collected. Also, to mark the notable changes made in terms of chemical usage, list of chemicals used in the past was also enquired. Though the whole list of chemicals used in the past is not available, the list of hazardous chemicals used in 2004 was received from the quality assurance team of Apollo. As per the data provided by the company, 7 of the chemicals used at present are hazardous.

Table 3.16: The list of chemicals used at Apollo Tyres Limited, Perambra in 2004 and 2014 (Based on the data provided by Apollo Tyres Limited, Perambra)

Sl.No	Hazardous Chemicals Used in 2004	List of chemicals used in 2014
1	Naphtha (Naphtha Coal Tar)	Aromatic Process Oil
2	Formaldehyde (37% Solution)	RAE Process Oil
3	Ammonium Hydroxide	Carbon Black*
4	Insoluble Sulphur	Precipitated partly hydrated Silica
5	Accelator (Vulkacit MOZ/SG)	Soluble Sulphur (0.5% oil treated)
6	MBTS Accelerator (Mercure MBTS)	Accelerator DPG
7	DPG Accelerator (N.N'Diphenylguanidine)	Accelerator TMTD
8	DCBS Accelerator (Accicure DCS)	Stearic acid*, Rubber grade
9	Perkacit TMTM (Rhenocure THIURAM)	Accelerator MBTS
10	N-234 Carbon black	Resorcinol Stearic acid Melt
11	Zinc stearate	Antioxidant TMQ
12	Lamp Black	Accelerator CBS
13	Compacted silica	Zinc oxide (Indirect)
14	RM Sulphur	Hard reinforcing clay
15	Stearic Acid	Phenol Formaldehye resin TMOD, 7.5% HMT
16	Wax Blend	Wax blend*
17	Permanax 6 PPD Antioxidant 25	Insoluble sulfur (oil treated 20%)
18	Silicon Oil (High Viscous)	Antiozonant DTPD
19	Retarder	Antiozonant 6 PPD
20	Nepthalic Oil	Accelator TBBS
21	Paraffinic Oil	Silicone emulsion*
22	Process Oil Medium	Retarder CTP
23	Mica Powder	Tackifying resin (Octyl phenol Formaldehyde resin)
24	Oleic Acid	HMMM
25	Caustic Soda	Peptiser DBD
26	35% Silicone emulsion	80 Mesh Crumb powder
27	Iso Propanol	Silane coupling agent
28		DPA/Acetone reaction product
29		Naphtha (Rubber solvent, Petroleum distillate)
30		Tread marking paints

31	Water based outer lube
32	Mineral rubber
33	Poluethene films/bags
34	Drum core cement (stick)
35	EVA Bag
36	Dipped Nylon Fabrics
37	Dipped polyester fabrics
38	Bead wire
39	Polypropylene liners
40	Identification yarns
41	Polyester cotton cloths
42	Accelarator MBT
43	Chlorobutyl Rubber
44	Naphthenic Process Oil*
45	Accelarator DCBS*
46	Accelarator ZEC
47	Silicone oil*
48	Embossed poly film

** indicates the hazardous chemicals that are still in use at Apollo Tyres, Perambra*

3.3.3. Employee Strength

Apollo Tyres is the largest employment provider in the area. Initially, Apollo employed about 600 people. And, the face of Apollo has turned out to be one of the leading tyre dealers in the world. With the increase in production, the number of employees has also increased. Today, Apollo has employee strength of 2232 and 849 contract workers at Apollo Tyres Limited, Perambra. It is an indicator of Apollo becoming the reason for increasing anthropogenic activities in the area. Therefore, it is directly linked with the biodiversity loss in the study area.

3.4. Steps Undertaken by Apollo for Biodiversity Conservation

Apollo Tyres has taken several steps regarding environment and biodiversity protection, especially since the concern for protection of the planet and promotion of sustainability became strong across the globe. These steps are categorized as direct and indirect action based who initiated it and for what purpose.

3.4.1. Direct Actions

Direct actions include all the programs implemented inside Apollo Company and in the neighbouring communities with an aim of protecting biodiversity and environment. Most of these actions are carried out under the supervision of Apollo's office of Corporate Social Responsibility after its establishment in 2010. All of the environment programs at Apollo Tyres come under a major environment protection program "Habitat at Apollo" which was established with an aim of promoting environmentalism inside the campus.

3.4.1.1. Organic Farming

Through the establishment of an organic farm inside the campus, a portion of Apollo's unused land was used for a productive purpose. It was managed in a wholesome organic way, meaning no agro-chemical was used for enhancing production. Instead, the waste slurry from the effluent treatment plant of the company was used as manure, thereby reducing waste at its source. Also, the products from the organic garden are used in the canteen so that a better quality food can be prepared for the Apollo employees.

3.4.1.2. World Environment Day Celebration

Every year Apollo celebrates World Environment Day under CSR. As part of the programs, biodiversity enhancement activities like planting tree sapling and vegetable seed distribution are carried out each year. One of the major activities carried out in the 2013 celebrations was the plantation of trees in a 1 km long line in the high way median in front of Apollo campus. Also, other activities like awareness programs on nature preservation and competitions are conducted in order to make the employees understand the importance of environment protection and biodiversity conservation.

3.4.1.3. Campaign against food wastage

Campaign against food wastage in the company is conducted during canteen hours, and people with zero food wastage are awarded. In addition, the quantity of food wasted is monitored after each meal time and it is displayed in the canteen every day so that employees visually realize the food that they are collectively wasting.

3.4.1.4. Paper Recycling

Since Apollo is large business institution, a huge quantity of paper is used for office works. Afterwards, the used papers are collected and recycled by sending to an agency outside the state.

3.4.1.5. Water recycling

As mentioned earlier Apollo has a large water foot print. Therefore, about 8000 litres of used water is recycled and used either in the production process or to irrigate the engineered garden and organic vegetable garden

3.4.1.6. Waste Management

In order to process the organic waste produced inside the campus, a biogas plant of capacity 80 m^3 is built inside the premise. The waste generated inside the canteen is digested inside the biogas plant and the energy produced is used in the kitchen. Also, a waste segregation pit is constructed recently to collect the waste and separate it for various methods of waste management. Bio-waste separated out from it will be processed in the biogas plant, while recyclable wastes such as plastic and glass will be send out to be recycled.

3.4.1.7. Promotion of Eco-friendly Product Usage

Also, Apollo Tyres has taken steps to promote the importance of using eco-friendly products inside the campus. One of them is using TNPL paper products, which is 100% recycled, for all office purpose.

3.4.2. Indirect Actions

The indirect actions enlisted under this section are technological changes of environmental significance brought into action in the company to improve the quality of air and water emitted.

3.4.2.1. Change of Coating material

Initially, chalk powder and kerosene were used as the coating material for rubber sheet bundles to avoid sticking. Since dust pollution was a major problem due to the use of chalk powder, the coating material was changed to polythene which can be further used and recycled.

3.4.2.2. Use of Renewable Energy

To reduce the use of non-renewable energy sources, the use of naphtha was reduced by using renewable energy forms like solar energy.

3.4.2.3. Carbon Credit Calculation

Apollo has taken measures to reduce its contribution to green house emission and subsequent global warming by calculating their own carbon credit. The annual carbon credit values of Apollo Tyres in displayed in Fig. 3.24.

Fig. 3.24: Carbon credit calculation of Apollo Tyres for the past two years (Adapted from Annual Environmental and Social Monitoring Report, Apollo Tyres, Perambra)

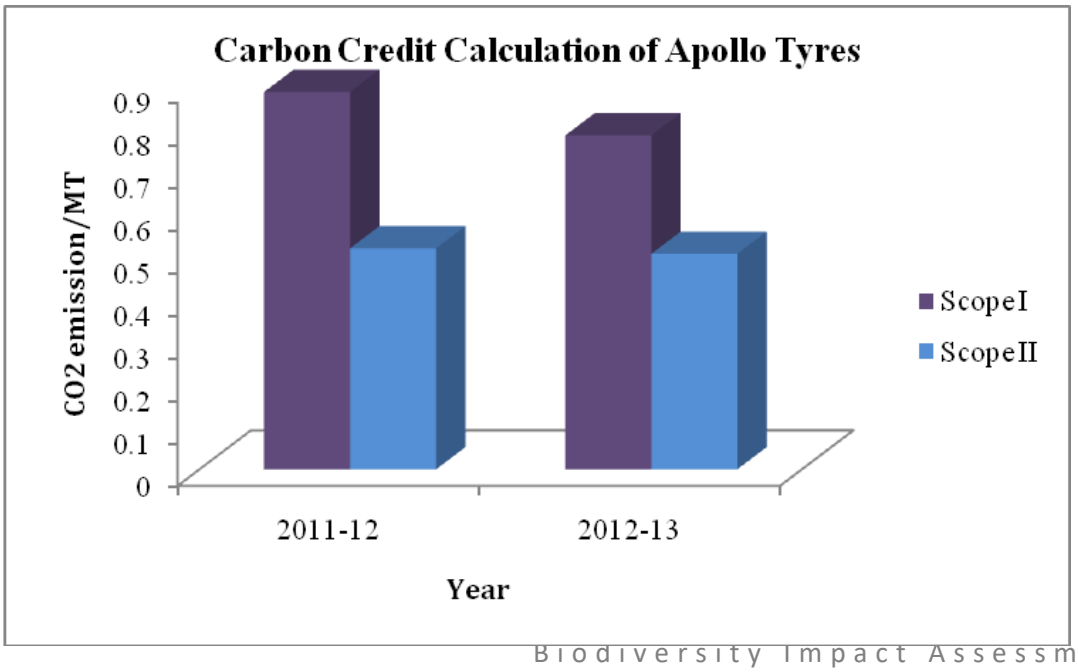
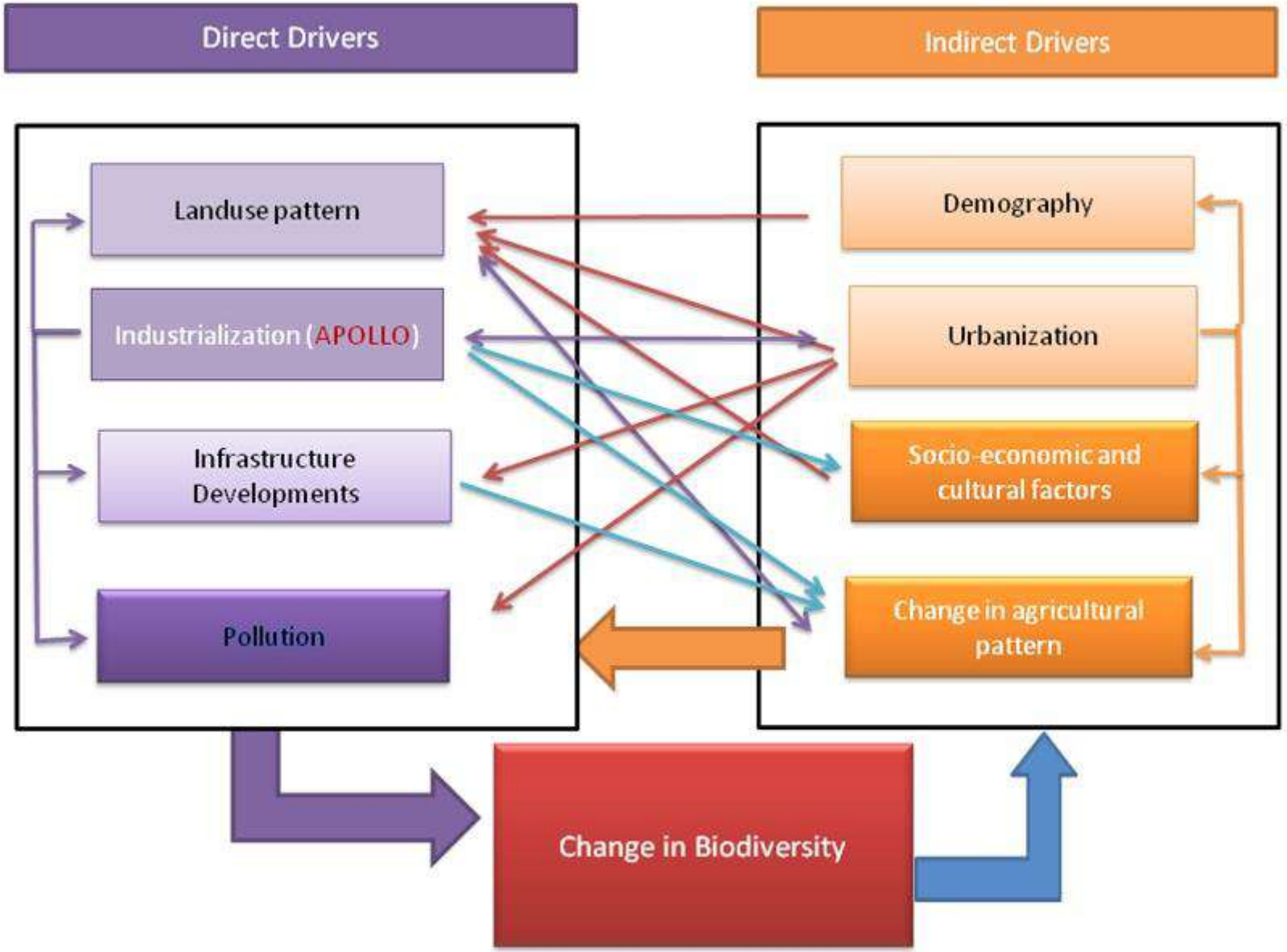


Fig. 3.25 Matrix analysis of drivers of changing pattern of biodiversity at Permapra



Biodiversity Impact Assessment at Perambra

Summary of Findings

- An assessment of the existing biodiversity at Apollo Tyres Limited, Perambra shows that there is a moderately rich biodiversity inside the campus (189 species of flora and 118 species of fauna).
- However, 28% percentage of the total flora and 71% of garden plant species at Apollo campus is exotic; therefore the number of native fauna is considerably less.
- At Apollo campus, the tree species (33%) outweighs all other floral categories while insects (59%) comprise a major proportion of faunal diversity.
- The surrounding areas of Apollo campus within 2.5 km radius have a good biodiversity richness and abundance, with more than 90% of floral population being native plants. Therefore, it supports a good number of native faunal populations.
- The direct drivers of changing pattern in the biodiversity in the area are land use/land cover pattern, industrialization, infrastructure development and pollution. Among them, pollution problems severely affect, and changes in land use/land cover pattern and industrialization moderately affect the flora and fauna species of the area. On the other hand, biodiversity is least affected by infrastructural developments in Perambra region.
- The indirect drivers of change in biodiversity assessed in the study are demography, urbanization, socio-economic and cultural factors and alterations in agricultural pattern. Out of which, the biodiversity of the area is most affected by socio-economic factors and alterations in agricultural pattern, whereas it is minimally affected by demography and urbanization.
- The analysis of quality assurance data of Apollo Tyres, Perambra indicates that the company has undertaken some measures to mitigate the pollution problems faced by the neighbouring communities due to Apollo, and its impact is clearly reflected in the positive responses from the community members.

Flower of Golden Cane Yellow Palm in the garden of Kalamassery Plant

4 Results :Kalamassery

4.1. Status of Biodiversity in the Study Area

The overall biodiversity status within the study area is moderately rich, in which the campus has a rich diversity of flora and fauna comparatively. However, according to the survey respondents, there is a substantial decline in biodiversity richness inside and surrounding area of Apollo campus over the last few decades due to disturbances related to urbanization, industrialization and infrastructure developments. Additioally, the biodiversity is continuously under the threat posed by habitat loss, pollution, and introduction of exotic species. Among the existing floral biodiversity, the majority of land in the study area is covered by secondary successional growth than primary growth. The biodiversity status inside the Apollo campus and the surrounding area are analyzed separately in the following sections.

4.1.1. Biodiversity Status inside Apollo Campus

The biodiversity richness inside the campus is moderate to rich. However, respondents of senior employee interview commented that there is a considerable decrease in the biodiversity due to infrastructure developments, human interferences and giving less priority to biodiversity compared to the past.

4.1.1.1. Flora

There are 262 plant species identified inside the Apollo campus. These species include different categories of plants such as trees, shrubs, herbs, climber, creeper and fern and in which majority of them are herbs, trees and shrubs, comprising 35%, 21% and 11% respectively. The plant biodiversity at Apollo consists of both native and exotic species. Among that, almost 22 % of total floral population are exotic, including trees and garden varieties. Garden plants, medicinal plants, bonsai collections and vegetables are present in specific locations such as engineered garden and organic farm. However, trees are scattered all over the campus, mainly concentrated in the backside of the campus. The dominant tree species present in the campus are Teak, Coconut tree, Papaya tree, Earpod Wattle, Brown salwood, and Indian mast tree. The current status of floral biodiversity is enlisted in Table 4.1.

Table 4.1: List of flora inside Apollo Campus in 2014

Sl. No	Malayalam Name	Common Name	*Scientific name*	Type*
1	Changalam Paranda	Devil's Backbone	*Vitis quadrangularis*	Climber
2	Cheruvazhuthana	African eggplant	*Solanum anguivi*	Climber
3	Curtain Plant	Curtain Plant	*Aeonium sp.*	Climber
4	Dancing Orchid	Oncidium	*Oncidium splendidum*	Climber
5	Dritharashtra pacha	Climbing Hempweed	*Mikania micrantha*	Climber
6	Kattu koval	Wild Ivy gourd	*Coccinia sp.*	Climber
7	Koval	Ivy gourd	*Coccinia grandis*	Climber
8	Mathan	Pumpkin	*Cucurbita maxima*	Climber
9	Money plant	Devils eye	*Epipremnum aureum*	Climber
10	Munthiri	Grape	*Vitis vinifera*	Climber

11	Padavalanga	Snake gourd	*Trichosanthes cucumerina*	Climber
12	Shangu Pushpam	Butterfly bean	*Clitoria ternatea*	Climber
13	Slace	Creeping Fig	*Ficus pumila*	Climber
14	Pal valli	Wax Leaved Climber	*Cryptolepis buchananii*	Climber
15	Naga Valli	Betle leaf	*Piper betle*	Climber
16	Vellari	Cucumber	*Cucumis sativus*	Climber
17	Vettila	Betel	*Piper betle*	Climber
18	Uzhinja	Balloon wine	*Cardiospermum halicacabum*	Climber
19	Pudapazham	Wild Maracuja	*Passiflora foetida*	Climber
20	Thotta payar	Hairy bean	*Mucuna bracteata*	Creeper
21	Kottangal	Indian pennywort	*Centella asiatica*	Creeper
22	Kumbalam	White ash guard	*Benincasa hispida*	Creeper
23	Shathaveri	Wild asparagus	*Asparagus recemosus Wild*	Creeper
24	Thazuthama	Spreading hogweed	*Boerhaavia diffusa*	Creeper
25	Puliyarila	Indian sorrel	*Oxalis corniculata*	Creeper
26	Mashitandu chedi	Shiny Bush	*Pteris pellucida*	Fern
27	Silver fern	Silver fern	*Pytirogramma calomelanos*	Fern
28	Pannal chedi	Pyrrosia	*Pyrrosia lanceolata*	Fern
29	Darbha	Sacrificial grass	*Desmostachya bipinnata*	Grass
30	Oolappullu	Kyasuwa grass	*Pennisettum pedicillatum*	Grass
31	Velutta Nirvasi	Kyllinga nemoralis	*Cyperus cephalotes Vahl*	Grass
32	Snehappullu	weeping lovegrass	*Eragrostis viscosa (Retz.) Trin.*	Grass
33	Switchgrass	Switchgrass	*Arundinella leptochloa*	Grass
34	Kaalappullu	Blanket grass	*Axonopus compressus*	Grass
35	Chenkodipullu	Indian Murainagrass	*Ischaemum indicum (Houtt.) Merr.*	Grass
36	Velutta nirvasi	White Water Sedge	*Kyllinga nemoralis*	Grass
37	Adalodakam	Malabar nut	*Justicia adhatoda*	Herb
38	Anachuvadi	Prickly leaved elephant's foot	*Elephantopus scaber*	Herb
39	Anthoorium	Anthurium	*Anthurium andraeanum*	Herb
40	Athi karuka	Acrab	*Spilanthus calva*	Herb
41	Balsam (violet & rose)	Patients Plant	*Impatiens balsamina*	Herb
42	Brahmi	Velvet curtain	*Bacopa monnieri*	Herb
43	Cabbage	Cabbage	*Brassica oleracea*	Herb
44	Cauliflower	Cauliflower	*Brassica oleracea*	Herb
45	Cheera chedi	Velvet curtain	*Amaranthus sp.*	Herb
46	Chemaparathi	Hibiscus	*Hibiscus roosasinensis*	Herb
47	Chena	Elephant foot yam	*Amorphophallus paeoniifolius*	Herb
48	Chineese Jasmin	Chinese Jasmine	*Jasminum Polyanthum*	Herb
49	Chittarutha	Rasna	*Alpinia calcarata*	Herb
50	Choriyanam	Indian Stinging Nettle	*Tragia involucrata*	Herb

51	Chunda	Turky Berry	*Solanum torvum*	Herb
52	Chuvanna amapal	Water lilly	*Nymphae sp.*	Herb
53	Daizy	Daizy	*Bellis perennis*	Herb
54	Dandha pala	Dyers's oleander	*Wrightia tinctoria*	Herb
55	Dressina	Pleomele	*Dracaena reflexa*	Herb
56	Euphorbia	Euphorbia	*Euphorbia milii*	Herb
57	Gold rose			Herb
58	Gold spot	Gold Spot	*Duranta erecta*	Herb
59	Gulgulu	Indian Bedellium	*Commiphora wightii*	Herb
60	Kaanavazha	Heliconia	*Heliconia rostrata*	Herb
61	Kacholam	Aromatic Ginger	*Kaempferia galanga*	Herb
62	Kadalasuchedi	Boguanvilla	*Bougainvillea glabra*	Herb
63	Kallathi	Fig	*Ficus tinctoria*	Herb
64	Daizy chedi	Little daizy	*Melambodium leuchanthum*	Herb
65	Karim kurunji	Cornhead	*Strobilanthes ciliatus*	Herb
66	Karimanjal	Black Turmeric	*Curcuma caesia*	Herb
67	Karimkurunji	Desert rose	*Adenium obesum*	Herb
68	Karingali	Dark Catechu	*Acacia catechu*	Herb
69	Karpura thulasi	Holly basil	*Ocimum tenuiflorum*	Herb
70	Kasthoori Manjal	Wild turmeric	*Curcuma aromatica*	Herb
71	Kattar Vazha	Indian Aloe	*Aloe vera*	Herb
72	Kattu chena	Wild Elephant yam	*Amorphophallus paeoniifolius*	Herb
73	Kattu thulasi	Clove Basil	*Ocimum Gratissimum*	Herb
74	Kattupichi	Starry wild jasmine	Jasminum multipartitum	Herb
75	Kizhar Nelli	Stone breaker	*Phyllanthus niruri*	Herb
76	Krishnakanthi	Dwarf morning glory	*Evolvulus alsinoides*	Herb
77	Lotus	Indian Lotus	*Nelumbo lutea*	Herb
78	Manja Bandi	Marigold	*Calendula officinalis*	Herb
79	Manja Kolambi	Golden Trumpet	*Allamanda cathartica*	Herb
80	Manja mula	Golden Bamboo	*Bambusa vulgaris*	Herb
81	Mashi thandu	Shining bush plant	*Peperomia pellucida*	Herb
82	Morning Glory	Morning glory	*Ipomoea sp.*	Herb
83	Mothappullu	Rice flatsedge	*Cyperus iria L.*	Herb
84	Mukutti	Sensitive plant	*Biophytum Sensitivum*	Herb
85	Mulaku-thakkali	Black nightshade	*Solanam nigrum*	Herb
86	Mulla	Jasmine	*Jasminum officinale*	Herb
87	Muzanda	Muzanda	*Mussaenda erythrophylla*	Herb
88	Nalu Mani Chedi	4'O Clock Plant	*Mirabilis sp.*	Herb
89	Namnthiyar Vattam	Crape Jasmine	*Tabernaemontana divaricata*	Herb
90	Neelakoduveli	Blue plumbago	*Plumbago carpensis*	Herb
91	Nilakara	Goanese	*Nergimia alata*	Herb
92	Nithya Kalayani	Cape periwinkle	*Catharanthus roseus*	Herb
93	Njotta Njodiyan	Native gooseberry	*Njotta Njodiyan*	Herb

94	Pacholi	Patchouli	*Pogostemon cablin*	Herb
95	Pani koorka	Coleus	*Coleus aromaticus*	Herb
96	Pichi	Spanish Jasmine	*Jasminum grandiflorum*	Herb
97	Potha	Bellary Grass	*Heteropogon contortus*	Herb
98	Eezha Chembakam	Frangipania	*Plumeria obtusa*	Herb
99	Rose chethi	Ixora	*Ixora sp.*	Herb
100	Roses	Rose	*Rosa sp.*	Herb
101	Shavam Nari	Madagaskar periwinkle	*Vinca rosea*	Herb
102	Thakkali	Tomato	*Solanum lycopersicum*	Herb
103	Thottavadi	Sensitive plant/ Touch me not	*Mymosa pudica*	Herb
104	Vadamulla	Centaurea cyanus	*Bachelor's Button Flower*	Herb
105	Vazhutana	Brinjal	*Solanum melongena*	Herb
106	Venda	Lady's finger	*Abelmoschus esculentus*	Herb
107	Yellow palm	Yellow palm	*Dypsis lutescens*	Herb
108	Ruellia	Ruellia	*Ruellia tweediana*	Herb
109	Cheruvula	Mountain Knot Grass	*Aerva lanata*	Herb
110	Hemadanthi			Herb
111	Kammal chedi	Singapore Daisy	Sphagneticola trilobata	Herb
112	Koduveli	Red leadwort	*Plumbago rosea*	Herb
113	Kuppamanjal	Tooth ache plant	*Acmella calva*	Herb
114	Maravuruthi			Herb
115	Murikootti	Cemetery plant	*Hemigraphis colorata*	Herb
116	Muyalcheviyan	Consumption weed	*Emilia sonchifolia*	Herb
117	Nilappakla	Asthma Weed	*Euphorbia thymifolia*	Herb
118	Oorala	Anshumati	Desmodium gangeticum	Herb
119	Ornamental illy	Byddha's belly		Herb
120	Paanal	Ban nimbu	*Glycosmis arborea*	Herb
121	Paarakam	Hairy Fig	*Ficus hispida*	Herb
122	Pal Muthuk		*Ipomea digitata*	Herb
123	Paron			Herb
124	Payani		*Pajanelia longifolia*	Herb
125	Puppani			Herb
126	Puthra jeeva	Putranjiva	*Putranjiva roxburghii*	Herb
127	Qualiaz			Herb
128	Ramacham	Vetiver	*Vetiveria zizanioides (Linn.)*	Herb
129	Ramba	Pandan Leaves	*Pandanus latifolius*	Herb
130	Pathumani	Table rose	*Portulaca grandiflora*	Herb
131	Tecoma			Herb
132	Thippali	Long Turmeric	*Piper longum*	Herb
133	Ummam	Devil's Trumpet	*Datura merel*	Herb
134	Vappini			Herb

135	Vathamkolli	Black Vasa	*Justicia gendarussa Burm.f*	Herb
136	Villar			Herb
137	Vishamuli			Herb
138	Kolaambi	Yellow Bell	*Allamanda cathartica*	Herb
139	Kattukaduku	Asian spider flower	*Cleome viscosa*	Herb
140	Payal	Artillery Plant	*Pilea microphylla*	Herb
141	Anakaita	American Century Plant	*Agave americana*	Herb
142	Kalnjarala		*Cissus heyneana Steud.*	Herb
143	Velichedi	Mouse tail Plant	*Phyllanthus myrtifolia*	shrub
144	Arali Pala	Nerium	*Nerium oleander*	Shrub
145	Avanak	Castor oil Plant	*Ricinus communis*	Shrub
146	Blue star	Willow blue star	*Amsonia tabernaemontana*	Shrub
147	Chembakam	Golenchi	*Plumeria obtusa*	Shrub
148	Chembakam	Frangipani	*Plumeria rubra*	Shrub
149	Cherru-pullate	Birdsville Indigo	*Indigofera linnaei*	Shrub
150	Chethi	Ixora	*Ixora coccinia*	Shrub
151	Communist pacha	Eupatorium	*Chromolaena odorata*	shrub
152	Croton Plant	Croton	*Codiaeum variegatum*	Shrub
153	Curry leaf plant	Curry leaf	*Murraya koenigii*	Shrub
154	Endhu	Cycas	*Cycas circinalis*	shrub
155	Erukku	Madar Plant	*Calotropis gigantia*	Shrub
156	Ittalkkanni	Honey Suckle Mistletoe	*Dendrophthoe falcata*	Shrub
157	Kallurukki	Sweet Broomweed	*Scoparia dulcis*	Shrub
158	Kappa	Tapioca	*Manihot esculenta*	Shrub
159	Kolambi	Yellow bell flower	*Tecoma stans*	Shrub
160	Kongini/ Kadukkan	Spanish Flag	*Lantana camera*	Shrub
161	Miniature Njaval	Miniature Black Plum	*Syzygium sp.*	Shrub
162	Neervalam	Croton	*Croton tiglium*	Shrub
163	Parijatham	Coral Jasmine	*Nyctanthes arbor-tristis*	Shrub
164	Sylon Pak			Shrub
165	Vaazha	Banana	*Musa sp.*	Shrub
166	Vaduka puli		*Citrus aurantifolia*	Shrub
167	Enja	Shikakai	Acacia concinna	Shrub
168	Mulberry	Mulberry	*Persia macarantha*	Shrub
169	Mathura puli			Shrub
170	Neermathalam	Sacred Garlic Pear	*Crateva religiosa*	Shrub
171	Ololikka	Indian plum	*Flacourtia jangomas (Lour.) Raeusch.*	Shrub
172	Varipam puli			Shrub
173	Ganapathi Narakam	Citron	*Citrusmedica*	Shurb
174	Chandanavempu	Indian Mahagani	*Toona ciliate Roe*	Tree
175	Thuja	Thuja	*Thuja occidentalis*	Tree
176	Acacia	Earpod Wattle	*Acacia auriculiformis*	Tree
177	Ambazham	Wild Mango	*Spondias pinnata*	Tree

178	Anjili	Wild Jack Fruit Tree	*Artocarpus hirsutus*	Tree
179	Aracanut	Aracanut tree	*Areca catechu*	Tree
180	Arali (pink flower)	Oleander	*Nerium oleander*	Tree
181	Arana Maram (Pendulam)	Indian Mast Tree	*Polyalthia longifolia*	Tree
182	Arayaal	Peepal Tree	*Ficus religiosa*	Tree
183	Aryaveppu	Neem	*Azadirachta indica*	Tree
184	Asokam	Ashoka tree	*Saraca asoca*	Tree
185	Badam	Tropical Almond	*Terminalia catappa*	Tree
186	Bottle brush	Bottle brush	*Callistemon citrinus*	Tree
187	Bottle Palm	Bottle palm	*Hyophorbe lagenicaulis*	Tree
188	Cashewnut	Cashew	*Anacardium occidentale*	Tree
189	Ceylon Vaga	Jacaranda Tree	*Jacaranda mimosifolia*	Tree
190	Chandana Veppu	Sandal Neem	*Toona ciliata*	Tree
191	Chandanam	Sandal wood tree	*Santalum album*	Tree
192	Champa	Rose apple	*Syzygium samarangense*	Tree
193	Channa (local species)	Malay ginger	*Costus speciosa*	Tree
194	Chappangam	Sappan Wood	*Caesalpinia sappan*	Tree
195	Sheemakonna	Mexican lilac	*Gliricidia sepium*	Tree
196	Cheeniku			Tree
197	Aalmaram	Indian Banyan tree	*Ficus benghalensis*	Tree
198	Ungu	Indian beech	*Pongamia pinnata*	Tree
199	Vatta	Gum plant	*Macranga peltata*	Tree
200	Cycus palm	Japanese sago palm	*Cycas revoluta*	Tree
201	Dividivi	Divi-divi	*Caesalpinia coriaria*	Tree
202	Elanji	Bullet-wood tree	*Mimusops elengi Linn.*	Tree
203	Ezhillam Pala	Devil Tree	*Alstonia scholaris*	Tree
204	Golden Cypress	Golden Cypress	*Xanthocyparis vietnamensis*	Tree
205	Gulmohar	Flamboyant	*Delonix regia*	Tree
206	Ippil Ippil	Wild tamarind	*Leucaena leucocephala*	Tree
207	Kadambu	Common Bur-flower	*Anthocephalus chinensis*	Tree
208	Kalashu	Indian Ash tree	*Lannea coromandelica*	Tree
209	Kanikonna	Indian Laburnum	*Cassia fistula*	Tree
210	Kanjiram	Snake wood	*Strychnos psilosperma*	Tree
211	Karimaruthu	Indian Laurel	*Terminalia alata*	Tree
212	Karinjotta	Niepa Bark Tree	*Samadera indica*	Tree
213	Karinochi	Five leaved Chast tree	*Vitex nigundo*	Tree
214	Katesam	Indian Cork Tree	*Millingtonia hortensis*	Tree
215	Kattu Jaathi	Nutmeg	*Myristica fragrans*	Tree
216	Keezhar Nelli	Hazarmani	*Phyllanthus amarus*	Tree
217	Lubi	Red gooseberry	*flacourtia inermis*	Tree
218	Maavu	Mango Tree	*Mangifera indica*	Tree

219	Mazha Maram	Rain Tree	*Albizia saman*	Tree
220	Mahagani	Mahogany	*Swietenia mahagoni*	Tree
221	Mangium	Brown salwood	*Racosperma mangium (Willd.) Pedley*	Tree
222	Mani Maruthu	Giant Crape-myrtle	*Lagerstroemia speciosa*	Tree
223	Manimaram	Giant Crape-myrtle	*Lagerstroemia speciosa*	Tree
224	Manja Vaka	Copper-pod	*Peltophorum pterocarpum*	Tree
225	Manjadi	Red Bead Tree	*Adenanthera pavonina*	Tree
226	Mantharam	Pink butterfly tree	*Bauhinia purpurea*	Tree
227	Marotti	Leathery leaved tree	*Hydnocarpus wightiana*	Tree
228	Muringa	drum stick plant	*Moringa oleifera*	Tree
229	Neela Vaaka	Green Ebony	*Diospyros buxifolia*	Tree
230	Neermaruthu	Arjun Tree	*Terminalia arjuna*	Tree
231	Njaaval	Black Plum	*Syzygium cumini*	Tree
232	Orange maram	Orange tree	*Citrus sinensis*	Tree
233	Panchasara Pazham/ Pottama	Jamaica cherry	*Muntingia calabura*	Tree
234	Pani Neer Chamba	Wild Jambua	*Syzygium occidentale*	Tree
235	Pappaya tree	Pappaya	*Carica papaya*	Tree
236	Peral	Indian Banyan	*Ficus benghalensis*	Tree
237	Perumaram	Indian Tree of Heaven	*Ailanthus triphysa*	Tree
238	Pink Mantharam	Pink butterfly tree	*Bauhinia purpurea*	Tree
239	Plaavu	Jack Fruit Tree	*Artocarpus heterophyllus*	Tree
240	Pongalyam	Matchbox tree	*Pongamia glabera*	Tree
241	Poomaruthu/Manimaruthu	Queen's Crape-myrtle	*Lagerstroemia speciosa*	Tree
242	Punna	Alexandrian laurel balltree	*Calophyllum inophyllum*	Tree
243	Raktha chandanam	Red sandal wood	*Pterocarpus santalinus Linn.f.*	Tree
244	Red palm	Red palm	*Acanthophoenix rubra*	Tree
245	Royal Palm	Royal Palm	Roystonea regia	Tree
246	Silver Oak	Silver oak	*Grevillia robusta*	Tree
247	Surni			Tree
248	Thekku	Teak	*Tectona grandis*	Tree
249	Thengu	Coconut Tree	*Cocos nucifera*	Tree
250	Thondi/Therakam	Brahma's Banyan	*Ficus exasperata*	Tree
251	Vatta Kumbil	Beechwood	*Gmelina arborea*	Tree
252	Parijatham	Florida Fiddlewood	*Citharexylum spinosum L.*	Tree
253	Kadukka	Chebulic myrobalan	*Terminalia chebula*	Tree
254	Malaveppu	Cape Lilac	*Melia azedarach*	Tree
255	Nagalimgam	Cannon Ball Tree	*Couroupita guianensis*	Tree
256	Pathiri	Trumpet Flower Tree	*Stereospermum colais*	Tree
257	Rudhraksham	Rosery nut	*Elaeocarpus angustifolius*	Tree
258	Sarva Sugandi	Allspice	*Pimenta dioica*	Tree
259	Seemakongini	Indian Snakeweed	*Stachytarpheta jamaicensis*	Tree

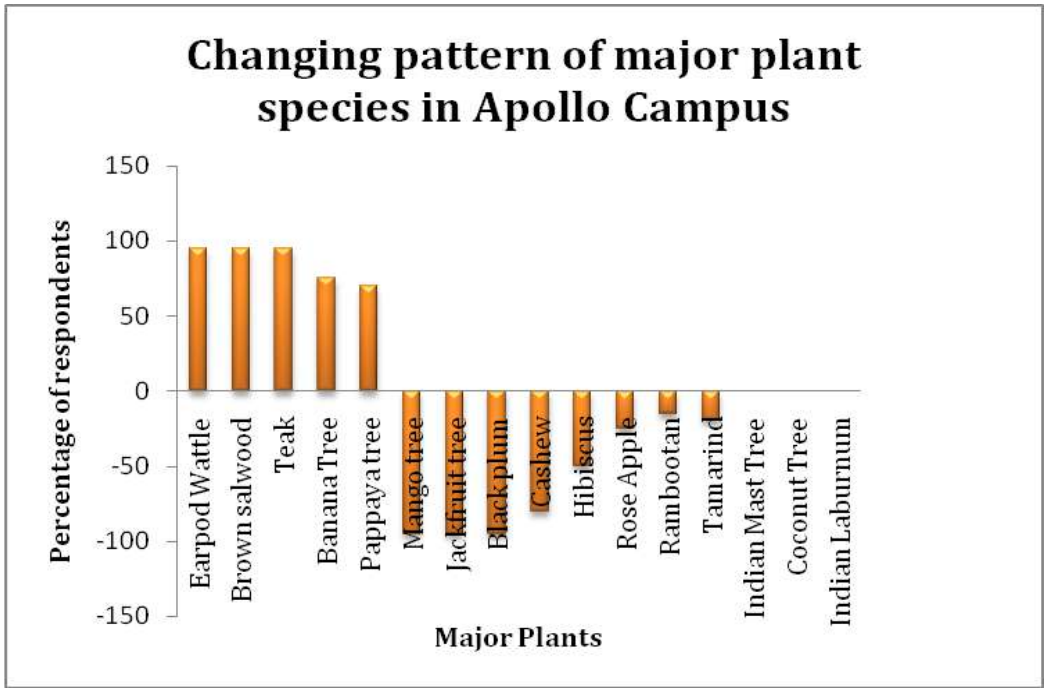
260	Thanni	Belliric myrobalan	*Terminalia bellirica Roxb.*	Tree
261	Cherujara		*Syzygium caryophyllatum (L.) Alston*	Tree
262		Rubber bush	*Ficus elastica Roxb. ex Hornem.*	Tree

As the past biodiversity status is collected based on the interview of senior employees in the Apollo Tyres, they could only recall the names of major plants present in the campus (Table 4.2). As per the senior employees' opinion, overall tree cover inside the campus decreased compared to 1970s. The Fig 4.1 indicates the trend in the abundance of major plant species inside the campus in comparison to the period of Premier Tyres. Almost 95 % of respondents of the interview said that fruit trees such as Mango tree, Jackfruit tree, and Black plum declined significantly as the trees were cut down for the infrastructural developments inside the campus. It indicates that the native fruit trees in the campus have reduced; therefore, it could affect the fauna population that depend on native flora for their food and shelter. One of the interviewees claimed that there were 36 varieties of Hibiscus inside the campus, but now Apollo has only a limited number of Hibiscus varieties. The number of Coconut tree, Indian mast tree and Indian Laburnum are almost same compared to the past. However, exotic tree species such as Earpod Wattle, Brown salwood and teak are introduced in the campus, and their number increased drastically inside the campus. Due to lack of sufficient information on past flora, the comparison of past and present flora is limited to the information gathered from the interviews.

Table 4.2: List of major flora inside Apollo campus during the period of 1978–1988 (Based on Senior Employees Interview)

Sl. No	Malayalam Name	Common name	*Scientific Name*
1	Mavu	Mango	*Mangifera indica*
2	Plavu	Jack fruit	*Artocarpus heterophyllus*
3	Kashumavu	Cashewnut	*Anacardium oxydental lin*
4	Njaval	Black Plum	*Syzygium cumini*
5	Thengu	Coconut tree	*Cocos nucifera*
6	Aranamaram	Indian Mast tree	*Polyalthia longifolia*
7	Mazhamaram	Raintree	*Albizia saman*
8	Vaga	Gulmohar	*Quercus*
9	Kanikonna	Indian Laburnum	*Cassia fistula*
10	Chembarathi	Hibiscus	*Hibiscus roosasinensis*
11	Rosa	Rose	*Rosa centifolia*
12	Champa	Rose Apple	*Syzygium Samarangense*

Fig 4.1: Changing pattern of selected flora inside the campus from1975/85 to 2014 (Based on Senior Employees Interview)



4.1.1.2. Fauna

There were 99 species of fauna observed inside the Apollo campus, out of which 31 were birds, 21 were butterflies, 18 were dragonflies, 10 were reptiles, 9 were mammals, 9 were other insects and one was ampibian species. The overall faunal diversity is moderate as the abundance of fauna species are not evenly distributed inside the campus (Table 4.3). Though the bird diversity is rich inside the campus, the sightings and calls of birds near the plant area are rare due to continuous human interventions and sound pollution. Most of the birds were observed in the southern corner of the Apollo campus, but the abundance of each bird species is less. In addition, there is a moderate diversity of butterflies and dragonflies in the campus, but the diversity of reptiles, mammals, other insects and ambibian is low. All these species are mainly threatened due to habitat loss inside the campus that could create imbalance in ecosystem services. Also, it has been noticed that the abundance of mosquitoes is very high in the campus as a result of higher rates of mosquito breeding in the stagnant water in the tyres stored in the ground.

Table 4.3: List of fauna inside the Apollo Campus in 2014 (Based on senior employees' interview)

Sl.No	Malayalam Name	Common Name	*Scientific Name*	Status*
BIRDS				
1	Pena Kakka	House Crow	*Corvus splendens*	Common
2	Ambala Pravu	Rock pigeon	*Columba livia*	Common
3	Madatha	Common Myna	*Acridotheres tristis*	Common
4	Kuyil	Asian Koel	*Eudynamys scolopacea*	Rare
5	Uppan/Chembothu	Greater Coucal	*Centropus sinensis*	Occasional

6	Nattumaram kothi	Black rumped Flame back	*Dinopium bengalensis*	Rare
7	Kula Kokku	Indian Pond Heron	*Ardeola grayii*	Common
8	Perumundi	Great Egret	*Ardea alba*	Rare
9	Cherumundi	Median Egret	*Mesophoyx intermedia*	Common
10	Nattu Thatha	Roseringed Parakeet	*Psittacula krameri*	Common
11	Olenjali	Indian Tree pie	*Dendrocitta vagabunda*	Occasional
12	Valiyakaruppan Thenkili	Loten's Sunbird	*Nectarinia lotenia*	Rare
13	Erattathalachi bulbul	Redwhiskered Bulbul	*Pycnonotus jocosus*	Occasional
14	Meenkothi Chathan	White Throated Kingfisher	*Halcyon smyrnensis*	Occasional
15	Chutteenthalkkil	Pied Bush- Chat	*Saxicola caprata*	Rare
16	Nakamohan	Asian Paradise Flycatcher	*Terpsiphone paradisi*	Rare
17	Puthangiri	White headed Babbler	*Turdoides malcolmi*	Common
18	Pachilakuduka	White cheeked barbet	*Megalaima viridis*	Rare
20	Indian Manjakili	Golden Oriole	*Oriolus oriolus*	Occasional
21	Mannathikili	Oriental Magpie Robbin	*Copsychus saularis*	Occasional
22	China Manjakkili	Balck Naped Oriole	*Oriolus chinensis*	Occasional
23	Kakkathamburati	Black Drongo	*Dicrurus macrocercus*	Common
24	Kadumuzhakki	Greater Racket-Tailed Drongo	*Dicrurus paradiseus*	Rare
25	Cheriya meenkothi	Common Kingfisher	*Alcedo atthis*	Occasional
26	Krishna Parunthu	Brahminy Kite	*Haliastur indus*	Occasional
27	Chakki Parunthu	Pariah Kite / Black kite	*Milvus migrans*	Common
28	Vellimoonga	Barn owl	*Tyto alba*	Rare
29	Pullu nathu	Brown hawk owl	*Ninox scutulata*	Rare
30	Angadi kuruvi	House sparrow	*Passer domesticus*	Common
31	Eranda	Lesser Whistling duck	*Dendrocygna javanica*	Rare
BUTTERFLIES				
1	Pottuvellatti	Psyche	*Leptosia nina*	Common
2	Manjathakaramuthi	Common Emigrant	*Catopsilia pomona*	Common
3	Thakaramuthi	Mottled Emigrant	*Catopsilia pyranthe*	Occasional
4	Manjapappathi	Common Grass Yellow	*Eurema hecabe*	Occasional
5	Chocolate albatross	Chocolate albatross	*Appias tyncida*	Common
6	Panchanethri	Common five ring	*Ypthima baldus*	Common

7	Theechirakan	Tawny Caster	*Acreaea violae*	Occasional
8	Thavidan	Common Bush Brown	*Mycalesis perseus*	Rare
9	Chakkarashalabham	Crimson Rose	*Pachilopta hector*	Occasional
10	Natturose	Common rose	*Pachilopta aristolochiae*	Occasional
11	Viravaalan	Tailed Jay	*Graphium agamemnon*	Rare
12	Marotti Shalabham	Tamil Yeoman	*Cirrochroa thais*	Rare
13	Ponthachuttan	Common Sailor	*Neptis hylas*	Rare
14	Aavanachoppan	Common castor	*Ricinus communis*	Occasional
15	Vanachottashalabham	Great Egg fly	*Hypolimnas bolina*	Occasional
16	Erikkuthappi	Plain Tiger	*Danaus chrysippus*	Common
17	Varayankaduva	Striped Tiger	*Danaus genutia*	Occasional
18	Aralishalabham	Common Indian crow	*Euploea core*	Occasional
19	Neelakaduva	Blue Tiger	*Tirumala limniace*	Rare
20	Sharashalabham	Rice Swift	*Borbo cinnara*	Occasional
21	Oalakkandan	Common Palmfly	*Elymnias hypermnestra*	Occasional
DRAGONFLIES AND DAMSELFLIES				
1	Changathi Thumbi	Asian Groundling	*Brachythemis contaminata*	Common
2	Swami thumbi	Blackspot Widow	*Neurothemis tullia*	Common
3	Chendhavidan vyali	Red- faced Skimmer	*Orthetrum Chrysis*	Occasional
4	Cheru venneran	Sombre Lieutenant	*Brachydiplax sobrina*	Occasional
5	Onathumbi	Global Wanderers	*Pantala flavescens*	Occasional
6	Mathil Thumbi	Indian Rockdweller	*Bradinopyga geminata*	Rare
7	Thavittu Venneeran	Blue Dasher	*Brachydiplax chalybea*	Occasional
8	Vayal thumbi	Oriental Scarlet	*Crocothemis servilia*	Rare
9	Chuttinilathan	Black-tipped Percher	*Diplacodes nebulosa*	Occasional
10	Pacha vyali	Green Skimmer	*Orthetrum sabina sabina*	Common
11	Shalabhathumbi	Common Picture Wing	*Rhyothemis variegata*	Rare
12	Karimban thumbi	Black – Marsh Trotter	*Tramea limbata*	Occasional
13	Pavizhavalan	White Burned Buskhawk	*Tholymis tillarga*	Occasional
14	Pulthurumban	Paddy field parasol	*Neurothemis intermedia*	Occasional
15	Nattu Nilathan	Ground Skimmer	*Diplacodes trivialis*	Occasional
16	Cheriya thanal thumbi	Clear-winged Flash Wing	*Vestalis gracilis*	Rare
17	Theekarimuthan	Elusive Adjutant	*Aethriamanta brevipennis*	Rare
18	Nattu Chathuppan	Yellow wax-tail	*Ceriagrion coromandelianum*	Rare
OTHER INSECTS				

1	Pachakkala/ Vittle	Grass Hopper	*Caelifera sp.*	Common
2	Vettile	Beetle	*Coleoptera sp.*	Common
3	Ettukali	Common HouseSpider	*Achaearanea tepidariorum*	Common
4	Theneecha	Honey bee	*Apis sp.*	Common
5	Urumpu	Ant	*Formicidae sp.*	Common
6	Eecha	House fly	*Musca domestica*	Common
7	Kadannal	Wasp	*Hymnoptera sp.*	Common
8	Kaduvakkothuku	Tiger Mosquito	*Aedes albopictus*	Common
9	Nettiyeppottan	Yellow fever mosquito	*Aedes aegypty*	Common
REPTILES				
1	Moorkan	Spectacled Cobra	*Naja naja*	Occasional
2	Valavalappan	Wolf snake	*Lycodon aulicus*	Occasional
3	Vellikattan	Krait	*Bungarus coruelus*	Occasional
4	Anali	Viper	*Daboiea russeli*	Occasional
5	Chera	Rat snake	*Ptyas mucosa*	Occasional
6	Onthu	Garden lizard	*Calotes versicolor*	Common
7	Palli	House Gecko	*Hemidactylus sp.*	Common
8	Arana	Common Skink	*Mabuya carinata*	Common
9	Aama	Indian pond Terrapin	*Melanochelys trijuga*	Rare
10	Udumbu	Monitor lizard	*Varanus bengalensis*	Occasional
MAMMALS				
1	Poocha	Domestic cat	*Felis catus*	Common
2	Patti	Dog	*Canis lupus*	Common
3	Keeri	Common Mongoose	*Herpestes edwardsii*	Occasional
4	Annan	Three striped Palm Squirrel	*Funambulus palmarum*	Common
5	Eli	Norway rat	*Rattus norvegicus*	Common
6	Veetteli	House Rat	*Rattus rattus*	Common
7	Panni eli	Large Bandicoot rat	*Bandicota indica*	Common
8	Thurappan eli	Lesser Bandicoot rat	*Bandicota bengalensis*	Common
9	Vavval	Bat	*Pterops giagantis*	Common
AMPHIBIANS				
1	Thavala	Indian Bullfrog	Hoplobatrachus tigerinus	Common

The status of fauna species present in the past is collected from the memory of employees, which is shown below (Table 4.4). According to the senior employees, the overall diversity of fauna species was rich in the past compared to the present. Almost 95 % of respondents commented that the trend of bird population diminished inside the campus. This is mainly because of decreasing number of native fruit trees inside the

campus as many fruit trees were cut down for infrastructural developments inside the campus. The diversity of reptiles is almost same, though the abundance reduced slightly. However, there is a significant decline in mammal population inside the campus because of habitat loss.

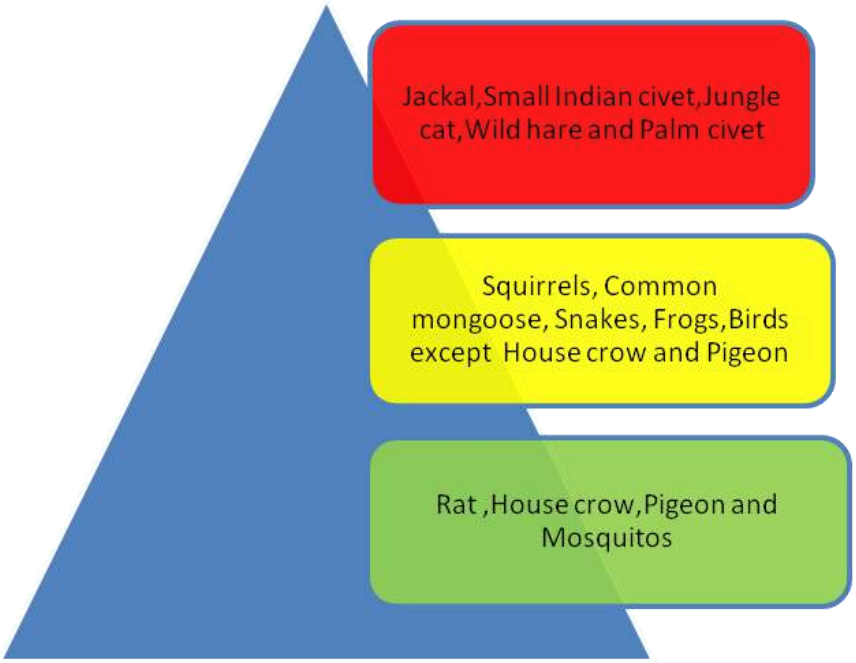
Table 4.4: List of fauna inside the Apollo campus in the period of 1975-85 (Based on senior employee survey)

Sl.No	Malayalam Name	Common Name	*Scientific Name*
BIRDS			
1	Kakka	House crow	*Corvus splendens*
2	Pravu	Pigeon	*Columba livia*
3	Madatha	Common Myna	*Acridotheres tristis*
4	Kuyil	Asian Koel	*Eudynamys scolopace*
5	Uppan/Chembothu	Greater Coucal	*Centropus sinensis*
6	Maram kothi	Black rumped Flameback	*Dinopium bengalensis*
7	Kula Kokku	Indian Pond Heron	*Ardeola grayii*
9	Cherumundi	Median Egret	*Mesophoyx intermedia*
10	Nattu Thatha	Roseringed Parakeet	*Psittacula krameri*
11	Aattakkuruvi	Baya Weaver	*Ploceus philippinus*
12	Pachilakuduka	Brown headed barbet	*Megalaima zeylanica*
13	Perumundi	Great Egret	*Ardea alba*
14	Olenjali	Indian Tree pie	*Dendrocitta vagabunda*
15	Thoppi kili	Redwhiskered Bulbul	*Pycnonotus jocosus*
16	Moonga	Brown owl	*Strix leptogrammica*
17	Ponman	White Breasted Kingfisher	*Halcyon smyrnensis*
18	Kakkathamburati	Black Drongo	*Dicrurus macrocercus*
19	Big erattavalan	Greater Racket- Tailed Drongo	*Dicrurus paradiseus*
20	Puthangiri	Large Grey Babbler	*Turdoides malcolmi*
21	Kuruvi	House sparrow	*Passer domesticus*
22	Pachilakuduka	Green Barbet	*Megalaima haemacephala*
23	Manjakili	Golden Oriole	*Oriolus oriolus*
24	China Manjakkili	Balck Naped Oriole	*Oriolus chinensis*
25	Choolan Eranda	Lesser Whistling duck	*Dendrocygna javanica*
REPTILES			
1	Moorkan	Cobra	*Naja naja*
2	Valavalappan	Wolf snake	*Lycodon aulicus*
3	Vellikattan	Krait	*Bungarus coruelus*
4	Anali	Viper	*Daboiea russeli*
5	Chera	Rat snake	*Ptyas mucosa*
6	Palli	House Lizard	*Hemidactylus sp.*
7	Arana	Golden Lizard/ Skink	*Mabuya sp.*
8	Aama	Pond Turtle	*Testudo sp.*

9	Onthu	Garden lizard	*Calotes versicolor*
10	Udumbu	Monitor lizard	*Varanus sp.*
MAMMALS			
1	Poocha	Domestic cat	*Felis catus*
2	Patti	Dog	*Canis lupus*
3	Keeri	Common Mongoose	*Herpestes edwardsii*
4	Annan	Three striped Palm Squirrel	*Funambulus palmarum*
5	Vauval	Bat	*Chiroptera*
6	Marapatti	Toddy cat	*Paradoxurus jerdonii*
7	Kattumuyal	Black naped hare	Lepus nigricollis
8	Veruk	Small Indian Civet	*Viverricula indica*
9	Kurukan	Jackal	*Canis aureus*
10	Veetteli	House Rat	*Rattus rattus*
11	Panni Eli	BrownRat	*Rattus norvegicus*
12	Kattu poocha	Jungle cat	*Felis chaus*
AMPHIBIANS			
1	Thavala	Indian Bullfrog	Hoplobatrachus tigerinus

The Fig 4.2 demonstrates the changing pattern of selected fauna inside Apollo campus compared to the time period of 1970s. The animals shown in the narrow part of the pyramid are not currently seen at the Apollo campus. These animals have disappeared from the campus mainly because of urbanization in the area and related human activities. The animals listed in the middle part still exist in the campus, but the abundance of these species reduced considerably. The bottom part of the pyramid displays the species of animals that had an increase in abundance over the years.

Fig 4.2: Changing pattern of selected fauna inside the Apollo campus (1975 -2014) (Based on senior employee interview)



4.1.2. Biodiversity Status in the Surrounding Area of Apollo Campus

The diversity of species in the surrounding area of Apollo campus is moderate to low, and there is a significant decline in the biodiversity due to increasing industrialization and urbanization compared to the past biodiversity.

4.1.2.1. Flora

Based on sampling study of biodiversity in the surrounding area of Apollo campus, almost 138 flora species were identified and listed below (Table 4.5). The existing floral diversity is mainly dominated by garden plants and secondary successional growth in the study area due to higher rates of development activities, congested housing and infrastructures. Therefore, the space available for natural vegetation is often diminished and subsequently reduced the native faunal diversity. However, according to the survey respondents, the floral biodiversity was moderate to rich in the past. In addition, people used to depend on homeyard cultivation for food item and occasionally medicines; therefore, the list of plants given in table 4.6 consists of only the plants that they were depended on and could remember the names.

Table 4.5: List of flora of surrounding area of Apollo Campus in 2014

Sl. No	Malayalam Name	Common Name	*Scientific Name*	Type
1	Curtain Plant	Curtain Plant	*Aeonium sp.*	Climber
2	Ethikanni	Honey suckle mistletoe	Loranthus falcatus	Climber
3	Ever green	Ever green	*Asparagus racemosus*	Climber
4	Kattu payar	Wild peas	Lathyrus vestitus	Climber
5	Koval	Ivy guard	*Coccinia grandis*	Climber
6	Kurumulaku	Black pepper	*Piper nigrum*	Climber
7	Money plant	Money plant	*Epipremnum aureum*	Climber
8	Padavalam	Snake gaurd	*Trichosanthes cucumerina*	Climber

9	Passion fruit	Passion fruit	*Passiflora edulis*	Climber
10	Paval	Bitter Gourd	*Momordica charantia*	Climber
11	Payar	Peas	*Phaseolus vulgaris*	Climber
12	White grass	Silver grass	*Leersia virginica*	Grass
13	Aadalodakam	Malabar nut	*Justicia adhatoda*	Herb
14	Ambal	Water lilly	*Nymphaea odorata*	Herb
15	Anthurium	Anthurium	*Anthurium andraeanum*	Herb
16	Balsam	Balsam	*Impatiens balsamina*	Herb
17	Bandi	Marigold	*Calendula officianalis*	Herb
18	Bridal boquet	Bridal boquet	*Plumeria pudica*	Herb
19	Cheera	Spinach	*Amaranthus sp.*	Herb
20	Chethi	Ixora	*Ixora coccinia*	Herb
21	Chineese bolssom	Chineese bolssom	*Impatiens balsamina*	Herb
22	Cypress	Cypress	*Cupressus sempervirens*	Herb
23	Daliya chedi	Daliya	*Dahlia hortensis*	Herb
24	Devadharu		*Cedrus deodara*	Herb
25	Dressina	Dressina	*Dracaena sanderiana*	Herb
26	Euphorbia	Euphorbia	*Euphorbia milii*	Herb
27	Karanam potti	Ghost chilly	Capsicum chinense peppe	Herb
28	Goldspot	Gold Spot	*Duranta erecta*	Herb
29	Jamanthi	Marigold	*Chrysanthemum indicum*	Herb
30	Jerapara	Jerapara	*Gerbera viridifolia*	Herb
31	Kachil	Greater/Asiatic Yam	*Dioscorea alata*	Herb
32	Kannavazha	Heliconia	*Heliconia rostrata*	Herb
33	Kalyana saughandikam	Garland Lily	*Hedychium coronarium*	Herb
34	Kanakambaram	Fire cracker flower	*Crossandra infundibuliformi*	Herb
35	Karinochi	Horseshoe vitex	*Vitex negundo*	Herb
36	Kattarvazha	Aloe vera	*Flacourtia Jangomas*	Herb
37	Lucky bamboo	Lucky bamboo	Dracaena sanderiana	Herb
38	Manjal	Turmeric	*Curcuma longa*	Herb
39	Mulla	Jasmine	*Jasminum grandiflorum*	Herb
40	Cheera	Mysore spinach	*Amaranthus sp.*	Herb
41	Naalumani chedi	4'O Clock Plant	*Mirabilis Jalapa*	Herb
42	Orchid	Orchid	*Orchidaceae*	Herb
43	Pachamulaku	Chilli	*capsicum spp*	Herb
44	Panal	Ban Nimbu	*Glycosmis mauritiana*	Herb
45	Panikoorkka	Indian Rock foil	*Plectranthus amboinicus*	Herb
46	Parijatham	Coral Jasmine	*Nyctanthes arbor-tristis*	Herb
47	Pichi	Spanish jasmine	*Jasminum grandiflorum*	Herb
48	Lilly	Lilly	*Lilium sp.*	Herb
49	Rajamalli	Peacock flower	*Caesalpinia pulcherrima*	Herb
50	Rosa	Rose	*Rosa centifolia*	Herb
51	Sacred heart	Coleus	*Solenostemon scutellarioides*	Herb
52	Sarvasughandhi	Allspice	*Pimneta diocia*	Herb

53	Shangu pushpam	Butterfly pea	*Clitoria ternalea*	Herb
54	Shavanari poovu	Vinca	*Catharanthus Roseus*	Herb
55	Pathumani	Table rose	*Portulaca grandiflora*	Herb
56	Thulsi	Basil	*Oscimum sanctum*	Herb
57	Thumpa	Thumbe	*Leucas aspera*	Herb
58	Vadamulla	Globe amaranth	*Gomphrena globosa*	Herb
59	Vatta	gum plant	*Macaranga peltata*	Herb
60	Vazhuthana	Brinjal	*Solanum melongena*	Herb
61	Venda	Lady's Finger	*Abelmoschus esculentus*	Herb
62	Communist pacha	Eupatorium	*Chromolaena odorata King*	Herb
63	Dahlia	Dahlia	*Dahlia hortensis*	Herb
64	Seeniya	Zinnia	Zinnia peruviana	Herb
65	Aatha	Custard apple	*Anona squamosa*	Shrub
66	Arali	Nerium	*Nerium oleander*	Shrub
67	Bougainvillae	Bougainvillae	*Bougainvillea glabra*	Shrub
68	Champa	Rose Apple	*Syzygium Samarangense*	Shrub
69	Chembarathi	Hibiscus	*Hibiscus roosasinensis*	Shrub
70	Chempakam	Golenchi	*Plumeria rubra acutifolia*	Shrub
71	Cherunarakam	Lemon	*Citrus lemon*	Shrub
72	Chilimba puli	Bilimbi	*Averrhoa bilimbi*	Shrub
73	Communist pacha	Eupatorium	*Chromolaena odorata King*	Shrub
74	Croton	croton	*Codiaeum variegatum*	Shrub
75	Egg fruit	Canistel	*Pouteria campechiana*	Shrub
76	Gandharajan	White emetic nut	*Gardenia gummifera Linn*	Shrub
77	Kallimul chedi	Catus	*Cactaceae*	Shrub
78	Kanikkonna	Golden shower tree	*Cassia fistula*	Shrub
79	Kappa	Tapioca	*Manihot esculenta*	Shrub
80	Kappalam	Papaya	*Carica papaya*	Shrub
81	Kariveppila	Curry leaves	*Murraya koenigii*	Shrub
82	Kolambi	Yellow bell flower	*Tecoma stans*	Shrub
83	Kongini/ Kadukkan	Spanish Flag	*Lantana camera*	Shrub
84	Kozhivalan	Mountain cypress	*Celosia nodiflora*	Shrub
85	Mulberry	Mulberry	*Morus alba*	Shrub
86	Muringa	Drum stick plant	*Moringa oleifera*	Shrub
87	Mussanda	Mussanda	*Mussaenda erythrophylla*	Shrub
88	Mylanchi	Henna	*Lawsonia inermisLinn.*	Shrub
89	Narakam	Lemon	*Citrus limon*	Shrub
90	Nathyarvattam	East Indian Rosebay	*Ervatamia coronaria*	Shrub
91	Ololikka	Red gooseberry	*flacourtia inermis*	Shrub
92	Orange	Orange	*Citrus sinensis*	Shrub
93	Pera	Guava	*psidium gavjava*	Shrub
94	Peringalam	Clerodendrum	*Clerodendrum viscosum*	Shrub
95	Supportica	Supportica	*Manilkara zapota*	Shrub
96	Vaazha	Plantain	*Musa sp.*	Shrub
97	Anjili	Wild Jack Fruit Tree	*Artocarpus hirsutus*	Tree
98	Arana maram	Indian Mast Tree	*Polyalthia longifolia*	Tree

99	Arayal	Banyan tree	*Ficus religiosa*	Tree
100	Aryavep	Neem tree	*Azadirachta indica*	Tree
101	Ashokam	Asoka tree	*Saraca indica*	Tree
102	Badam	Badam	*Terminalia catappa*	Tree
103	Christmas tree	Christmas tree	*Araucaria araucana*	Tree
104	Dividivi	Divi-divi	*Caesalpinia coriaria*	Tree
105	Elanji	Bullet-wood tree	*Mimusops elengi Linn.*	Tree
106	Green palm	Cuban belly palm	*Acrocomia crispa*	Tree
107	Jathi	Nutmeg	*Myristica fragrans*	Tree
108	Kadaplavu	Bread fruit tree	*Artocarpus Altilis*	Tree
109	Kamuk	Arecanut	*Areca catechu*	Tree
110	Kashumaavu	Cashewnut	*Anacardium occidentale*	Tree
111	Kodampuli	Garcinia	Garcinia cambogia	Tree
112	Koovalam	Bael	*Aegle marmelos*	Tree
113	Maavu	Mango tree	*Mangifera indica*	Tree
114	Mahagani	Mahogany	*Swietenia macrophylla*	Tree
115	Manjadi	Peacock flower fence	*Adenanthera pavonina*	Tree
116	Mantharam	white orchid tree	*Bauhinia tomentosa*	Tree
117	Maruthu	White Marudah	Terminalia arjuna	Tree
118	Mazhamaram	Raintree	*Albizia saman*	Tree
119	Mula	Bamboo	*Bambuseae*	Tree
120	Neerkadambu	Kaim	*Mitragyna parviflora*	Tree
121	Nellipuli	Star Gooseberry	*Phyllanthus acidus*	Tree
122	Paala	Devil Tree	*Alstonia scholaris*	Tree
123	Pana	Palm	*Arecaceae*	Tree
124	Panjimaram	Cotton tree	*Gossypium hirsutum*	Tree
125	Parathi	Portia Tree	*Thespesia populnea*	Tree
126	Plavu	Jackfruit plant	*Artocarpus heterophyllus*	Tree
127	Pongalyam	Putranjiva	*Putranjiva roxburghii*	Tree
128	Potama	Indian charcoal tree	*Trema orientalis*	Tree
129	Puli	Tamarind	*Tamarindus indica*	Tree
130	Red palm	Red palm	*Acanthophoenix rubra*	Tree
131	Seemakonna	Gliricidia	*Gliricidia sepium*	Tree
132	Thekku	Teak	*Tectona grandis*	Tree
133	Thengu	Coconut tree	*Cocos nucifera*	Tree
134	Thondi/Therakam	Brahma's Banyan	*Ficus exasperata*	Tree
135	Vaaka	Gulmohar	*Quercus*	Tree
136	Cheenimaram			
137	Chora venga		*Pterocarpus sp.*	
138	Egva			

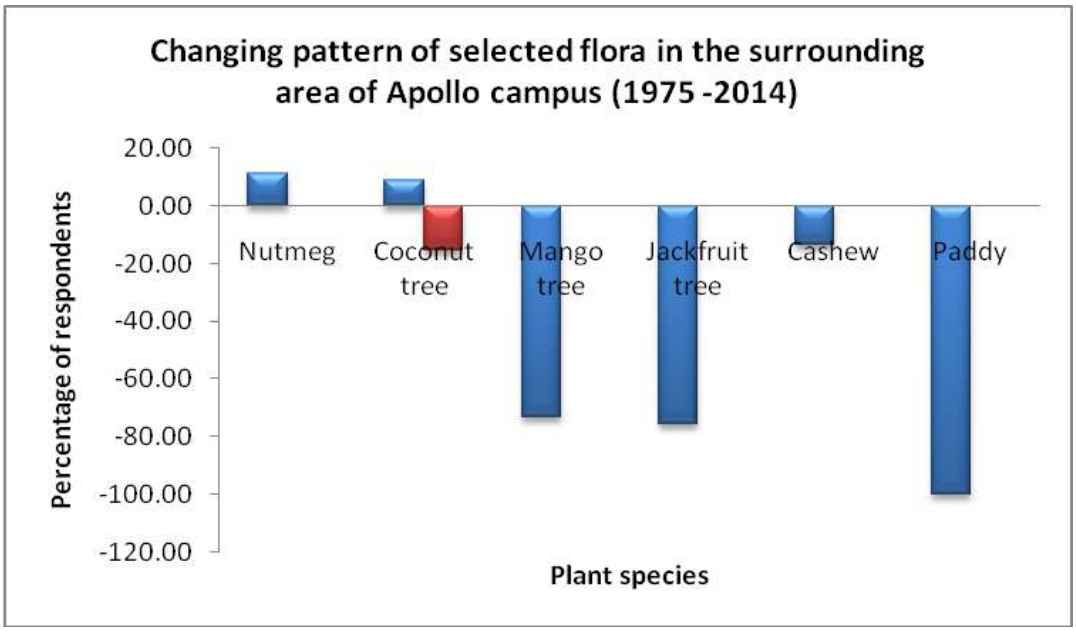
Table 4.6: List of major plants of surrounding area of Apollo campus in 1975-85 (Based on historical survey)

Sl.No.	Malayalam Name	Common Name	*Scientific Name*	Type
1	Amarakka	Lablab bean	*Lablab purpureus*	Climber
2	Koval	Ivy guard	*Coccinia grandis*	Climber
3	Kumbalam	White ash guard	*Flacourtia Jangomas*	Climber
4	Kurumulaku	Pepper	*Piper nigrum*	Climber
5	Muthira	Horse Gram	*Macrotyloma uniflorum*	Climber
6	Padavalam	Snake guard	*Trichosanthes cucumerina*	Climber
7	Paval	Bitter guard	*Momordica charantia*	Climber
8	Payar	Peas	*Phaseolus vulgaris*	Climber
9	Pechinga	Ridge gourd	*Luffa acutangula*	Climber
10	Vellari	Cucumber	*Cucumis sativus*	Climber
11	Mathan	Pumpkin	*Cucurbita maxima*	Creeper
12	Thannimathan	Water melon	*Citrullus lanatus*	Creeper
13	Chama	Little millet	*Panicum sumatrense*	Herb
14	Cheera	Amranthus	*Amaranthus sp.*	Herb
15	Chembu	Taro	*Colocasia esculenta*	Herb
16	Chena	Yam	*Amorphophallus paeoniifolius*	Herb
17	Ellu	Sesame	*Sesamum indicum*	Herb
18	Inji	Ginger	*Zingiber officinale*	Herb
19	Kachil	Greater yam	*Dioscorea alata*	Herb
20	Kaithachakka	Pineapple	*Ananas comosus*	Herb
21	Mathura kizhangu	Sweet potato	*Ipomoea batatas*	Herb
22	Nellu	Paddy	*Oryza sativa*	Herb
23	Pachamulaku	Green chilly	*Capsicum annum*	Herb
24	Pullu	Ragi	*Eleusine coracana*	Herb
25	Rubber	Rubber	*Hevea brasiliensis*	Herb
26	Sheemakonna	Gliricidia	*Gliricidia sepium*	Herb
27	Thena	Desho grass	*Pennisetum pedicellatum*	Herb
28	Vazhuthana	Brinjal	*Solanum melongena*	Herb
29	Venda	Lady's finger	*Abelmoschus esculentus*	Herb
30	Aatha	Custard apple	*Anona squamosa*	Shrub
31	Champa	Rose Apple	*Syzygium Samarangense*	Shrub
32	Cocoa	Cocoa	*Theobrama cacao*	Shrub
33	Kappa	Tapioca	*Manihot esculenta*	Shrub
34	Kappalam	Pappaya	*Carica papaya*	Shrub
35	Kariveppila	Curry leaf	*Murraya koenigii*	Shrub
36	Mula	Bamboo	*Bambuseae*	Shrub
37	Perakka	Guava	*Psidium guajava*	Shrub
38	Vaazha	Plantain	*Musa sp.*	Shrub
39	Aal	Baniyan tree	*Ficus sp.*	Tree
40	Adakka	Arecanut	*Areca catechu*	Tree
41	Ambazham	Hog plum	*Spondias pinnata*	Tree

42	Anjali	Wild jack	*Artecarpus hirsutus*	Tree
43	Elanji	Bullet-wood tree	*Mimusops elengi Linn.*	Tree
44	Kanjiram	Strychnine tree	*Strychnos nuxvomica*	Tree
45	Kashumaavu	Cashew	*Anacardium occidentale*	Tree
46	Kommatti	Blinding Tree	*Excoecaria agallocha*	Tree
47	Kudampuli	Indian Garcinia	*Garcinia cambogia*	Tree
48	Maavu	Mango tree	*Mangifera indica*	Tree
49	Mazhamaram	Raintree	*Albizia saman*	Tree
50	Pana	Palm	*Arecaceae*	Tree
51	Panjimaram	Cotton tree	*Gossypium hirsutum*	Tree
52	Plavu	Jack fruit	*Artocarpus heterophyllus*	Tree
53	Pooparathi	Portia Tree	*Thespesia populnea*	Tree
54	Puli	Tamarind	*Tamarindus indica*	Tree
55	Thekku	Teak	*Tectona grandis*	Tree
56	Thengu	Coconut tree	*Cocos nucifera*	Tree
57	Vaga	Gulmohar	*Quercus*	Tree
58	Vatta	gum plant	*Macaranga peltata*	Tree

The Fig 4.3 shows a changing pattern of selected flora in the surrounding area of Apollo campus from the opinion of survey respondents. The abundance of fruit trees and paddy fields declined significantly in the study area, whereas there is a slight increase in cash crops such as nutmeg. Due to the increasing urbanization and industrialization, town settlement in the area increased, thereby rocketing the demand and price of the land. Thus, land owners started to divide and sell plots to the new comers to the area in order to build houses. During the house construction, the trees were cut down due to lack of space and to get timber. Therefore, the number of common trees in the area started to reduce rapidly. In case of coconut tree, there is different opinion among people because in some sampling spots, paddy fields were converted into coconut plantations that increase the number coconut trees. However, in some sampling spots coconut trees were cut down for infrastructure developments. Interestingly, one rubber plantation of about 10 acres still remain in the city about a 100m distance away from the Apollo campus though it is not shown in agriculture department records.

Fig 4.3: Changing pattern of selected flora of surrounding area of campus from 1975 -2014 (Based on historical survey)



4.1.2.2. Fauna

Based on sampling study, 64 species of fauna are recorded, which include 25 birds, 12 butterflies, 12 dragonflies, 8 reptiles and 7 mammals (Table 4.7). The survey respondents commented that the diversity of fauna, especially, birds, domestic animals and wild animals, were rich in the past compared to the present. A list of major fauna in the surrounding area of Apollo campus during the period of 1975 - 1985 was compiled from the responses given by surveyed community members (Table 4.8).

Table 4.7: List of fauna of surrounding area of Apollo campus in 2014

Sl.No.	Malayalam Name	Common Name	*Scientific Name*
BIRDS			
1	Kakka	House crow	*Corvus sp.*
2	Pravu	Pigeon	*Columba livia*
3	Madatha	Common Myna	*Acridotheres tristis*
4	Kuyil	Koel	*Eudynamys scolopacea*
5	Uppan/Chembothu	Lesser Coucal	*centropus sinensis*
6	Maram kothi	Kerala Golden Back Woodpeacker	*Dinopium benghalense*
7	Kula Kokku	Indian Pond Heron	*Ardeola grayii*
8	Vella kokku	Median Egret	*Egretta intermedia*
9	Thatha	Roseringed Parakeet	*Psittacula krameri*
10	Olenjali	Indian Tree pie	*Dendrocitta vagabunda*
11	Thoppi kili	Red whiskered Bulbul	*Pycnonotus jocosus*
12	Ponman	White Breasted Kingfisher	*Halcyon smyrnensis*
13	Puthangiri	Large Grey Babbler	*Turdoides malcolmi*
14	Nakamohan	Asian Paradise Flycatcher	*Terpsiphone paradise*

15	Mannathikili	Magpie Robbin	*Copsychus saularis*
16	Pachilakuduka	Brown headed barbet	*Megalaima zeylanica*
17	Manjakili	Golden Oriole	*Oriolus oriolus*
18	Manjakaruppan	Balck headed Oriole	*Oriolus xanthornus*
19	Kakkathamburati	Black Drongo	*Dicrurus adsimilis*
20	Big erattavalan	Greater Racket- Tailed Drongo	*Dicrurus paradiseus*
21	Kattukozhi	Grey Jungle Fowl	*Gallus sonneratti*
22	Ceriya Meenkothi	Common small Kingfisher	*Alcedo atthis*
23	Neelakozhi	Purple Moorhen	*Porphyrio porphyrio*
24	Krishna Parunthu	Brahminy Kite	*Haliastur indus*
25	Kozhi	Domestic hen	*Gallus domesticus*
BUTTERFLIES			
1	Pottuvellatti	Psyche	*Leptosia nina*
2	Manjathakaramuthi	Common Emigrant	*Catopsilia pomona*
3	Chocolate albatross	Chocolate albatross	*Appias tyncida*
4	Panchanethri	Common five ring	*Ypthima baldus*
5	Erikkuthappi	Plain Tiger	*Danaus chrysippus*
6	Varayankaduva	Striped Tiger	*Danaus genutia*
7	Aralishalabham	Common Indian crow	*Euploea core*
8	Neelakaduva	Blue Tiger	*Tirumala limniace*
9	Thakaramuthi	Mottled Emigrant	*Catopsilia pyranthe*
10	Manjapappathi	Common Grass Yellow	*Eurema hecabe*
11	Chakkarashalabham	Crimson Rose	*Pachilopta hector*
12	Natturose	Common rose	*Pachilopta aristolochiae*
DRAGONFLIES			
1	Changathi Thumbi	Asian Groundling	*Brachythemis contaminata*
2	Swami thumbi	Blackspot Widow	*Neurothemis tullia*
3	Chendhavidan vyali	Red- faced Skimmer	*Orthetrum Chrysis*
4	Cheru venneran	Sombre Lieutenant	*Brachydiplax sobrina*
5	Onathumbi	Global Wanderers	*Pantala flavescens*
6	Thavittu Venneeran	Blue Dasher	*Brachydiplax chalybea*
7	Chuttinilathan	Black-tipped Percher	*Diplacodes nebulosa*
8	Pacha vyali	Green Skimmer	*Orthetrum*
9	Karimban thumbi	Black – Marsh Trotter	*Tramea limbata*
10	Pavizhavalan	White Burned Buskhawk	*Tholymis tillarga*
11	Pulthurumban	Paddy field parasol	*Neurothemis intermedia*
12	Nattu Nilathan	Ground Skimmer	*Diplacodes*
REPTILES			
1	Moorkan	Cobra	*Naja naja*
2	Valavalappan	Wolf snake	*Lycodon aulicus*
3	Vellikattan	Krait	*Bungarus coruelus*

4	Anali	Viper	*Daboiea russeli*
5	Neerkkoli	Checkered Keel Back	*Natrix sp.*
6	Chera	Rat snake	*Ptyas mucosa*
7	Onthu	Garden lizard	*Calotes versicolor*
8	Palli	House Lizard	*Hemidactylus sp.*
MAMMALS			
1	Poocha	Domestic cat	*Felis catus*
2	Patti	Dog	*Canis lupus*
3	Keeri	Common Mongoose	*Herpestes edwardsii*
4	Annan	Three striped Palm Squirrel	*Funambulus palmarum*
5	Marapatti	Toddy cat	*Paradoxurus jerdonii*
6	Veetteli	House Rat	*Rattus rattus*
7	Panni Eli	BrownRat	*Rattus norvegicus*

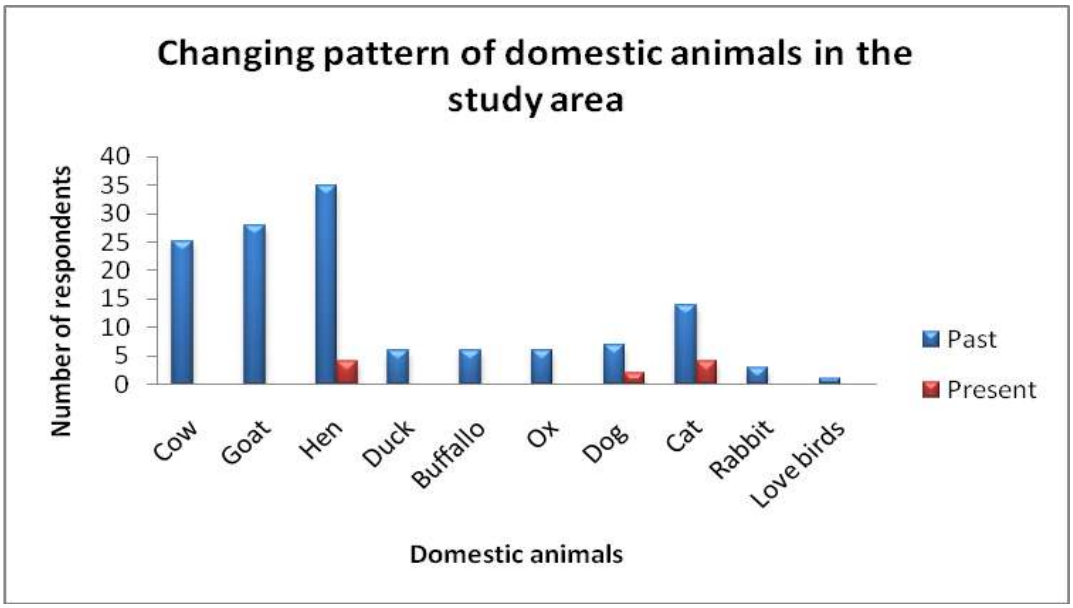
Table 4.8: List of major fauna in the surrounding area of Apollo campus from 1975-85 (Based on historical survey)

Sl.No.	Malayalam Name	Common Name	*Scientific Name*
BIRDS			
1	Kakka	House crow	*Corvus sp.*
2	Pravu	Pigeon	*Columba livia*
3	Madatha	Common Myna	*Acridotheres tristis*
4	Kuyil	Koel	*Eudynamys scolopacea*
5	Uppan/Chembothu	Lesser Coucal	*Centropus sinensis*
6	Maram kothi	Kerala Golden Back Woodpeacker	*Dinopium benghalense*
7	Kula Kokku	Indian Pond Heron	*Ardeola grayii*
8	Vella kokku	Median Egret	*Egretta intermedia*
9	Perumundi	Great Egret	*Ardea alba*
10	Thatha	Roseringed Parakeet	*Psittacula krameri*
11	Olenjali	Indian Tree pie	*Dendrocitta vagabunda*
12	Thoppi kili	Red whiskered Bulbul	*Pycnonotus jocosus*
13	Ponman	White Breasted Kingfisher	*Halcyon smyrnensis*
14	Puthangiri	Large Grey Babbler	*Turdoides malcolmi*
15	Nakamohan	Asian Paradise Flycatcher	*Terpsiphone paradise*
16	Mannathikili	Magpie Robbin	*Copsychus saularis*
17	Pachilakuduka	Brown headed barbet	*Megalaima zeylanica*
18	Manjakili	Golden Oriole	*Oriolus oriolus*
19	Manjakaruppan	Balck headed Oriole	*Oriolus xanthornus*
20	Kakkathamburati	Black Drongo	*Dicrurus adsimilis*
21	Big erattavalan	Greater Racket- Tailed Drongo	*Dicrurus paradiseus*
22	Kattukozhi	Grey Jungle Fowl	*Gallus sonneratti*
23	Ceriya Meenkothi	Common small Kingfisher	*Alcedo atthis*

24	Neelakozhi	Purple Moorhen	*Porphyrio porphyrio*
25	Krishna Parunthu	Brahminy Kite	*Haliastur indus*
26	Kozhi	Domestic hen	*Gallus domesticus*
27	Moonga	Brown owl	*Strix leptogrammica*
28	Tharavu	Domestic duck	*Anas platyrhynchos domesticus*
REPTILES			
1	Moorkan	Cobra	*Naja naja*
2	Valavalappan	Wolf snake	*Lycodon aulicus*
3	Vellikattan	Krait	*Bungarus coruelus*
4	Neerkkoli	Checkered Keel Back	*Natrix sp.*
5	Anali	Viper	*Daboiea russeli*
6	Peumpampu	Indian Python	*Python molurus*
7	Muthala	Crocodile	*Crocodylinae*
8	Chera	Rat snake	*Ptyas mucosa*
9	Onthu	Garden lizard	*Calotes versicolor*
10	Palli	House Lizard	*Hemidactylus sp.*
11	Arana	Golden Lizard/ Skink	*Mabuya sp.*
MAMMALS			
1	Patti	Dog	*Canis lupus*
2	Pashu	Cow	*Bos sp.*
3	Poocha	Domestic cat	*Felis catus*
4	Aadu	Domestic Goat	*Capra aegagrus*
5	Eruma	Buffalo	*Bubalus bubalis*
6	Kattumuyal	Black naped hare	Lepus nigricollis
7	Keeri	Common Mongoose	*Herpestes edwardsii*
8	Kattu poocha	Jungle cat	*Felis chaus*
9	Kurukkan	Jackal	*Canis aureus*
10	Kattupanni	Wild boar	*Sus scrofa*
11	Veetteli	House Rat	*Rattus rattus*
12	Annan	Three striped Palm Squirrel	*Funambulus palmarum*
13	Kala	Ox	*Ovibos moschatus*
14	Muyal	Domestic rabbit	*Oryctolagus cuniculus*
15	Chennaya	Wolf	Canis lupus
16	Korangan	Monkey	Common langur
17	Marapatti	Palm Civer	*Paradoxurus jerdonii*
18	Veruk	Small Indian Civet	*Viverricula indica*
19	Panni eli	BrownRat	*Rattus norvegicus*

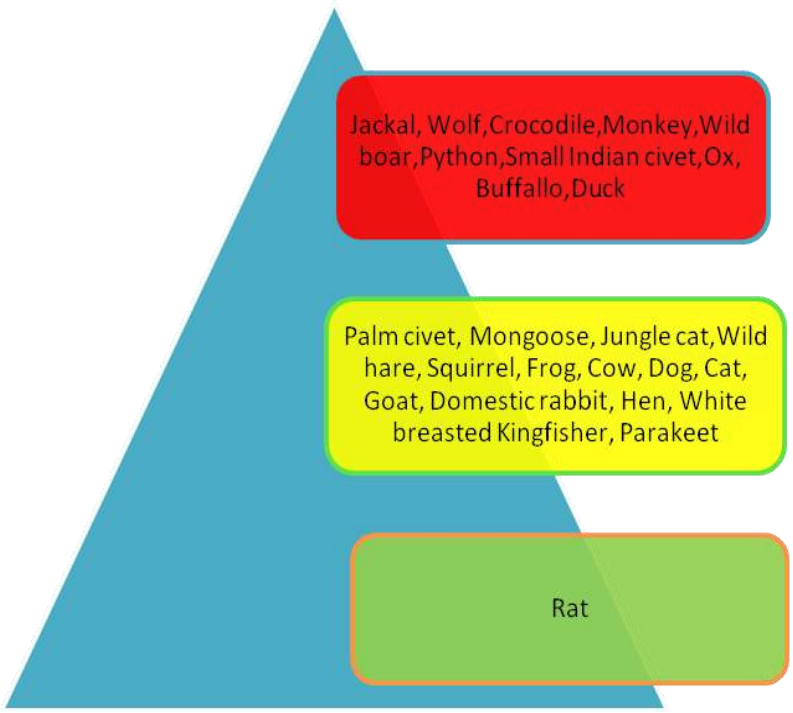
The diversity of domestic animals in the surrounding area has diminished as a result of less space availability in the urban area. The dependency and abundance of domestic animals reduced significantly compared to the past (Fig 4.4).

Fig 4.4: Changing pattern of domestic animals in the study area in the period of 1975 -2014 (Based on Historical Survey)



Similarly, the abundance of other faunal species also declined over the years due to urbanization and industrialization. The Fig 4.5 points out the changing pattern of selected fauna in the surrounding area of Apollo campus from 1975 to 2014. The animals shown in the narrow part of the pyramid are not currently seen in the surrounding area of Apollo campus. These animals have vanished from the region mainly because of urbanization and associated human activities. The animals listed in the middle part are present in the surrounding area of the campus, but the abundance of species reduced considerably. The bottom part of the pyramid indicates the species with increase in abundance in the surrounding area.

Fig. 4. 5: Changing pattern of selected fauna of the surrounding area of Apollo campus from 1975 to 2014 (Based on Historical Survey)



4.2. Drivers of Change in Biodiversity

Biodiversity can be influenced by various factors that can cause changes in ecosystem and ecosystem services. These factors are called drivers of change which can be direct and indirect. Direct drivers of change are human induced factors that directly impact biodiversity, resulting in biophysical changes in the environment, which leads to social or economic impacts in the society. Indirect drivers of change are societal changes which could under certain conditions influence direct drivers of change, ultimately leading to impacts on biodiversity.

4.2.1. Direct drivers of change on biodiversity

Direct drivers of change are developmental factors that were initiated with the aim of improving the standard of life, but eventually resulted in negatively affecting the biodiversity of the area. The direct drivers of changes such as land use pattern, infrastructure developments, industrialization and pollution are considered in this study.

4.2.1.1. Land use pattern

Change in land use pattern is one of the main driving forces of environmental changes that have impacts on the quality of water, land, air, biodiversity, ecosystem processes and the climate system itself. The most important cause of change in biodiversity is the conversion of land resulting in alteration of existing habitat completely or partially. The land use and land cover pattern of a region is a result of natural and socio-economic factors and its utilization by man in time and space

Land Use Pattern based on Geographical Information System (GIS)

The land use and land cover pattern of 5 km radial distance around Kalamassery Apollo campus in 1967 and 2011 is analyzed from a geographic perspective. Figs 4.6a & 4.6b display land use and land cover pattern of surrounding area of Apollo campus in 1967 and 2011. It clearly shows that there is an increase in township, industrial area and built up area, and decrease in barren areas, waterbody, and mixed crop with houses. Most of the barren area is turned into township and built up area, which is reflected in the current status of these categories. For instance, the township area expanded from 4% to 22 % and built up area increased from 1 % to 7% over the last three decades (Fig. 4.6c). In addition, some portion of mixed crop with houses is changed to township, built up area and industrial area. Therefore, mixed crop area with houses and barren area declined from 73 % to 63% and 17 % to 2 % respectively (Fig. 4.6c). It is obvious that human activities related to urbanization and industrialization has profoundly changed the land use and land cover pattern in this area resulted in the degradation of natural vegetation and change in biodiversity. Though the area for mixed crop with houses decreased, there is no decrease in human settlement, houses, flats and other infrastructures.

Fig 4.6: Land use/land cover pattern around Kalamassery Apollo Tyre Campus

Fig 4.6 a) Land use/land cover pattern in 1967

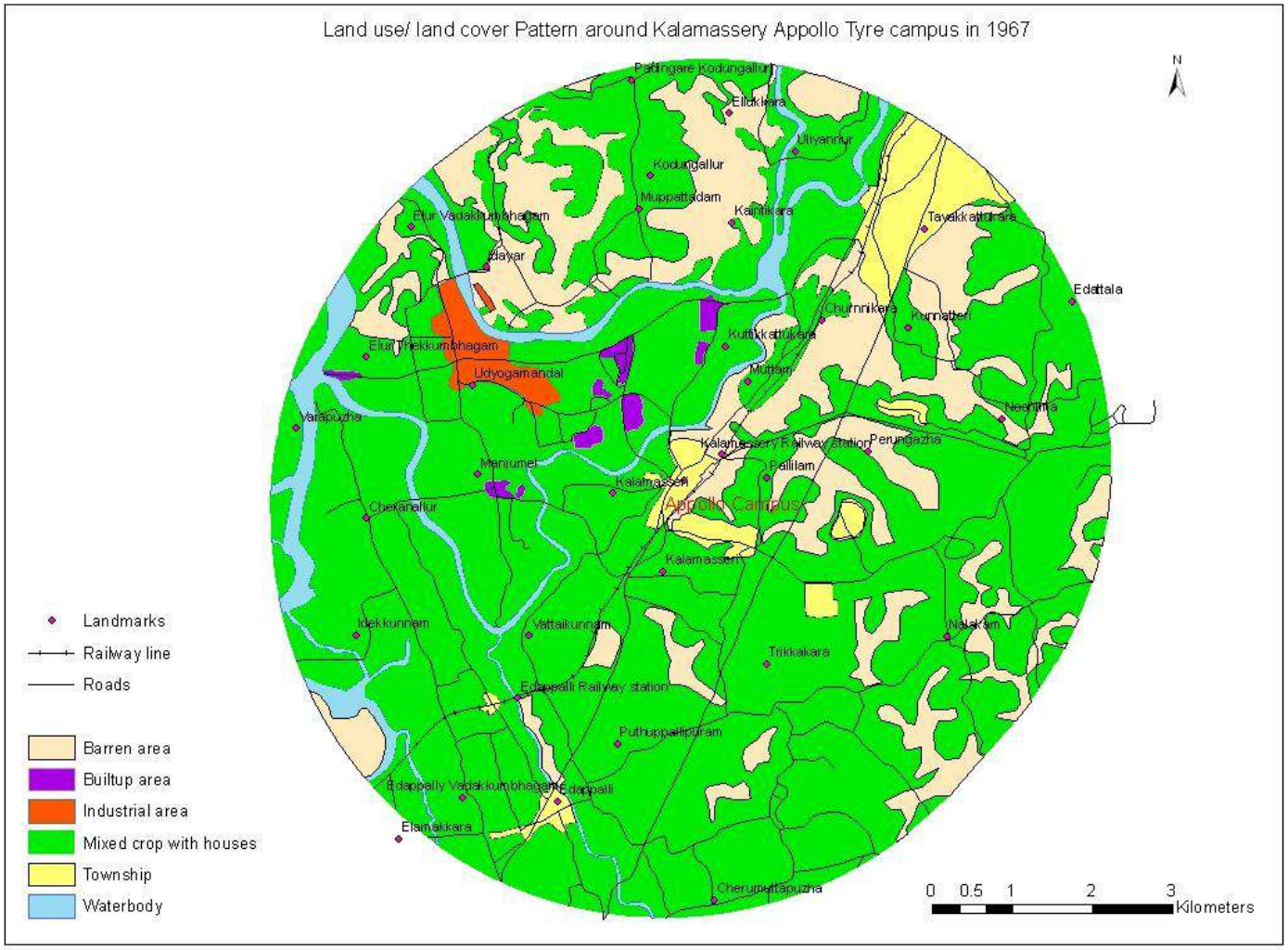


Fig 4.6 b) Land use/land cover pattern in 2011

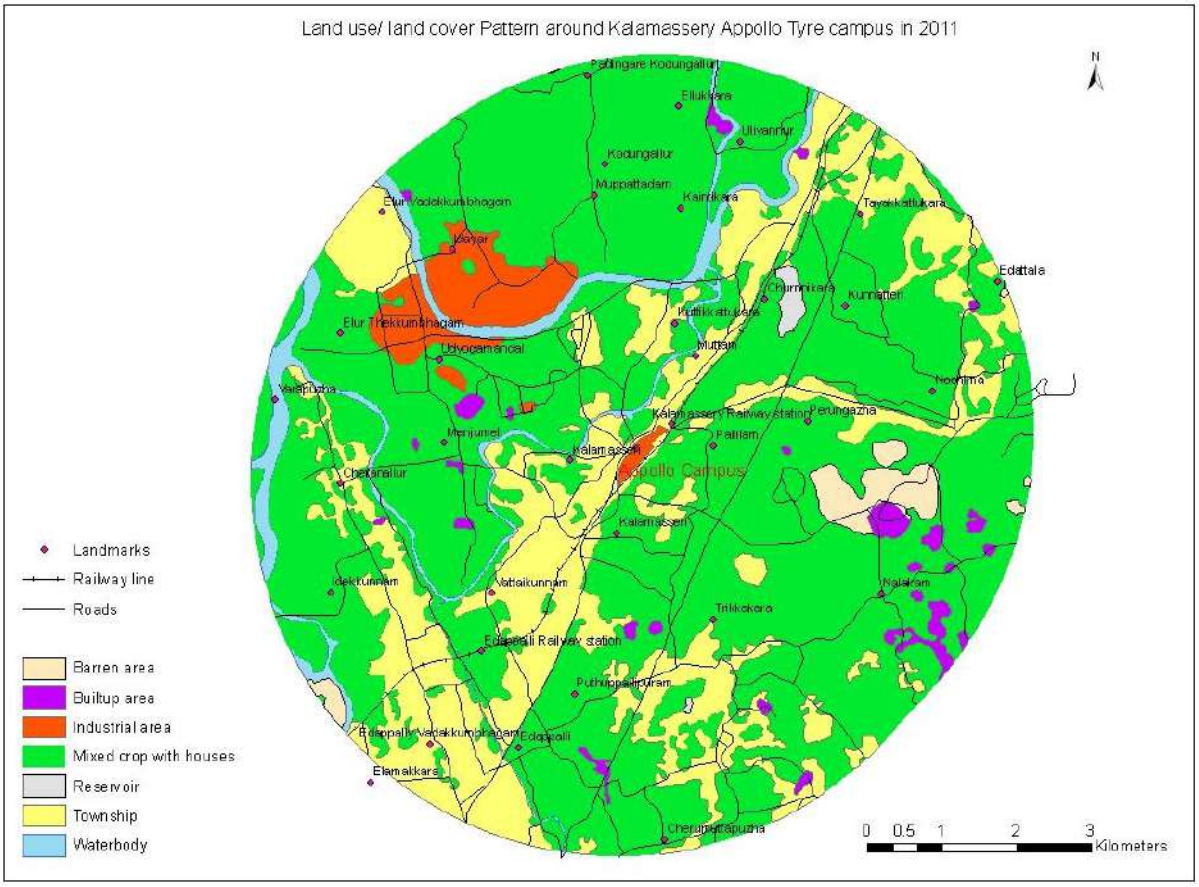
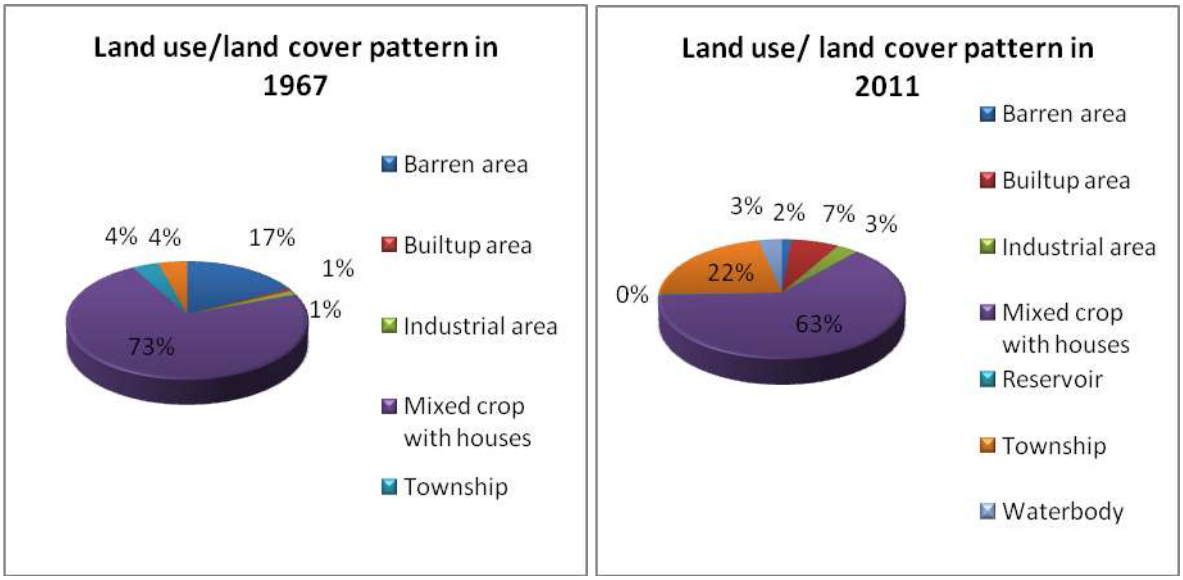


Fig 4.6 c) Percentage of land use/land cover pattern in 1967 and 2011



Normalized difference Vegetation Index of the years 1971 and 2011 of 5 km radial distance around Kalamassery Plant of Apollo Tyres was analysed to understand the vegetation cover in the region. The very low vegetation vigor category indicates no vegetation in these areas. Here

it represents buildings and establishments, houses, roads, water bodies, rocky area and other barren areas. Low and medium category indicated vegetations including herbs, shrubs and woody tree area with housing and any other manmade structures. The moderately high vegetation vigor indicates continuous patch of trees with understory vegetations (4.7a and 4.7b).

In the surrounding area of Apollo Tyres, vegetation vigor is very low and low categories are found to be increased and medium and moderately high categories are decreased. It indicates the urban sprawl and development of national high way in the area. Increasing urbanization and industries declined overall vegetation cover in the area that causes alteration in the floral biodiversity.

Fig 4.7: The Normalized Difference Vegetation Index (NDVI) in 1971 and 2011

Fig 4.7a) Normalized Difference Vegetation Index (NDVI) in 1971

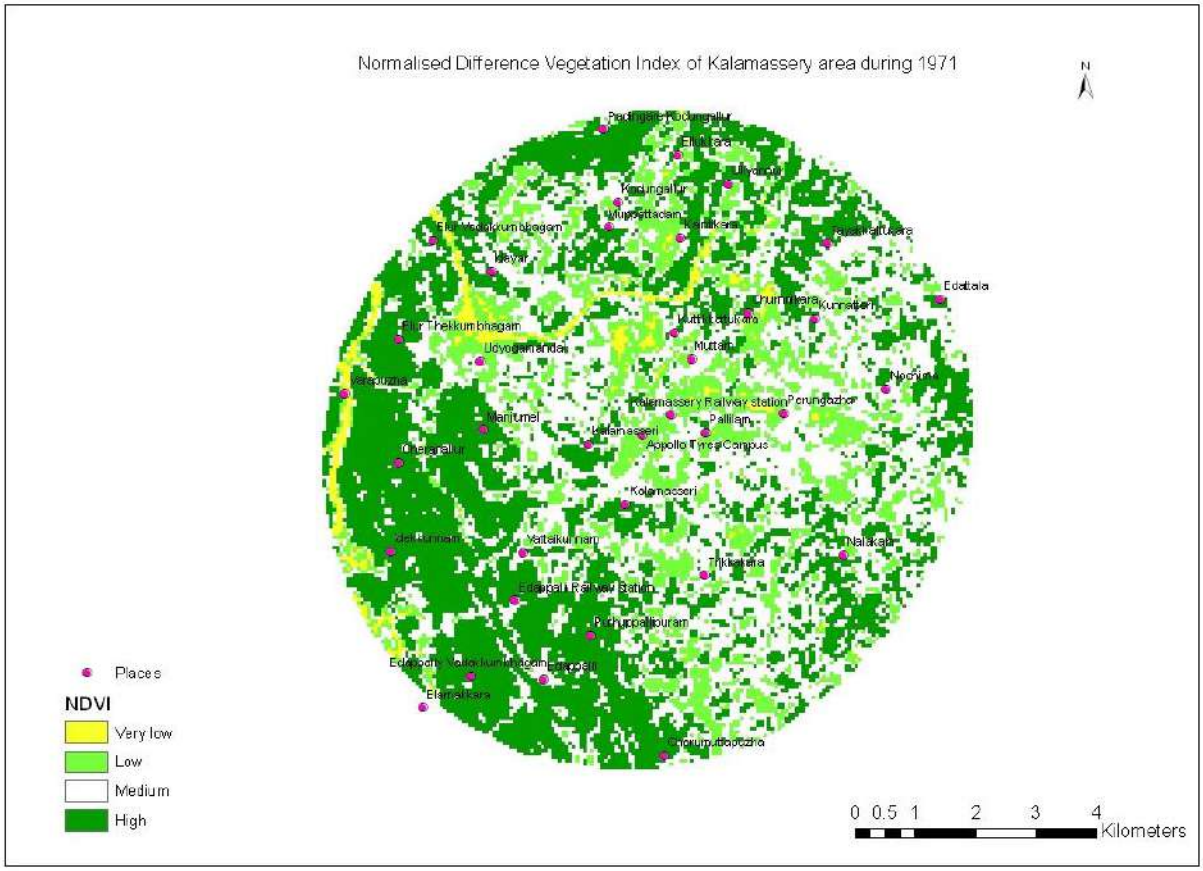
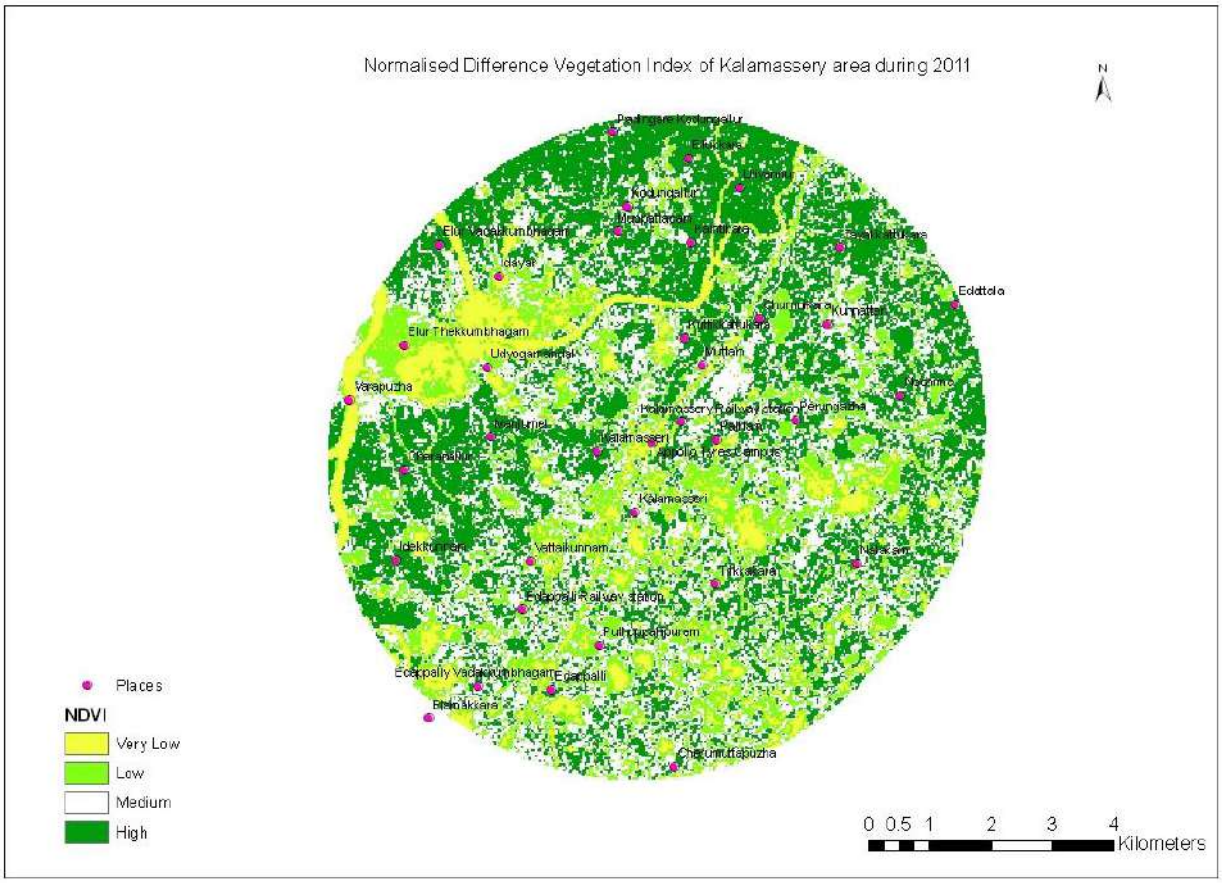


Fig 4.7 b) Normalized Difference Vegetation Index (NDVI) in 2011



Land Use Pattern Based on Secondary Data

Secondary data collected from the concerned local government offices, which are Kalamassery Agricultural Office, Eloor Agricultural Office and Choornikkara Agricultural Office, aincludes the land use pattern of the study area as well. As these data are mainly gathered from agricultural offices, it is focused on agricultural lands. Similar to GIS data, there is a noticeable change in the land use pattern of surrounding area of Apollo campus (Fig 4.8). In 1990s, among the total geographical area of Kalamassery Municipality, 83 % of land was used as cultivated area and homestead, which includes 303 hectares paddy fields, 25 hectares rubber plantation and other cultivations such as pepper, arecanut, coconut, and cashew. Only 17 % of land was used for other purposes such as infrastructures, roads, railway etc. However, now the land use pattern is reversed, only 17 % of land is used for cultivation and rest of the agricultural lands and natural vegetation are used for infrastructural development or converted to housing plots (Fig 4.8 a). Similarly, in Eloor municipal area also the total cropped area was decreased from 80% (1980s) to 39% (2013), whereas land area used for other purposes has increased from 20 % to 61 % (Fig 4.8 b). Establishment of industries and increasing urbanization mainly resulted in the drastic change in land use pattern and associated biodiversity loss in both municipalities. On the other hand, in the Choornikkara

Panchayat, cultivation has decreased slightly due to the effect of developments in Kalamassery and Eloor. In 1980s 53 % of land was occupied by cultivated land and garden land; however, now it has decreased to 47 % (Fig 4.8c). These data support the change in land use pattern showed in GIS map; ultimately, developments such as township, industries and built up alter the biodiversity and natural environment in this area. In addition, homestead farming was prevalent in this area, but there are no vacant places for cultivation due to the congested housing resulted from urbanization in the area.

Fig 4.8 a) Land use pattern of the Kalamassery Municipality in 1990s and 2013 (Adapted from Baseline data, Kalamassery Agriculture Office)

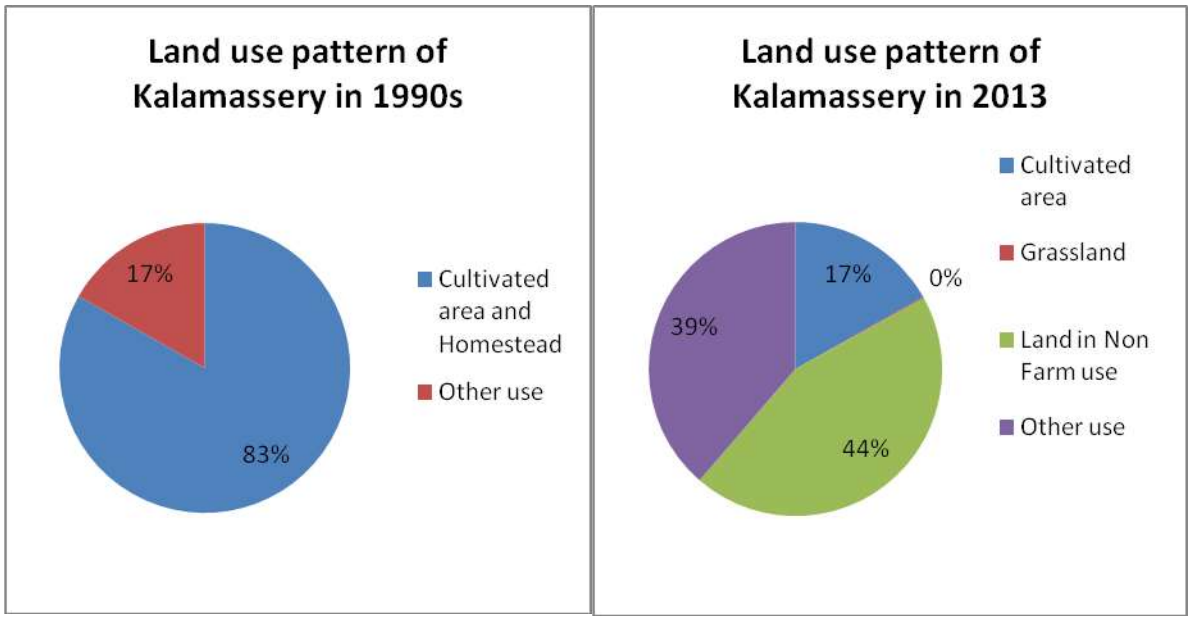


Fig 4.8 b) Land use pattern of Choornikkara Panchayat in 1980s and 2012 (Adapted from Baseline data, Choornikkara Agriculture Office)

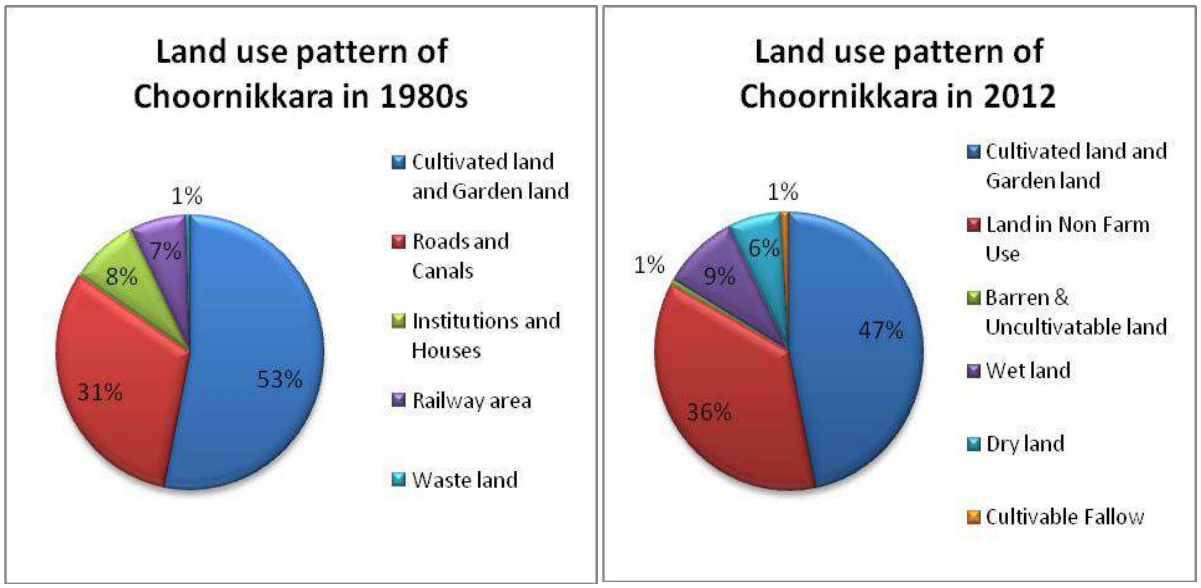
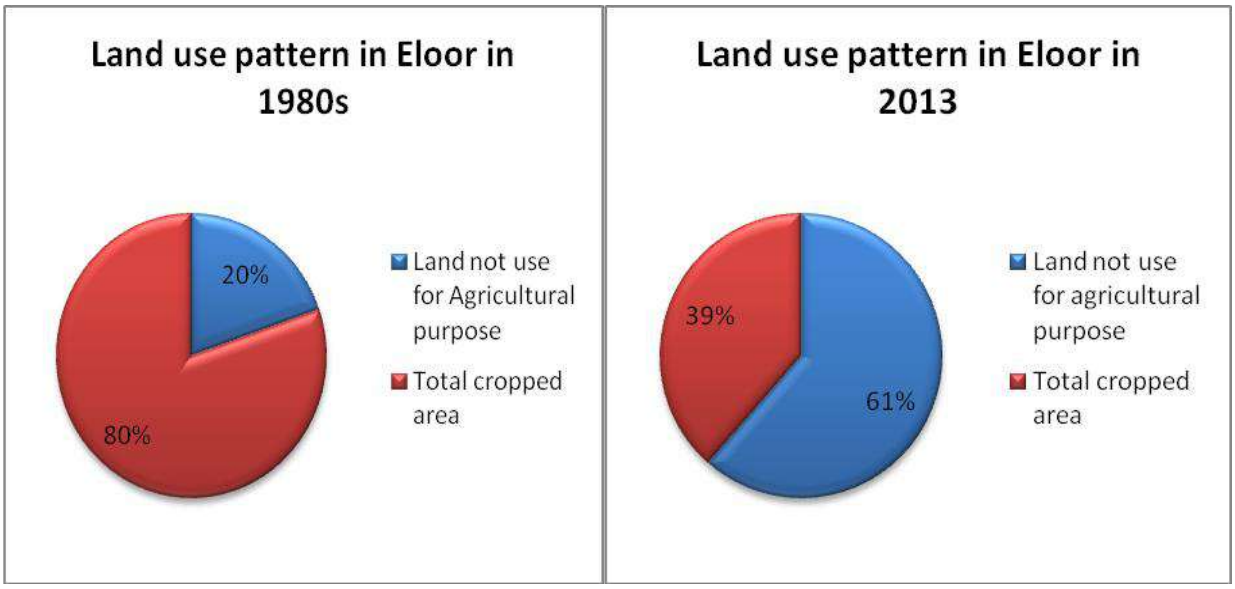


Fig 4.8 c) Land use pattern of Eloor Municipality in 1980s and 2013 (Adapted from Baseline data, Eloor Agriculture Office)



4.2.1.2. Industrialization

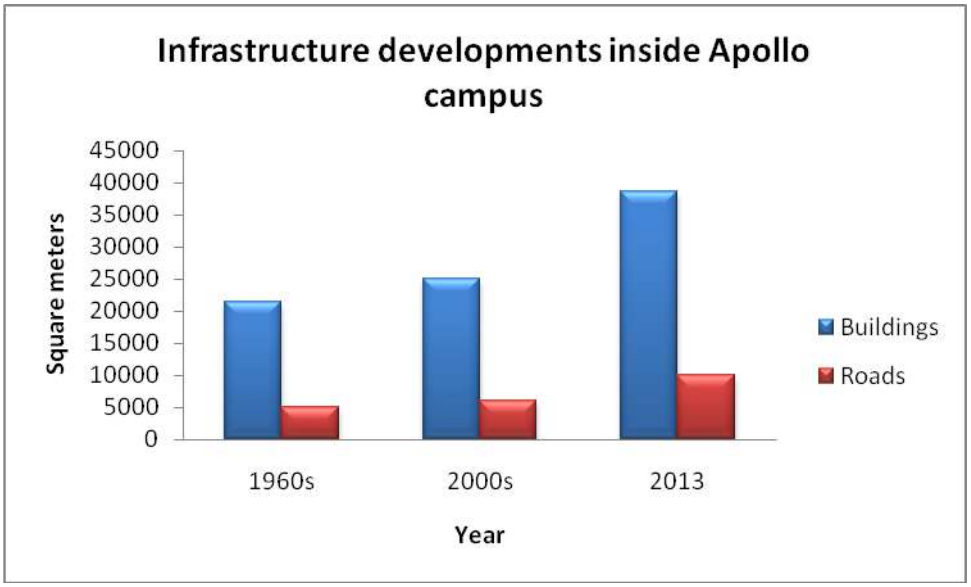
Kalamassery was a concentrated region of industrialization with several large, medium and small scale factories and IT companies. The pioneer large scale industry established in Kalamassery was A.D Sassoon and Bombay textiles, which was later known as Chithra mills during the period of the king Sri Chithira Thirunnal. After that, there were many other large scale to small scale industries established in Kalamassery, which are Travancore Ogale glass factory,Travancore Chemical Manufacturing (TCM),Chakolas Spinning and Weaving mills, Toshiba Anand Batteries, Agobin Traders, Premier Tyres, Hindustan Machine Tools (HMT), Carborandom Universal, Sri Aiyappa Flour mills, Modern Bakeries, Transformers India Limited, and Industrial estate. Premier Tyres was established in 1962 and in the same decade HMT and Carborandom Universal were incorporated in Kalamassery area, so it has changed the entire outlook of the city. In addition, the Eloor industrial township is also located near to Kalamassery. India's first large scale fertilizer plant, Fertilizers and Chemicals Travancore Limited (FACT), was set up in Eloor in 1943 as a private enterprise. People from different parts of India work in these companies, so many of them relocated to the city. Even people worked in Eloor bought land in Kalamassery as pollution was high in Eloor area. Therefore, urbanization took place in Kal amassery area rapidly, and large amount of agricultural lands and natural vegetation had been converted to built up and other infrastructures. Later, many industries such as Ogale glass factory, TCM, Chithra mills, Thoshiba Anand Batteries, Agobin Traders, Trasformer India limited and Chakolas Spinning and Weaving mills were shut down as they were unable to adopt advanced technologies. In 1995, Premier Tyres was taken over by Apollo Tyres as the company was running in loss. Alterations of biodiversity and landscape have started even before the establishment of Premier Tyres. The impacts on biodiversity has increased due to beginning of new industries, expansion of existing industries and followed

infrastructure developments such as roads, shops, flats and housing plots. Currently, the most famous factories in Kalamassery are HMT, Apollo Tyres, Carborandom Universal and industrial estate. Furthermore, there are almost 75 factories in Eloor in which Hindalco industries Ltd and Cochin petromin pvt Ltd are located near to Kalamassery. About 78 industries and an industrial estate with small scale industries run within 5 km radius of Apollo Tyre campus. Therefore, cumulative impacts from factories and subsequent developments negatively affect biodiversity and natural vegetation in this area. Actually the number of industries in Kalamassery declined compared to 1960's, but there is no improvement in altered biodiversity as this is highly influenced by the industries in Eloor, other infrastructure developments already happened and associated human activities.

4.2.1.3. Infrastructure developments

Infrastructure developments can negatively affect biodiversity and its components by altering natural vegetation and associated fauna. There is a remarkable infrastructure development inside and surrounding area of Apollo campus. The major infrastructure developments are four lined National Highway, sea port airport road, vallarpadam container road, large number of shops, hotels, flats, educational institutions and houses. According to secondary data, there is a tremendous increase in number of shops and houses in the surrounding area. In 2000's, there were 33363 building including shops, houses and factories in Kalamassery, but now it has increased to 35648 building (Vikasanarekha of Kalamassery, 2000 – 2013). Therefore, conversion of land is still continuing, so it causes biodiversity loss. Inside Apollo campus also the infrastructure developments, including plant and road extension increased dramatically that could have resulted in the change of biodiversity inside the campus. The Fig 4.9 indicates the infrastructure developments such as extension of plant area and roads occurred eventually inside the Apollo campus. In the beginning of Premier Tyres, the buildings were only occupied about 21500 sq. m and 5000 sq.m was used as road out of 1240000 sq.m. Therefore, rest of the land inside campus supports flora, fauna and other biodiversity components inside Apollo campus. Now, the plant area is increased to 38595 sq. m and road area inside campus is increased to 10000 sq.m. According to interviewed senior employees, the major threats of biodiversity inside the apollo campus are building construction, roads, pollution and giving less priority to biodiversity. Almost 100 % of respondents state that building construction and road constructions are a major threat of biodiversity whereas 20 % of respondents said pollution is also a reason for the change in biodiversity. Furthermore, 95 % of respondents declared that tree cover, green cover and fauna population inside Apollo campus decreased compared to the past. For the plant extension and road construction, many native fruit trees were cut down that reduces the floral diversity and related faunal diversity inside the campus.

Fig 4.9: Infrastructure developments inside the Apollo campus (Adapted from Infrastructure record, Engineering department, Apollo Tyres Kalamassery)



4.2.1.4. Pollution

Different types of pollutions such as water pollution, air pollution, municipal solid waste and sewage are prevalent in the study area due to the large number of factories, infrastructures and human settlement. The major water body present in the study area is a tributary of Periyar River, which is now polluted due to the disposal of liquid waste from markets, factories and sewage. Therefore, it affects the diversity of fish species in the river. Most of the people were heavily depended on river water for their domestic needs in the past. However, now the dependency on the river has reduced mainly due to the deterioration of water quality in the river, and change in life style and availability of modern facilities in the households. Moreover, the majority of local residents are concerned about the possible contamination of private wells due to the discharge from large number of industries in the region; therefore they consume treated pipe water from the municipality. Table 4.8 shows water quality of Periyar River at Kalamassery area.

Table 4.8: Water quality of Periyar River at Kalamassery area in 2008, 2009 and 2010 (Adapted from KSPCB Annual Air and Water Quality Directory)

Parameters	Unit	2008	2009	2010
pH		5.4	6.57	6.9
Conductivity	µmhos/cm	139	647.75	57
DO	Mg/l	2	4.66	5.45
BOD	Mg/l	0.5	1.82	1.9
Nitrate-N	Mg/l	6	0.33	0.28
Amm-N	Mg/l	0	0.06	0.01
TC	No/100 ml	100	1052	3139
FC	No/100ml	0	214	478

Chromium	µg/L	21	-	-
Zinc	µg/L	78.5	-	-

Table 4.9 indicates annual average ambient air quality result of Kalamassery and Eloor industrial area in 2008, 2009 and 2010.The ambient air quality data shows that the annual average of all parameters are within limits. However, in certain months the parameters like SPM and RSPM has shown excess value than the limits. Though the PM emission from the industrial smoke stacks is normally within limits, the excess of PM in the ambient air can be attributed mainly to the ongoing construction activities in the industrial, residential and transportation sectors such as metro rail. In addition, a considerable propotion of surveyed respondents mentioned that smog from factories in Eloor, carbon particle deposition from Apollo Tyres, vehicular pollution, and unpleasant odour from municipal dumpyard are also notecible sources of pollution.

Table 4.9: Annual average ambient air quality result of Kalamassery and Eloor Industrial Area in 2008, 2009 and 2010 (Adapted from KSPCB Annual Air and Water Quality Directory).

Parameters	Location	2008	2009	2010	Limit
Sulphur Dioxide ($\mu g/m^3$)	Kalamassery	5.2	4.5	17.6	80
	Eloor	3.9	2	17.6	
Nitrogen Oxides ($\mu g/m^3$)	Kalamassery	11.4	12.5	18.1	80
	Eloor	5.2	6.5	18.1	
Respirable Suspended Particulate Matter ($\mu g/m^3$)	Kalamassery	44	40	78	120
	Eloor	47	51	78	
Suspended Particulate Matter ($\mu g/m^3$)	Kalamassery	70	61	88	360
	Eloor	82	104	88	

Solid and liquid waste management is also a severe problem in the study area. Municipality dumpyard is overflowed due to high rate of disposal of wastes from shops, hotels, industries and households. Due to lack of sufficient home yard, people faced problem with disposal of domestic wastes. Many people used to dispose wastes in roadside, river and unused properties owned by other people. However, municipality adopted a waste collection system three months ago by providing separate bins for decomposable and recyclable wastes. This recently introduced waste collection system was able to mitigate the domestic solid waste management problem to a great extent. Sewage system is also not properly maintained in Karippai road near Apollo Tyres. The open sewage carries wastes from shops, markets and even septic tank to the tributary of periyar and causes alteration in river biodiversity. Moreover, it is a significant problem for the residents in that area. Due to congested housing plots in Kalamassery area, people are concerned about septic tank leakage from neighboring houses, so they do not use water from their wells for drinking purpose.

4.2.2. Indirect drivers of change in biodiversity in the area

Indirect drivers of change are the factors that influence direct drivers of change, and ultimately leading to impacts on biodiversity and ecosystem services. Demography, urbanization, socioeconomic and cultural changes in the locality and change in the agricultural pattern are considered in this study.

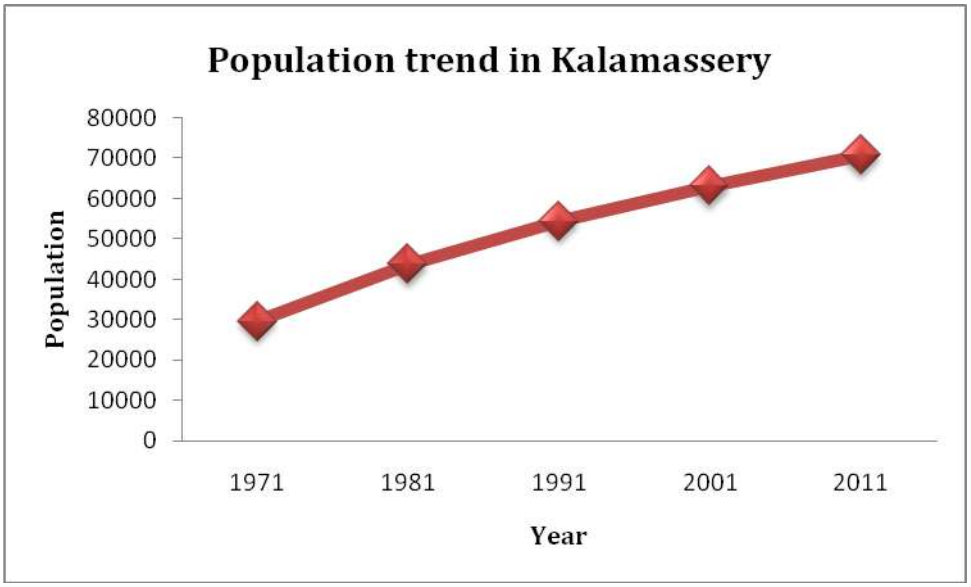
4.2.2.1. Demography

There is a drastic population growth in the study area, especially in Kalamassery region, due to the migration of people into the city for employment and education purposes coupled with increasing population of the local residents (Table 4.10). Almost 95 % of historical survey respondents stated that the population in the area was very less in 1960s compare to the present. According to them, the population in Kalamassery area started to increase after the establishment of industries and educational institutions. The Fig 4.10 displays the increasing pattern of population in Kalamassery area, which is the most populated region in the study area. The population growth leads to occupancy of maximum land, pollution, over exploitation of both floral and faunal resources, and introduction of exotic species. In addition, increasing demand of land resulted in the conversion and fragmentation of natural habitat that interrupts biodiversity in the area. Therefore, population growth and human activities can indirectly affect the pattern of biodiversity and altogether resulted in biodiversity loss.

Table 4.10: Population dynamic of the surrounding area of Apollo (Adapted from Vikasana Rekha of Kalamassery Municipality, Eloor Municipality and Choornikkara Panchayat)

Location	**Kalamassery**			**Choornikkara**		**Eloor**	
Year	**1971**	**1991**	**2011**	**1991**	**2001**	**1991**	**2001**
Population	29546	54342	70776	34837	36998	34455	35573
Male	14018	26553	35076	-	-	17953	17773
Female	15528	27789	35700	-	-	16502	17800

Fig 4.10: Trend of population in Kalamassery Municipality (Based onVikasana Regha 1996 and 2013, Kalamassery Municipality)



4.2.2.2. Urbanization

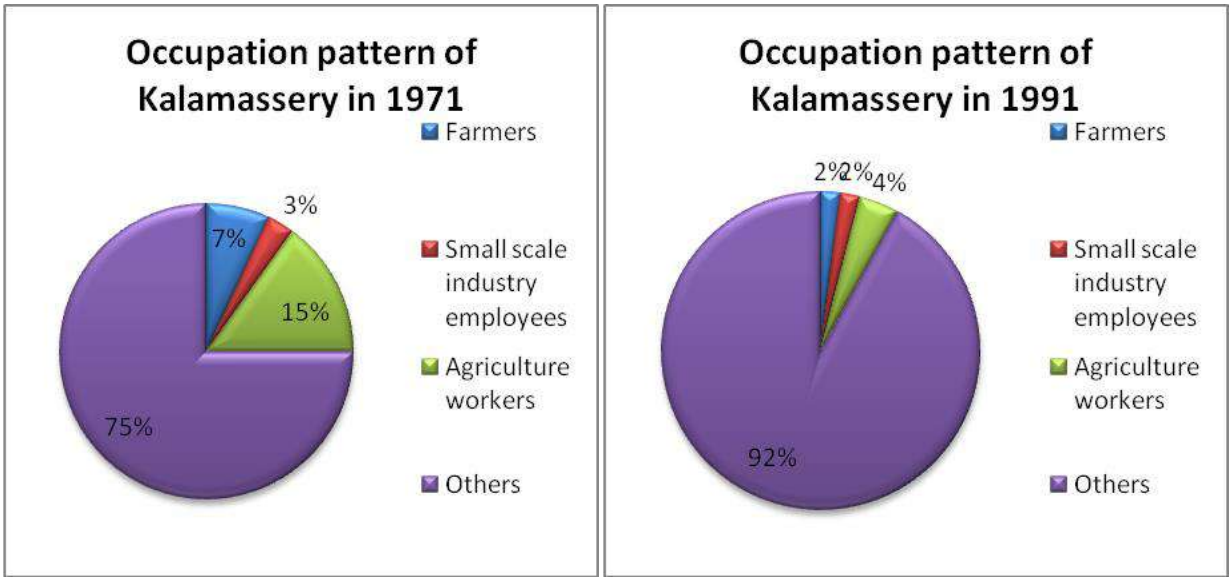
Urbanization is considered as one of the major driving forces of change in biodiversity. The rising population growth in an area leads to the expansion of urban areas and related developments. Therefore, the growth of urban areas resulted in the destruction and fragmentation of large areas of natural habitats through construction of roads, institutions, industries, flats and houses, thereby severely affecting species rely on those habitats (Brennan et al, 2010). In the study area, the urbanization started to increase after 1990s though there were lots of industries present in this area before that period. Due to rapid increase of population in Kalamassery panchayat and Eloor panchayat, they were changed to Municipalities in 1990s (Table 4.10). Thus, infrastructure developments such as construction of National Highway, housing flats and other major commercial buildings rapidly increased after 1990s in the study area. For instance, in 1991, there were only 11430 houses in Kalamassery Municipality and 7560 houses in Eloor Municipality, but now it has increased to 17810 houses and 13445 houses respectively (Vikasana Regha, 1991 and 2011). It implies that the demand for land and consumeristic lifestyle of people increased eventually, so the conversion of natural vegetation and agricultural lands occurred for the construction of new buildings such as shops, hotel and commercial buildings. Biodiversity greatly reduced due to fragmentation of natural habitats for the developmental activities as small habitats are unable to support the same level of biodiversity. Furthermore, introduction of non-native species and replacement of native species drastically alter the composition of biodiversity in the area. Though urban areas contain a large number of small scale habitats such as gardens, parks and wasteland that supports a considerable diversity, there is a significant decrease of natural biodiversity in the study area.

4.2.2.3. Socio-economic and cultural changes in the locality

Socio- economic changes in the society also indirectly affect biodiversity and ecosystem in the area. After the establishment of a large number of industries in this region, the dependency on

agriculture, home yard items and domestic animals reduce due to the unavailability of sufficient land for farming. Among surveyed people, 62 % of them had domesticated animals in their houses such as cow, goat, hen and duck that used to meet their demand of milk and egg. However, now only 9% surveyed respondents have domestic animals in their houses. Similarly, dependency on home yard items also declined as people have busy lifestyle and unavailability of land for cultivation. However, introduction of exotic garden plants has substantially increased; for instance, the exotic garden plant variety, Euphorbia, is found in most of the houses in this area. Though it enhances the aesthetic beauty of their houses and improve the green cover, it causes a change in the faunal biodiversity as it cannot support native fauna. Even the occupation pattern and lifestyle of people in this study area has entirely changed compared to the past, especially in Kalamassery area (Fig 4.11). Therefore, people give less importance to flora and fauna in their locality that can result in the change of biodiversity in this area.

Fig 4.11: Occupation pattern of Kalamassery area in 1971 and 1991 (Based on Vikasana Regha 1996, Kalamassery Municipality)



4.2.2.4. Change in agricultural crop pattern in the study area

Usually, agriculture supports the conservation and sustainable use of biodiversity, but change in the agricultural pattern can be a major driver of biodiversity loss. Conversion of agricultural land into housing plots and infrastructures cause significant loss of biodiversity due to habitat loss and depletion of food availability of dependent species. Most of the paddy fields in this area have been converted into housing plots and infrastructures; therefore, it affects many species such as paddy pipit, parakeet and other fauna, that are dependent on paddy fields for their sustenance. Homogenization of agricultural production system, introduction of exotic speices and modern agricultural practices can also negatively affect biodiversity as it reduces the diversity of flora and fauna species and alter their habitat and

niche. Furthermore, conversion of biodiversity rich areas such as wetlands and riparian zone into agricultural land also cause loss or change in biodiversity.

To assess the impact of agriculture on biodiversity in the study area, available data of major cultivation pattern and cultivated area of Kalamassery municipality, Eloor municipality and Choornikkara panchayat are collected. Fig 4.12a displays changing pattern of major crop cultivation in the Kalamassery municipality. Overall trend shows a decreasing pattern of cultivation in the study area except an increasing trend of coconut cultivation in Choornikkara Panchayat (Fig 4.12c). This is because of the conversion of paddy lands into a coconut plantation at first in order to use the land for other commercial purposes later. Currently, the major cultivation in the study area is coconut though coconut cultivation faces various threats such as diseases and pest attack. In addition, the Fig clearly shows a substantial decline of paddy fields in the study area and in Eloor municipality paddy cultivation and sesame cultivation disappeared completely (Fig 4.12b). Alteration of agricultural pattern resulted in loss of biodiversity in the study area including flora and fauna.

Fig 4.12: Changing pattern of major agricultural crops over years

Fig 4.12 a) Changing pattern of major agricultural crops in Kalamassery Municipality (Adapted from Kalamassery Agricultural Office)

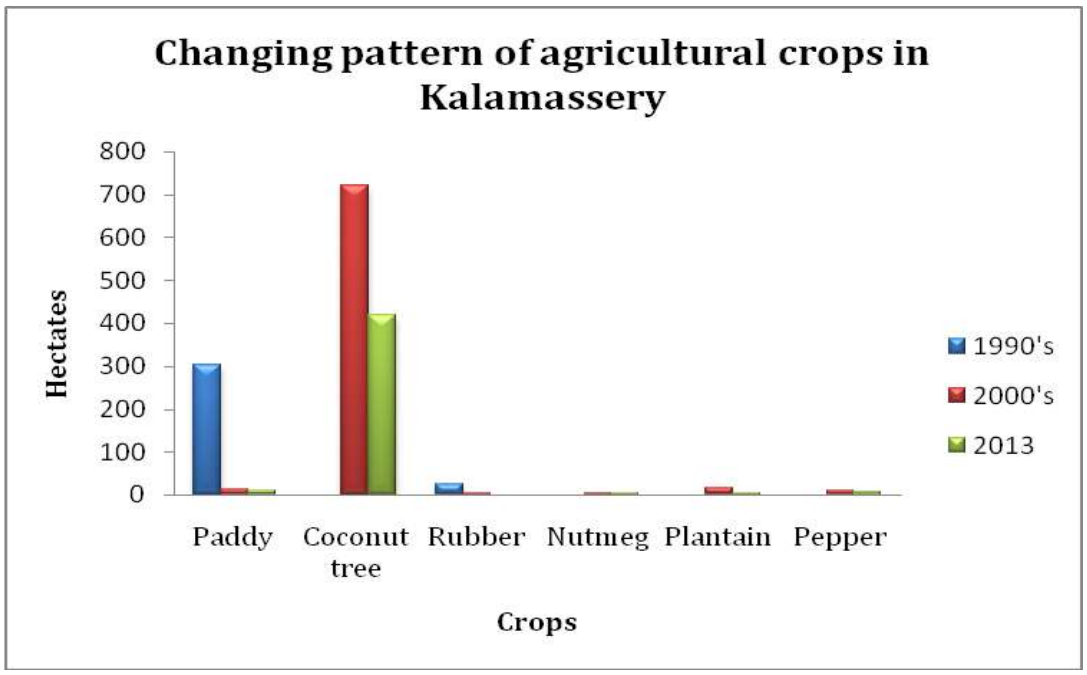


Fig 4.12 b) Changing patterns of major agricultural crops in Eloor Municipality (Adapted from Eloor Agricultural Office)

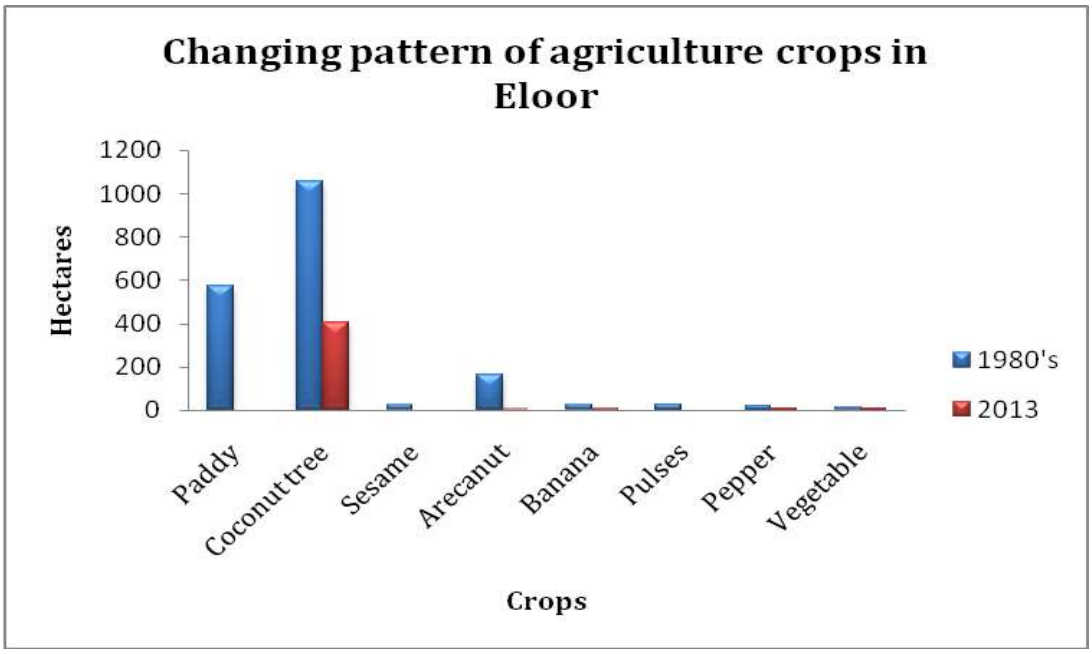
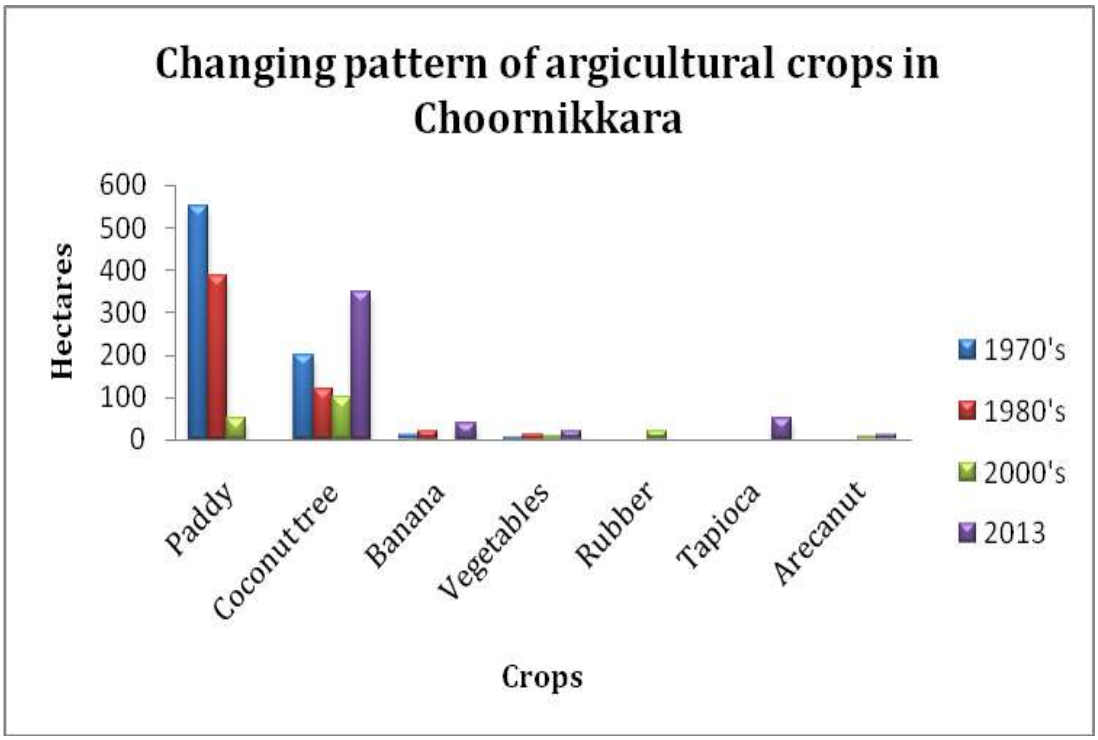


Fig 4.12 c) Changing pattern of major agricultural crops in Choornikkara Panchayat (Adapted from Choornikkara Agricultural Office)



4.3. Analysis of Apollo's effect on change in biodiversity

It is difficult to segregate the impacts of Apollo on biodiversity as the biodiversity loss occurred in the surrounding area due to the cumulative effects of many factors such as human activities, urbanization and pollution from a large number of industries. However, change in biodiversity inside Apollo campus is mainly due to habitat loss through infrastructure developments such as plant extension and construction of roads and change in land utilization inside Apollo campus without giving any priority to biodiversity. It reduces the diversity of flora and fauna inside Apollo campus. Other factors that could affect the survival of biodiversity inside the Apollo campus and surrounding area are emission, effluents and related chemical exposure from Apollo campus.

4.3.1. Emissions, Effluents and Chemicals

The major air quality parameters of concern in this area are sulphur dioxide, nitrogen dioxide, carbon monoxide and particulate matter. Ambient air quality is regularly monitored in different locations of workplace and outside the boundary of Apollo campus. Table 4.11 & 4.12 display the available data of average ambient air quality monitoring of different locations near the outside boundary of Apollo campus and inside work place. According to data received, all the parameters are within limits. However, a minor portion of community members mentioned that deposition of carbon particle was a noticeable problem in the past but now it has decreased significantly. This may be because of effective pollution control measures taken by Apollo such as carbon particles trapping method inside the smoke stack or temporary non-functioning of banbury unit in Apollo campus Kalamassery.

Table 4.11: Ambient Air Quality Monitoring of Outside the Boundary of Apollo Campus (a – Near main gate, b – Near Godown, c – Near ETP) (Adapted from Quality Monitoring Data of Apollo)

Sl.no	Parameter	Limit by CPCB	2009			2010			2011			2012			2013		
			a	b	c	a	b	c	a	b	c	A	b	c	a	b	c
1	Sulphur Dioxide (SO2) µg/m3	80	20.5	18.5	19.3	18.6	18.1	18.3	21.3	20.4	21.75	21.7	20.53	20.9	18.63	19.53	20.47
2	Nitrogen Dioxide (NO2) µg/m3	80	24	22.6	21.7	26.5	22.3	21.1	23.8	22.2	23.4	23.47	21.27	22.63	17.56	18.03	18.9
3	Total suspended Particulate matter(µg/m3)	360	72.4	74.7	68.8	59.5	61.3	66.9	-	-	-	-	-	-	-	-	-
4	RPM (µg/m3)	120	31.5	34.8	29.2	23.4	27.2	30.5	-	-	-	-	-	-	-	-	-
5	Particulate matter µg/m3 (size less than 10 µm)	100	-	-	-	-	-	-	35.65	33.8	33.45	37.13	35.56	33.93	45.83	50	52.57
6	Particulate matter µg/m3 (size less than 2.5 µm)	60	-	-	-	-	-	-	14.15	12.25	13.3	15.53	13.56	13.66	22.33	25.17	24.8
7	Lead µg/m3(Pb)	1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8	Carbon Monoxide mg/m3 (CO)	2	0.5	0.7	0.8	0.3	0.5	0.6	0.49	0.49	0.6	0.47	0.44	0.55	0.67	0.43	0.6
9	Ammonia as NH3 µg/m3	4	0.03	0.03	0.03	0.02	0.01	0.02	0.03	0.03	-	0.03	0.03	0.03	0.03	0.04	0.04
10	Benzene (C6H6) µg/m3	5	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
11	Benzo (a)Pyrene ng/m3	1	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
12	Arsenic(As) ng/m3	6	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
13	Nickel(Ni) ng/m3	20	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
14	Ozone(O3) µg/m3	100	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 4.12: Ambient Air Quality Monitoring Inside Different Work Place Locations (a – Curing area, b – Tyre building, c - Banbury) (Adapted from Quality Monitoring Data of Apollo)

Sl.no	Parameter	Limit by CPCB	2009			2010			2011			2012			2013	
			a	b	c	a	b	c	a	b	C	a	b	c	a	b
1	Sulphur Dioxide (SO2) (µg/m3)	80	19	19.05	18.1	19.25	19.8	19.8	17.53	17.37	17.73	19	18.53	18.17	17.5	17.2
2	Nitrogen Dioxide (NO2) (µg/m3)	80	22.65	22.75	20.05	24.95	24.9	24.25	25.1	24.4	23.63	19.83	21.2	22.3	18.55	18.7
3	Total suspended Particulate matter (µg/m3)	200	82.55	83.75	79.5	86.4	0.5	82.85	80.4	85.5	79.3	-	-	-	-	-
4	RPM (µg/m3)	100	29.4	40.2	39.5	30.95	45.4	41.3	41.6	42.2	38.4	-	-	-	-	-
5	Particulate matter (µg/m3)(size less than 10)	100	-	-	-	-	-	-	45.95	44.9	42.05	43.86	42.77	41.77	43.15	44.7
6	Particulate matter (µg/m3) (size less than 2.5)	60	-	-	-	-	-	-	22.25	24.6	24.85	23.9	22.87	21.3	21.55	21.9
7	Lead (Pb) (µg/m3)	1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8	Carbon Monoxide (CO) (mg/m3)	2	0.4	0.6	0.5	0.55	0.45	0.35	0.63	0.63	0.64	3	0.56	0.61	0.54	0.56
9	Ammonia (NH3) (mg/m3)	4	0.022	0.02	0.025	0.021	0.0205	0.022	0.04	0.03	0.03	0.05	0.04	0.04	0.22	0.45
10	VOC		18.6	17.3	16.2	-	-	-	-	-	-	-	-	-	-	-
11	Benzene (C6H6) (µg/m3)	5	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
12	Benzo (a)Pyrene (ng/m3)	1	-	-	-	-	-	-	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

4.3.2. Water consumption & Waste water treatment

Apollo Tyre Company at Kalamassery consumes around 1200 kiloliter water per day. The main source of water for the company is Edamula River, which is a tributary of the Periyar River. To control water pollution due to Apollo Company, an Effluent Treatment Plant (ETP) is installed inside the company. After the utilization of water in different tyre manufacturing processes, it goes to ETP and, thereafter treated water flows to an uncultivated paddy field. Table 4.13 indicates effluent quality monitoring from ETP outlet. Furthermore, Apollo has a water purification plant also in their campus for drinking and cooking purposes. Table 4.14 shows quality monitoring of drinking water in the Apollo campus. Though most of the parameters are within limits, in 2011, there was an excessive content of chlorine in the water, which is 1382.79 mg/l. Moreover, senior employees in the Apollo campus responded that the drinking water quality in the Apollo is not satisfied.

Table 4.13: Effluent Quality Monitoring of Sewage Treatment Plant from ETP Outlet (Adapted from Quality Monitoring Data of Apollo)

Sl. No.	Parameters	Limit by KSPCB	Value Reported							
			2006	2007	2008	2009	2010	2011	2012	2013
1	pH	5.5 - 9	7.33	7.35	7.28	7.29	7.26	7.28	7.47	7.32
2	Suspended Solids (mg/l)	100	24	20	18.6	23.8	34.1	32.2	35.15	26.34
3	Dissolved Solids (mg/l)	1200	2.5	238	2.29	2.8	325	480	667	765.43
4	BOD ,3days, 270C (mg/l)	30	24.8	21.34	20.15	18.2	23.56	24.8	25.5	18.43
5	COD (mg/l)	250	68	70	11.2	72	112	148	114	156.57
6	Oil& Grease (mg/l)	10	1.2	0.97	1.4	1.6	1	1	1.05	0.97

Table 4.14: Drinking Water Quality Monitoring (Adapted from Quality Monitoring Data from Apollo)

Sl. No	Parameteres	Desirable Limit	2007	2008	2009	2010	2011	2012	2013
			Result	Result	Result	Result	Result	Result	Result
1	pH	6.5 -8.5	6.7	6.86	6.95	6.65	6.755	6.87	7.056
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Colour (Color Units)	5	3	3.5	4	4	12	4	3.166
5	Turbidity (NTU,max)	5	0.1	0.5	0.4	0.6	4.35	BDL(MDL-0.1)	BDL(MDL-0.1)
6	Total Dissolved Solids (mg/l)	500	30	56	133.5	37	23.38	71.5	65.33
7	Total Hardness as CaCO3 (mg/l)	300	14	21	47.05	12.6	59.6	34.8	23.89
8	Chloride as CI (mg/l)	250	7.88	15.318	32.155	12.205	1382.79	15.185	19.12
9	Sulphate as SO4 (mg/l)	200	2.22	3.565	6.43	2.28	29.995	8.52	8.1425
10	Nitrate as NO3 (mg/l)	45	1.87	1.95	0.74	0.125	0.145	0.25	0.2025
11	Fluoride as F (mg/l)	1	0.25	0.28	0.235	BDL(MDL-0.1)	0.285	0.11	0.14
12	Alkalinity as CaCO3 (mg/l)	200	12	23.2	79.95	14.65	15.9	31.19	24.766
13	Iron as Fe (mg/l)	0.3	0.17	0.327	0.12	0.25	1.225	0.09	0.058

4.3.3. Chemicals used in Apollo

Following are list of chemicals presently use in Apollo tyres Kalamassery for the production of Tyres, in which four of them are hazardous as per the hazardous list provided by the company (Table 4.15). If the hazardous wastes are not disposed properly, it could affect the floral and fanuna community severly.

Table: 4.15. List of Chemicals use in Apollo Tyres, Kalamassery (Adapted from data provided by Apollo Tyres, Kalamassery)

Sl. No	Chemicals (*indicates Hazardous Chemicals)
1	Lamp Black*
2	Oleic acid*
3	Silicone Emulsion 35%*
4	Naphtha (Rubber Solvent)*
5	Isopropyl Alcohol
6	Anti-tack agent ML
7	Anti -tack Agent AOSL-46
8	Water Based inside Tyre Lubricant
9	Talc IP Grade
10	Polythylene Glycol
11	Nalco 444 (Phosphate)
12	Nalco 19 pulv (sulphate)
13	Alfloc 113 (PH Booster)
14	Bionil CM
15	Bionil D 610
16	Trac 107

4.3.4. Change in Land Utilization inside Apollo Campus

Change in land utilization also makes a difference in biodiversity inside the Apollo campus. Fig 4.13 shows changes in area wise land utilization in Apollo campus in 1960's and 2013. Comparing both cases, the area of the factory is increased due to plant extension, which is unavoidable for the progress of the company. Moreover, the road area also increased for the easy transport inside the Apollo campus. Consequently, vacant area and garden decreased dramatically that reduces the biodiversity inside the campus. Cutting down of trees and other flora inside Apollo campus for plant extension or road construction without giving importance to biodiversity resulted in loss of flora and associated fauna.

Fig 4.13: Change in land utilization in Apollo Campus (Based on the data provided by Engineering Department of Apollo Tyres Limited, Kalamassery)

Fig 4.13a) Area wise land utilization in 1960s

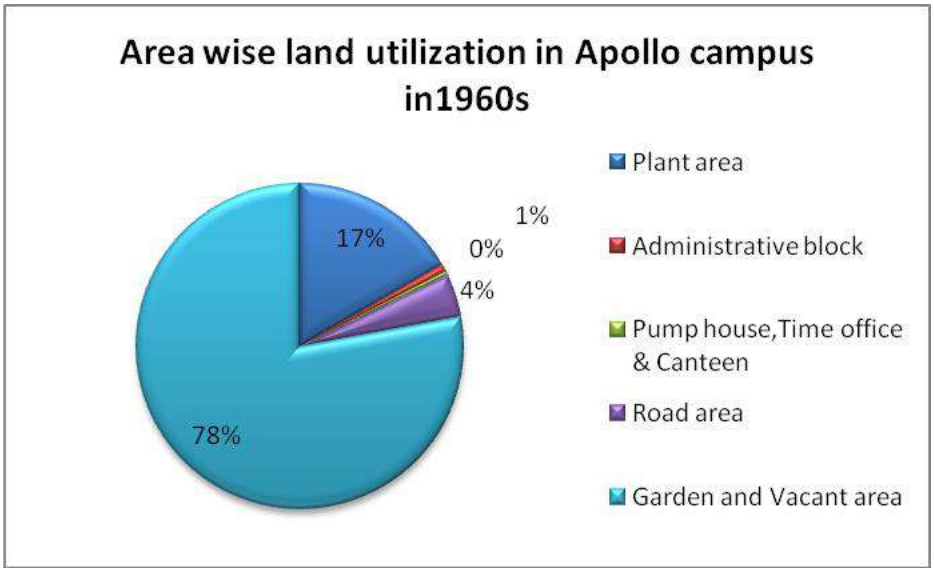
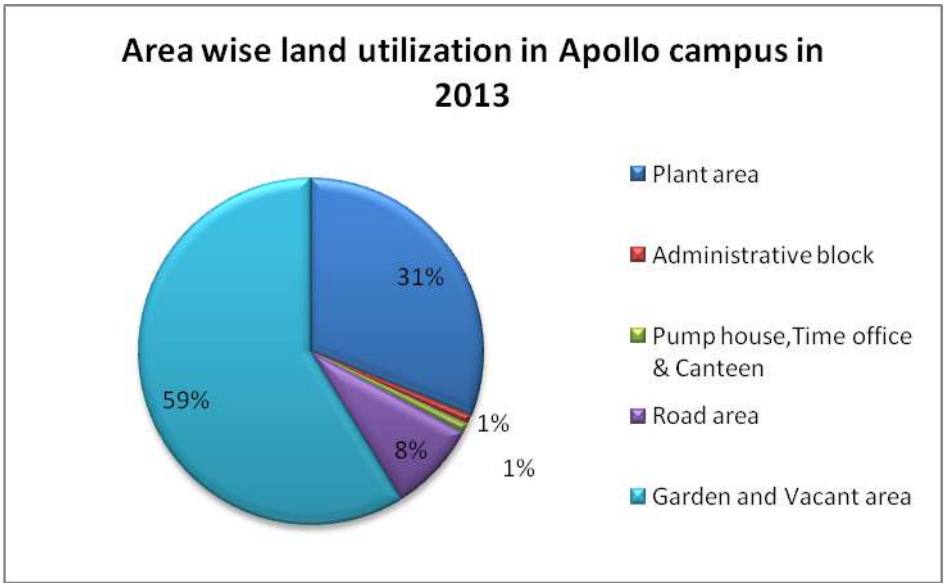


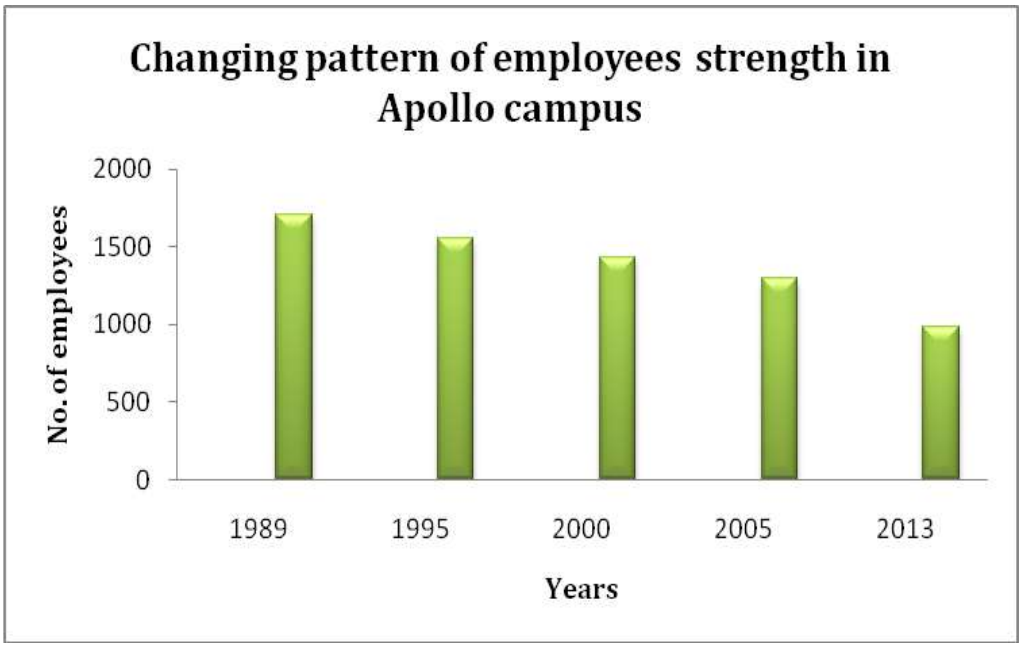
Fig 4.13b) Area wise land utilization in 2013



4.3.5. Employees Strength

As per the data provided by Apollo tyres, there is a decreasing pattern of employees' strength in Apollo Tyres (Fig 4.14), Kalamassery including only permanent workmen and officers. However, the number of contract workers and management trainees are increasing according to senior employees' opinion. Currently, there are 450 contract workers in the Apollo Tyres Kalamassery.

Fig 4.14 Changing Pattern of Employees Strength in Apollo Tyres, Kalamassery (Data provided by Apollo Tyres)



4.4. Steps undertaken by Apollo Tyres on biodiversity protection

Apollo tyre company adopted different activities under **Habitat Apollo** to protect biodiversity and environment inside and outside Apollo campus, which are organic farming, planting trees in highway median, World Environment Day celebration, monitoring food waste generated, sessions on environment, water and paper recycling, biogas plant and sewage treatment plant for waste management.

4.4.1. Organic farming

Under **Habitat Apollo**, an organic garden is created with vegetables such as lady's finger, spinach, pumpkin, cabbage, cauliflower, white ash guard and yam for the proper utilization of vacant land inside Apollo campus. It makes the vacant land greener and support the biodiversity inside the campus. The harvested food products are used in canteen in the campus or guest house. This is an eco-friendly initiative done by Apollo to promote biodiversity inside the campus and it is maintained by gardeners in the Apollocampus.

4.4.2. World Environment Day Celebration

Apollo celebrate World Environment Day every year with a variety programmes such as planting tree saplings, distribution of seedlings and seeds, classess about nature and other activities such as quiz competition etc. However, according to senior employees proper care is not given to planted tree sapling after the World Environment Day.

4.4.3. Monitoring of food wastage

The quantity of food wastage is displayed in the canteen every day to encourage employees to avoid wastage of food.

4.4.4. Sessions on Environment

Apollo conducted sessions on water consumption, waste management, energy consumption and biodiversity enhancement inside the campus to give awareness to employees to minimize wastage of resources.

4.4.5. Paper recycling

Under habitat Apollo all used papers are collected from the office and send it for recycling. This initiative is green activity started by Apollo that indirectly reduces consumption on biodiversity.

4.4.6. Water recycling

Treated water from sewage treatment plant is used for gardening that gives nutrients to plants as well as helps to monitor the quality of treated water.

4.4.7. Waste management

A biogas plant is constructed inside the Apollo campus to dispose biodegradable waste from canteen and the biogas from the plant is used for boiling drinking water in the canteen. They have implemented segregation system of wastes in their canteen, and the bio-degradable wastes are disposed into the biogas plant However, the maintenance of biogas plant is not properly done regularly and not all bio-degradable wastes are disposed into the biogas plant.

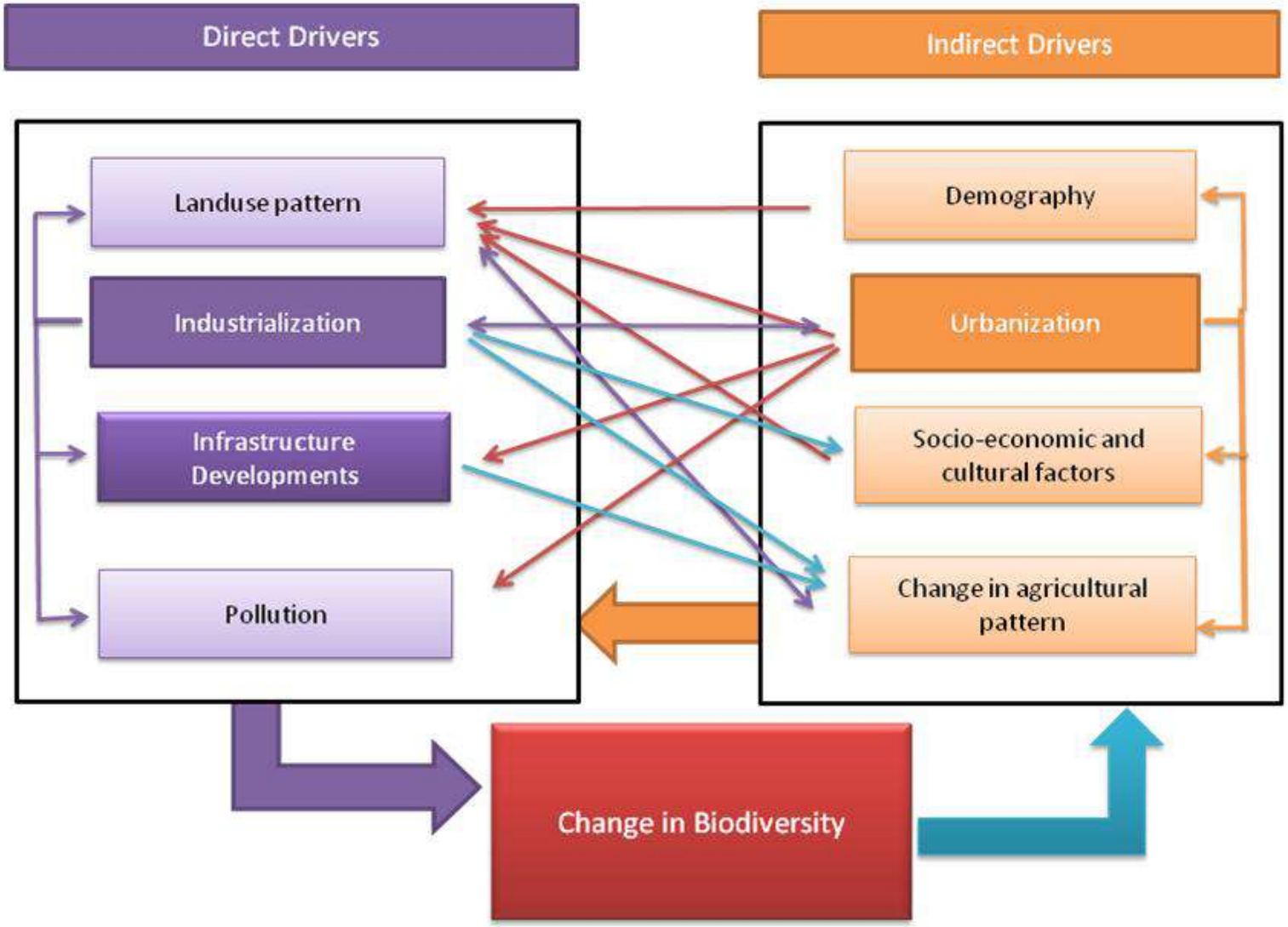
4.4.8. Other activities to reduce environmental pollution

First of all, Apollo has increased the height of smoke stack that reduces carbon pollution in the surrounding compared to the past. To reduce resource depletion, they have reduced furnace oil consumption, air leakage, steam leakage. Other practices such as reduction of oil spillage, spillages inside lubes, cement spillage and disposal system for spews and flashes. In addition, they have installed solar lights, variable drives, LED lights etc to reduce energy consumption.

4.5. Matrix Analysis on Apollos role in changing Biodiversity

Fig 4.17 illustrates the connection between the direct and indirect drivers, and how it ultimately resulted in the change of biodiversity. The dark shades represent the major drivers that caused impact on biodiversity in the study area. As it is shown in the diagram, the drivers are interlinked and the cumulative effects of these drivers change the biodiversity in the region and even cause biodiversity loss.

Fig. 4.17 Matrix analysis on the drivers of changing pattern of biodiversity at Kalamassery



Biodiversity Impact Assessment at Kalamassery

Summary of Findings

- The overall biodiversity status within the study area is moderately rich, in which the campus has a rich diversity of flora and fauna comparatively. 262 species of flora and 99 species of fauna were found inside the campus.
- The dominant categories of plant species are herbs, trees and shrubs, comprising 35%, 21% and 11% respectively. The plant species consist of native and exotic species including garden varieties, almost 22% of total floral population inside the campus are exotic. The overall faunal diversity is moderate as the abundance of fauna species are not evenly distributed inside the campus.
- However, according to survey respondents, there is a substantial decline of biodiversity richness inside and surrounding area of Apollo campus over years due to habitat loss, pollution and other disturbances related to urbanization and industrialization.
- The surrounding areas of Apollo campus within 2.5 km radius has moderate to low species diversity (138 species of flora and 64 species of fauna). The existing floral diversity is mainly dominated by garden plants and sussessional growth in the study area due to development activities, congested housing and infrastructures.
- The direct drivers of changing pattern of biodiversity in the study area are land use/land cover pattern, industrialization, infrastructural development and pollution. All these drivers are interlinked, and among that industrialization and infrastructural developments adversly affect biodiversity and its components by altering natural vegetation and associated fauna.
- The indirect drivers in the study area are demography, urbanization, socio-economic and cultural factors and change in agricultural pattern. Urbanisation is considered as one of the major driving forces of change in biodiversity that leads to fragmentation of large areas of natural habitats, thereby severely affecting species rely on that habitat.
- However, it is difficult to segregate the impacts of Apollo on biodiversity as the biodiversity loss occurred in the surrounding area due to the cumulative effects of direct and indirect factors, especially industrialization and urbanisation in the study area.

5

Biodiversity Enhancement Programme : Proposal

5.1. Strategies of Biodiversity Enhancement Program

The ultimate strategic goal of the enhancement program is to improve the status of biodiversity inside the Apollo campuses and surrounding areas. Apart from enhancing ecosystem services by increasing green cover and faunal diversity in the region, it will also become an effective education tool. Moreover, it reduces atmospheric carbon level through improved carbon sequestration. By ensuring the participation of employees and community members in the implementation process, companies' linkage to the employees and community will be strengthened. The enhancement programs make better use of nooks and corners of the campus and offers ecological, aesthetic and economic benefits. In addition it will improve Apollo's image as a green corporate and increases stakes in the global carbon market.

5.2. Proposals for Biodiversity Enhancement at Apollo Tyres Limited, Perambra

After the close examination of the current status of biodiversity and space available inside and outside Apollo campus, a list of biodiversity enhancement programs and the potential avenues for their implementation were designed. During the development of these programs, the suggestions of the community members and Apollo employees were taken into consideration. Biodiversity restoration programs for inside the campus and outside the campus are categorized separately in this section. Also, some community involvement programs are also suggested so as to esure that the collective effort of Apollo Tyres and neighboring communities become fruitful as Apollo reach out to its community.

5.2.1. Biodiversity Enhancement Programs Inside Apollo campus

Apollo Tyres is the largest corporate company occupying a large land mass compared to any other institutions in the area. Since this land mass provides habitat for large number of flora and fauna, it is high time that Apollo take necessary actions to protect and enhance its biodiversity wealth. Therefore, programs that are feasible for Apollo Tyres are biodiversity gardening, low cost waste management activities, water footprint reduction techniques and promotional programs of environmentalism.

5.2.1.1. Biodiversity Gardening

Biodiversity gardening is a unique attempt to biodiversity conservation through simple and low cost methods. Since habitat loss is the major cause for the declination of global biodiversity, effective methods of habitat provision is necessary to enhance biodiversity. Hence, creating biodiversity garden inside Apollo will provide much needed habitat for hundreds of species right inside our campus. A biodiversity garden creates critical habitat for our native pollinators and a healthy ecosystem for humans. The area near to Apollo's buildings and backyards could be transformed into biodiversity gardens by just planting trees, shrubs or herbs and protecting them to stabilize its own. Such areas may provide fruits or flowers for human use and more significantly attract a wide variety of animals to the campus. This will create a co-existence and make the campus a naturally sustainable habitat. Once the

proposed gardens are implemented they can be showcased to the public community which will be an educative experience for them. Thematic biodiversity gardens are based on a theme which will create better conservation for the entire habitat. The benefits of building such thematic gardens are given below.

a) Initially the improved diversity of flora, which in turn attract the fauna to the campus thereby improving the faunal biodiversity as well
b) Better use of nooks and corners of the campus with increased diversity and abundance of flora and fauna; it offers ecological, aesthetic and economical (fruits, vegetables, flowers and other goods) benefits.
c) Informal education through visual learning; ensures excellent awareness output and good conservation impacts
d) Reduction of atmospheric carbon level through improved carbon sequestration and carbon trapping thereby contributing to the mitigation of climate change
e) Better utilization of wastes and waste management at its source; less pollution and promotion of sustainable practises
f) Change of Apollo's impage in the public and create a sense of ownership about Apollo among the community

In the context of Apollo campus, there are a number of steps that can be undertaken to create a biodiversity garden inside the campus.

1. Select indigenous plants only and create a water-wise garden

Global warming and associated climate change predictions point out that our region become drier over the years due to unpredictable rainfall pattern. Therefore, the water will become scarce and expensive as the time goes. Hence, it is not affordable to waste water on gardens and a water-wise garden, a garden that wisely utilizes water, has to be introduced.

Indigenous plants adapted to our climate uses less water, and are well suited to grow in tropical conditions. Therefore, planting more native plants in the campus will reduce water usage for the irrigation of garden plants. For instance, the gardens in the campus are outlined by lawns made of Chinese grass, which is an exotic species. This grass species is expensive in terms of management and consumes a large amount of water every year. On the other hand, introducing native grass species such as Buffalo grass avoids the two above mentioned concerns. Also, the added benefit is that the cost of planting this grass species is very little or zero due to its availability in abundance in the nearby grasslands and abandoned barren lands. For that reason, an eco-friendly gardening can only be ensured if more native plants are planted in the campus.

2. Butterfly garden

Creating a butterfly garden would probably be the easiest way to make the campus more eco-friendly. Also, it is the best way to make better use of the nooks and corners of the campus that remains unused as an ideal butterfly garden can be created with as less land area as 3

cents. Butterflies can be attracted and sustained in the campus by planting about 60-70 species of both nectarine and food plants, including trees like soap nut tree. Since native butterflies will only be attracted to native garden plants it is vital to plant indigenous garden plants in order to create a butterfly garden. Choosing the plants that caterpillars and butterflies like to feed to be planted in the garden will automatically invite more butterflies to the campus while complimenting the aesthetic beauty of the campus (University of Minnesota, 2013).

From the context of Apollo, there is high scope for building three butterfly gardens inside the campus. At present there are 27 species of butterflies at Apollo campus, though many of them are not abundant, and the chosen areas for the butterfly garden are the areas where most of them are seen. In order to bring a professional touch to the butterfly gardens and to make it educational for the company staffs and visitors, bill boards stating about the importance of butterflies, butterflies gardens, type of butterflies and the role of each plant planted in the butterfly gardens on various stages of a butterflies' life cycle can be displayed in the garden.

Butterfly garden 1: The first butterfly garden will be constructed in the small space that is in front of playground and beside the first security post. Since the unmaintained grasslands in the playground is the most favoured spot for breeding and foraging by certain species like Tawny coaster, building one butterfly garden near the playground will automatically attract them to it. As there are no native plants in the proposed site, it is crucial to plant more nectarian and fruit bearing plants.

Butterfly garden 2: The second butterfly garden can be constructed in the small unused space that is beside the guest house on the way to the organic vegetable garden. Since this is also one of the favourite places for butterflies in the campus, addition of more native plants to the area would be sufficient for its creation.

Butterfly garden 3: The third and bigger butterfly garden can be built in one corner of the unused area behind the car parking lot. Since this is the area is constantly disturbed by the noise from the plant area, more effort has to be put in it to make sure that butterflies are attracted to the garden. Therefore, the area has to be totally covered by native nectarian and fruit plants.

3. Bird garden

Making a bird garden in the open space of the company premise would create a much lively natural habitat inside the campus. The main aim of the creation of bird garden is to provide a resting and roosting space for the bird population inside the campus, and to attract more birds to the facilities provided. In turn, the bird diversity and abundance in the campus will be improved. One of the positive sides of the bird garden is that it may not necessarily require a specific land area for itself. On the other hand, the spaces that are used for other purpose can also be made into a bird garden. The important factors required for bird garden are native flowering and fruit bearing plants that would provide yearlong food supply. In order to create a much attractive habitat for birds, placing small stones and rocks and creating a fresh water pond for bird bath would be effective. Also, placing nests within the garden will invite more birds to lay egg and rear young ones within the

campus. However, it should be kept in mind that plants and grasses grown in the garden should not be trimmed as it will chase the birds away (Global Stewards, 2013).

At Apollo, two bird gardens will be created, and other areas will be made suitable to attract more birds by hanging bird nests in small trees of the engineered garden and on Indian Mast trees planted in a line along the sides of internal roads. Also, more fruit plants could be added in the garden as it was noticed that many birds in the area are feeding on the fruits produced by the existing plants in the campus.

Bird garden 1: The tree line behind the guest house is the resting place for many birds such as owls, drongos, robins, barbets, orioles, kingfishers and woodpeckers. Therefore, hanging bird nests in these trees will provide them with roosting and resting spaces. Also, by planting more fruit bearing trees and creating a bird bath, it can be converted to a bird garden.

Bird garden 2: The second bird garden could be created in the unused scrub jungle behind the stage in the play ground. During the field visits, the presence of lapwings, coucal, flap tails, barbets, kingfisher, flower peckers and bulbuls were noticed in this unused space. Therefore, it can be converted to a beautiful bird garden by hanging several types of bird nests, planting fruit trees and creating a bird bath.

As Apollo is the roosting place for a large number of birds at the end of each day, the proposed bird gardens will create an attractive habitat for them as well. In addition, it will complement the aesthetic beauty of the campus and showcase Apollo's prioritization on biodiversity conservation.

4. Fruit tree garden

Fruit trees become the source of sustenance for the birds and insects in an area. By focusing on the significance of fruit trees for biodiversity enhancement, native fruit trees will be planted throughout the campus with special thrust given to the scrub jungles near to the truck parking area, coal storage yard and scrap yard. This will act as a haven for birds and insects as these trees will be a food source and dwelling place for them.

5. Fish ponds

Several small and medium sized ponds can be constructed in different sites in the campus. These sites can be anywhere in the campus as the space and facility for management allows, but a number of potential sites for the ponds are proposed in the map provided. Since it is not feasible to fill these ponds with fresh water, only the waste water that has been treated in STP will be used in it. These ponds will provide drinking water for the birds and will act as a breeding ground for dragonflies and damselflies. One of the negative sides of these ponds is that mosquitoes will make a breeding place out of it. Therefore, fish species like carp and guppies and frogs will be grown in it, which will check the mosquito larvae population in the ponds. Also, ornamentary water plants like water lilies and lotus could be grown in it to enhance the aesthetic beauty of the plant. Additionally, setting some park benches in the garden beside the ponds will make a relaxing place in Apollo's garden, which could be used to entertain guests in a natural environment, so that they can appreciate the effort that Apollo has put in to enhance the natural beauty of its campus.

6. Wild tree garden

Large woody wild trees are almost in disappearance, even in villages of Kerala. About 75 species of wooden trees can be planted in the campus, at various locations especially in the unused land sites. Also a wild tree belt can be created in the periphery of the campus so that it will add up the green cover in the campus. When the trees are planted, it should create different layers of trees according to their heights so that it will give much greener appearance when looking from outside.

7. Wild grass corner

An empty corner or spot where little growths can be ideal for a patch of wild grass left to grow and seed can be made inside the campus. The seeds will provide seed-eating birds with food and increase the diversity of these bird species that prefer wild grass seed. For that the ideal site is the unmaintained grass land near the scrap yard as many birds like jungle babbler were recorded from the site during the field visit. A portion of the site will be maintained so that more varieties of grasses can be grown in there.

8. Star garden

In India, especially in the southern parts of the country, there are certain beliefs regarding the connection of one's birth star and a tree and animal or bird. These trees are called star trees. Thus there exist 27 star trees, one for each birth star. The proposed star garden consists of all 27 trees, and it creates a sense of attachment our own star tree, leading to the personal level conservation. Also, it may encourage them to plant the tree that represents their birth star in their homes as well, thus nature conservation, in a way, will be extended to the families of the employees as well. The star garden of Apollo Tyres will be set up in $1/3^{rd}$ of the land behind the car parking lot, adjacent to the proposed butterfly garden.

9. Bamboo garden

Bamboos and rattans are one of the diverse groups of plants of tropical countries that can survive without inputting care. The proposed Bamboo garden will have more than 60 species of native bamboos and rattans. This will provide a secure habitat for many wild animals too. The garden will created in the unused land mass behind the company canteen. Since the place already a number of bamboo variety, it can be assumed that other species also may grow well. Therefore, it is the ideal place for creating a bamboo garden inside the campus. This could become an educational experience to the viewer if boards explaining about each bamboo and rattan species planted in the garden.

10. Medicinal garden

Up to date, more than 350 species of native plants with potential medicinal properties are recorded in Kerala. Creating a garden inside Apollo campus will be an excellent learning centre and will increase the ratio of native plants inside the campus. Also, it will aid the company medical team in dealing with health issues and disease treatment of the company employees. The proposed

medicinal garden will be set up in the remaining space of the unused land behind the car parking lot.

11. Apiculture

The ideal place for setting honey bee boxes inside Apollo Tyres, Perambra will be the rubber plantation. About 10-15 honey bee boxes will be set up in either ends of the rubber plantation. It not only increases the bee population inside the campus, but produce good quality honey that could be gifted to VIPs visiting the plant.

12. Agro-biodiversity garden (Organic Farm)

Apollo Tyres, Perambra has a vast land area that is unused at the moment. To make better use of the land, an agro-biodiversity garden, showcasing all spices and major agricultural crops of Kerala, will be implemented. The ideal place for the agro-biodiversity garden is the coconut plantation, which occupies a large land area and has lots of spaces in between each coconut tree. The garden will be maintained organically without using any chemical agro-chemicals so that it will improve the diversity of insects, worms and other soil organisms inside in it. If the garden become much diverse, insect number will be controlled by their natural predators present in the garden itself. However, in cases of emergency, it is recommended to use bio-pesticides only. Also, the treated water from ETP can be made into better usage, thereby reducing the amount of water released out through the outlets. Through this way, a significant portion of the vegetables and other edible products used in the canteen can be produced within the campus.

13. Live Rubber Museum

Near to the area where rubber plants are grown in Perambra campus, a demo unit that showcases the production of rubber from its initial stage can be built. Old rubber trees will be retained for this purpose in a 20 cent plot, while replanting the remaining area with various rubber plant varieties. Small renovations in that area can attract the visitors and the workers. It not only increases the campus beauty but also provide educational benefits.

Though many biodiversity enhancement activities are suggested in this section, the major challenge that Apollo will face in the future while working on it is that the company does not have a proper green policy that collaborate biodiversity conservation with the production activities, thereby doing business in a greener way. Therefore, there is an immediate need for a green policy that would ensure an effective and sustainable implementation of environmental protection activities. Also, it has been noted that though company has strict quality monitoring rules and regulation, all the activities occurring under it are carried out as if following a mandatory law. Other than that, minimal interest has been noted among them so far about the biodiversity enhancement and environmental protection. Hence, more awareness activities have to be carried at Apollo to maximize the employee participation so that the collective efforts of Apollo as a family will ensure the sustainability of nature and ecosystem services inside the campus.

14. Belt of Snake Repellent Plants

Apollo campus at Perambra has its fair share of snake diversity and population. Since the campus has a lot of wilderness in its rubber plantations and other unused areas, it provides a comfortable habitat for the snakes. However, these snakes do not always confine to the wild areas; instead they come out to the areas of human invasion. Since snakes are dreaded creatures by people, they are being killed inconsiderate of whether they are poisonous or not. Therefore, it affects the snake diversity and population in the campus. Also, there is a higher risk for people to be bitten by the venomous snakes of the campus which could have detrimental impacts on the company employees. Both these problems can be solved by making belt of snake repellent plants around the wild areas and the sides of internal roads. Its creation is not very expensive as it involves wild plants that are available in abundance. For instance, plants like Basil, American mint, *Aristolochia indica*, *Aristolochia bracteata* and *Aristolochia tagala* are proven to have snake repellent activity due to certain chemicals present in them. Since these plants are found in most of the rural communities and wilderness in Apollo campus, making a belt of them around the roads will be cheap and effective in repelling the snakes.

5.2.1.2. Waste Management

Biodiversity of an area is inseparably linked to the environmental quality of the location. Hence the waste management measures also should be implemented to enhance the biodiversity inside the campus. For that, a number of activities are proposed under this section.

1. Compost green waste (Pit composting using microbial consortium)

At present most collected waste is disposed of in landfills or discarded improperly. Within the landfills biodegradable waste produces methane, a powerful greenhouse gas. Greenhouse gases play a major role in global warming, and our activities are rapidly increasing the level of greenhouse gases in the atmosphere. Reducing the amount of waste that is send to the landfill will reduce methane release and reduce our contribution to global warming. Hence a composting unit with just a few pits should be needed to fertilise the plants. The plant could be built in the vacant areas near to the ETP so that any difficulty due to the smell emanating from the pit during the bio-waste digestion could be solved. A compost pit unit will improve the efficiency of the plant to process all its biodegradable waste, which in turn will be turned to organic manure that could be used in the agro-biodiversity garden to get a better yield.

2. Phytoremediation

The removal pollutants in the effluent can be facilitated by introducing aquatic plants that can accumulate chemical contaminants in their cells. Therefore, plants that are able to perform phytoremediation should be introduced to the settling tanks. By periodically removing the old plants and introducing new ones would ensure that the accumulated contaminants are not returning back to the water. There will be two phytoremediation units implemented in the

campus. The first one will be created by converting the existing settling tank beside the organic garden near to the guest house. Since it has a good net covering, growing aquatic species that can feed on the settling waste would also be fruitful. The second proposed phytoremediation unit will be created near to the ETP tank beside the canteen. A bigger pond will be created there to which treated water from ETP will be passed which will be purified by the plants introduced to the pond.

5.2.1.3. Water Conservation

As per the data collected, Apollo consumes a large amount of water from Chalakkudi River. Being situated in a heavily rained place and having a vast area as the campus, a number of techniques are there for Apollo to adopt to reduce their water footprint.

1. Rainwater harvest

Since Apollo occupies a large area for the campus, there is a high scope for Apollo to set up rainwater harvesting units in their campus. It will be one of the best options for Apollo to reduce its water consumption from the river. A number of rainwater harvesting units can be built inside the campus as the space allows.

2. Recharge well

Recharge wells are one of the effective techniques to check runoff and to increase groundwater discharge by trapping the rainwater. It is the cheapest and cost effective technique that Apollo can adopt to improve the ground water flow in the area. For that, a number of discharge wells are proposed in the areas near to the banana plantation. However, more recharge wells could be created in other parts of the campus without hampering its aesthetic beauty.

5.2.1.4. Employee Participation

Though many activities have been suggested in the two aforementioned sections, it would be practical without the support of Apollo employees. In order to have a proper promotion of environmentalism in the campus, employee involvement should be increased in eco-friendly activities. For that, Apollo should encourage its staffs by conducting competitions and by awarding the winners. For instance, the responsibility for the agro-biodiversity mentioned in the first section could be divided and given to a group of employees who are keen to act for nature conservation. Then, 'green group of the year' award can be awarded to the group with maximum yield. Similar kind of competitions could be conducted for the "Green Employee of the Year" as well.

Also, frequent sightings of snakes, especially venomous species like Indian Spectacled Cobra and Russel's Viper, have been reported by the company staffs. Since they are not trained to manage such situations, there is no other alternative other than killing them. Therefore, the abundance and diversity of snake population in the campus is under threat. This problem can

be solved if the company staffs, especially security team, are trained to get rid of the snakes without killing them and being bitten by them.

Moreover, new programs have to be executed at Apollo Tyres in order to ensure the employee engagement in biodiversity enhancement. It not only promotes environmentalism at the campus, but the employees will start to carry out similar conservation programs in their own homes. Thus, an eco-friendly and biodiversity conservationist society can be moulded out of Apollo Tyres.

5.2.2. Biodiversity Enhancement outside Apollo campus

Apollo Tyres is the only large scale business entrepreneur existing in the study area. Therefore, Apollo Tyres is the only corporate company that could take the responsibility of improving the biodiversity of the study area. Hence, a list of the potential activities for the biodiversity enhancement of the study area is discussed below and many of them are developed with the input from the surveyed community members.

1. Wild tree garden

The greenery, especially the native trees, of the area is decreasing day by day. Therefore, many of the households are hugely affected by the increasing temperature, especially those who are leaving in the sides of NH. Therefore, it is high time that tree plantation programs are conducted in the area. One of the potential activities that Apollo could do is planting tree saplings in the roadsides and highway median. For that, Apollo could conduct a joint collaboration program with the Forest Department so that more wild-tree saplings could be made easily available for the program.

2. Pond management

Ponds and other water bodies were very important in the past as they posed an environmental, ecological and cultural significance. However, today there water bodies are on the verge of total deterioration due to improper management by the people. Today many water bodies have lost its pristine form due to the improper liquid and solid waste dumping and loss of its original ecology. Through a study of ponds in the surrounding areas of Apollo Tyres, five water bodies are identified. The status and type of fauna depended on them are given in Table 5.1.

Table 5.1: Water bodies in surrounding areas of Apollo Tyres

Sl no	Name of the water body	Present condition	Depended fauna	Ecological, Agricultural and cultural significance	Past conservation programs
1	Stream at Perambra	Moderately polluted with liquid waste and chemicals from nearby shops A clean up is very much needed	Fish: Tiger Panchax	• One of the major sources of water for agricultural purposes in the past	Not known

2	Peringankulam	Polluted with solid wastes and unchecked growth of aquatic plants Proper management is neccessary	Fish: Common snakehead, Walking catfish, Giant danio, Orange chromide, anabas lestudanta Insects: Damsel flies and dragon flies Supports a good population of birds	• Water was used for cultivation in the nearby paddy fields in the past and present • Of cultural significance as the name of the place came from the name of the pond • Major water source for households in the past • Halting spot for pilgrims to Shabarimala	A clean up was done about 8 month ago, but the quality of water at present is bad
3	Azhakam lift Irrigation	Proper management exists	Fish: Common snakehead	• Major water source for agriculture in the area	February, 2014
4	Canal	Irregular water supply Polluted by improper waste disposal	Not known	• Major water source in the past for land cultivation • Heavily depended on it in the past for household purpose	Not known
5	Kurishin kulam	Unclean due to the large amount of sediments settled in the pond	Fish: Common snakehead, Walking catfish, Tiger panchax	• Depended for agriculture	February, 2014

As stated in the table 5.1 many of the existing water bodies are polluted and are not in a condition to provide water for various purposes. Therefore, Apollo can take initiatives to clean them and support the type of fauna grown in it. If a program that involves community involvement in cleaning up these ponds is implemented, it will bridge the gap between Apollo Tyres as a big entrepreneur and the local communities

3. Plant fruit trees in the highway median

According to the opinion of a number of surveyed community members, though many ornamentary plants are planted on the highway median, they are of no use as they grow up. Instead, planting bushy fruit bearing plants in the median would be more effective as it will provide food supply for people and the animals like squirrels and birds. However, it should be kept in mind that the plants are bushy rather than trees as the median is not strong enough to support the trees.

4. Introduce traditional garden plants

Today a majority of the households grows several garden plants in their yards, but most of them are exotic. Therefore, the diversity of traditional garden plants in the households in the

study area is very poor. Consequently, the existing garden plants cannot support depended fauna like flower peckers and sunbirds. In order to improve the diversity of native flora and fauna in the study area Apollo can take initiatives such as planting native garden plants in the roadsides and distributing the seeds and seedlings.

5. Seed distribution and competition

The study area which was an agriculture based community in the past has become totally depended on the imported agro products, which are produced while applying harmful agro chemicals, for their sustenance. However, many of the community members are very interested in engaging in cultivation and produce their vegetables from their own backyards. Therefore, Apollo can take initiatives to provide high quality seed varieties to the community members. In order to make other members interested in the cultivation, competitions can be conducted and the winners who achieved a better yield could be awarded with prizes.

6. Waste collection system

One of the problems identified through historical survey is that households of Perambra face lack of a waste collection system. Though it was not a problem in the past as most of families had more spaced backyards to bury the bio-wastes and burn plastic and paper, the situation has changed totally. Like any other areas that became developed, the size of land holdings of individual homes have reduced and they lack enough space for waste management. Therefore, a proper waste collection system is necessary Perambra before the waste problem exacerbates. Here, Apollo can play a role in collecting the recyclables and send it for recycling. Also, many community members have requested for the provision of biogas plant and compost pit at an affordable subsidy rate so that they can treat their biodegradable waste within their homes itself

7. Recharge well

Perambra is a region that is heavily affected by water scarcity during drier summer seasons. Therefore, providing recharge wells to each household to trap the rainwater and to improve the ground water discharge to their personal wells would solve the problem to a certain extent. Provision of recharge would be more beneficial for hilly areas like Nadukunnu and Cherukunnu.

5.1.3. Community Involvement in Biodiversity Conservation

Community engagement in conservation activities is very important for the successful implementation of proposed activities in the communities. Since most of the traditional conservation programs excluded human residents of the study area, it lacked the cooperation of the local residents and consistently failed in drawing the desired results. Therefore, any biodiversity enhancement activity that Apollo Tyres would like to carry out in the neighboring communities should primarily aim to gain the complete participation of the community members which will inturn result in the successful implementation of the proposed programs.

1. Apollo Biodiversity Club (ABC)

Today's children are tomorrow's citizens. Therefore, initiating biodiversity enhancement programs with children and schools will have much more long lasting effect in the community. For that Apollo can do several activities under ABC that involve both children and elders:

a) Awareness program at schools about biodiversity conservation
b) Summer camps at Apollo for children of Apollo employees and other children in which children learn the importance of biodiversity through small nature exploration experiments and a trip to Kodassery reserve forest.
c) Tree plantation campaign in collaboration with nearby schools
d) Awareness programs for women and men about biodiversity conservation

Fig. 5.1. Suggested logo for Apollo Biodiversity Club (ABC)

Fig. 5.2 explains the biodiversity enhancement through biodiversity gardening and employee and community involvement in a nutshell. Also, the biodiversity enhancement programs to be implemented inside the campus are visually demonstrated in Fig 5.3. Implementing the proposed activities at Apollo will bridge the gap between the company and the community members. Also, it will create a sense of ownership among people towards Apollo and the gratitude they already have about Apollo for providing job and there by improving the quality of their life will be further deepened. Moreover, the above mentioned activities could only be implemented strategically if an environmental education is appointed at both campuses.

Fig. 5.2: Summary of Proposals for biodiversity enhancement at Apollo Tyres Limited, Perambra

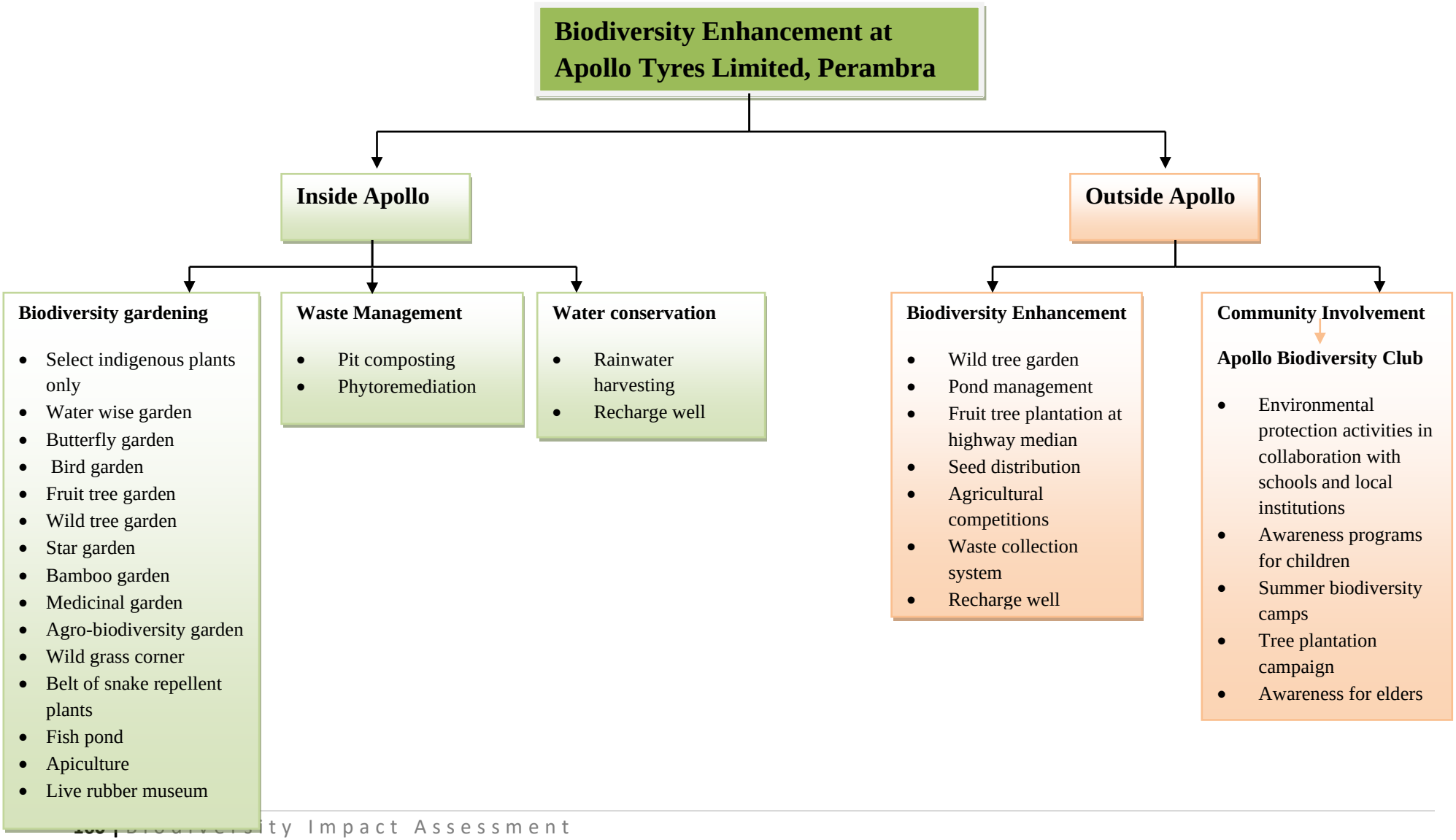


Fig 5.3: Proposed biodiversity enhancement projects inside Apollo Tyres Limited,

Tentative Schedule of Biodiversity Enhancement Programs at Apollo Campus and Surrounding Areas of Perambra Plant

Biodiversity Enhancement Programs	Inside Apollo Campus																
	Butterfly Garden	Fruit Tree Garden	Bird Garden	Star Garden	Bamboo Garden	Medicinal Garden	Agro-biodiversity Garden	Wild Grass Corner	Fish Pond	Api-culture	Live Rubber Museum	Wild Tree Garden	Belt of Snake Repellent Plants	Pit Compost	Phytoremediation Tank	Rainwater Harvesting	Recharge Well
1 year																	
2 year																	
3 year																	
4 year																	
5 year	Improved Floral and Faunal Biodiversity inside the campus, Better use of unused spaces of the campus and A greener environment inside the campus																
6 year																	
7 year																	
8 year																	
9 year																	
10 year	Enhanced reputation of Apollo as a green business enterprise, better image of Apollo among community members and international competitors																

Legend:

	Period of implementation
	Period of management
	Benchmark years
	Achievement

Biodiversity Enhancement Programs	Outside Apollo						
	Biodiversity Enhancement and Waste Management				Apollo Biodiversity Club (ABC)		
	Pond Management	Fruit Tree Garden	Wild Tree Garden	Waste Collection System	Summer Biodiversity Camps	Tree Planatation Campaign	Awareness Programs through Schools
1 year							
2 year							
3 year							
4 year							
5 year	Improved Floral and Faunal Biodiversity in the campus, Better management of available natual resources and Enhanced image of Apollo among community members						
6 year							
7 year							
8 year							
9 year							
10 year	Enhanced reputation of Apollo as a green business enterprise and Creation of a sense of ownership among community members regarding Apollo						

Legend

	Period of implementation
	Period of management
	Benchmark years
	Achievement

5.3. Proposals for Biodiversity Enhancement at Apollo Tyres Limited, Kalamassery

Biodiversity enhancement programs are needed to mitigate the impacts on biodiversity within the Apollo campus and the surrounding area associated with the development phases of the company. It not only ensures greenery but also provides habitat to a number of species. Furthermore, it helps to generate carbon credits and increase the linkage of company with employees and neighbouring community. Restoring biodiversity also increases the aesthetic beauty of the campus and can provide a blissful environment to the workers as well as to the visitors. Biodiversity restoration can be closely connected with the '**Habitat Apollo**' initiative along with the involvement of the workers within the factory. Furthermore, there is an urgency of green policy or biodiversity policy for the company, and it should be incorporated in the main agenda of the company for the success of any biodiversity enhancement programs and acquiring biodiversity accreditations. Suggestions of the community members and Apollo employees were taken into consideration to design the enhancement programs.

Biodiversity Gardening

Biodiversity Gardening is a unique attempt to the conservation of biodiversity through education by transforming Apollo campus into thematic gardens. Habitat loss is the primary cause of declining biodiversity worldwide. A biodiversity garden creates much needed habitat for hundreds of species, right in our own campus. It provides critical habitat for our native pollinators and a healthy ecosystem for humans as well. This will create a co-existence and make the campus a naturally sustainable habitat. Thematic biodiversity gardens are based on a theme which will create a better conservation of the entire habitat.

Biodiversity gardens provide the following benefits mainly:

- Improved diversity, mainly among flora, but naturally it leads to improved faunal diversity too
- Utilization of nook and corner of the campus as a greenery with lots of fauna and flora; offering ecological, aesthetic and economic (fruits, flowers, seeds etc.) benefits
- Each tree or habitat (garden) is a good learning center; high level learning, especially informal education, with excellent awareness output and good conservation impacts
- Reduction of atmospheric carbon level through better carbon sequestration; contribution to mitigation of climate change
- Improved bio waste management- less pollution

General Principle for creating a biodiversity garden is to plant indigenous (native) plants only and create a water-wise garden. Global warming predictions for our region indicate that we can expect our climate to become drier with rainfall becoming increasingly unpredictable. Water is going to become scarce and more expensive. It is vital therefore that we should not waste water in our gardens and start water-wise

gardening (wise use of water). Indigenous (native) plants adapted to our climate use less water and are better adapted to tropical conditions. Among biodiversity gardens, thematic biodiversity gardens are more educative and having better conservation potential.

5.3.1. Biodiversity Enhancement program inside the Apollo campus, Kalamassery

Analysing the current status of biodiversity and space availability inside and surrounding area of Apollo campus, Kalamassery, a list of biodiversity enhancement programs and the potential avenues for their implementation are designed.

1. Fruit trees garden

The space behind the contract employees shed and vacant places in the LPG yard is very much suitable for a 'fruit tree garden'. Fruits are the best media for growing many types of insects and fruit trees in the garden will attract a rich variety of birds. It also increases the diversity of plant species inside the campus.

2. Butterfly garden

The garden in front of the engineering material store (EMS) and space infront of cement house can be transformed to a 'butterfly garden'. Butterflies can be attracted and sustained in the campus by planting about 60-70 species of plants (including trees like soap nut tree) consist of both nectarian and food plants. Butterfly is a very sensitive organism, so the presence of different butterfly species in the campus helps for natural monitoring of air quality in the campus.

3. Star garden

A star garden can be constructed in the backside of the curing plant. The Star Garden will comprise of trees linked to the equal number of stars in the astrology. Thus, there exist 27 star trees, one for each birth star. It makes a sense of attachment to our own tree that may lead to personal level conservation. It will encourage the employees to plant the tree that represent their birth star in their homes; thereby the concept of conservation is also extended to their familes.

4. Bamboo garden

A bamboo garden near the vacant area of STP can be constructed to significantly enhance the biodiversity of the campus. Bamboos and rattans are one of the diverse groups of plants of tropical countries that can survive without inputting care. The proposed Bamboo garden will have more than 60 species of native bamboos and rattans. This will provide a secure habitat for many wild animals too. An informational board about each species can also be placed near tree that will provide an educational experience to the viewers.

5. Woody tree belt

A woody tree row in the backside of the engineering material store and a wild tree belt in the periphery of the campus can be created to add up the green cover in the campus. A variety of wooden tree species can be planted in the campus, at various locations especially in the unused land sites.

6. Native nectarian plant garden

Native nectarian plants can be planted in the existing garden in front of the Apollo Campus, Kalamassery. Currently, the garden is dominated by exotic plants that do not support native fauna. Pollinating insects need flowering plants with nectar. Therefore, planting native nectarian helps to increase both flora and fauna diversity.

7. Fish pond in STP releasing water

Creating a fish pond as suggested is a good way to increase the biodiversity of the campus by bringing species such as fish, frogs and dragonflies. The water released from the STP can be used as the water in the pond after standardised corrective programmes. This gives an aesthetic beauty to the campus and increases the fauna diversity.

8. Green waste compost

Green waste compost can be constructed between the scrap yard and godown using microbial consortium. At present, most of the collected waste is disposed of in landfills or discarded carelessly. Within the landfills biodegradable waste produces methane, a powerful greenhouse gas. Greenhouse gases play a major role in global warming, and our activities are rapidly increasing the level of greenhouse gases in the atmosphere. Reducing the amount of waste send to the landfill will reduce the methane release and will have less contribution to global warming. Hence, a composting pit (just few pits) should be needed to fertilise the plants.

9. Small bird sanctuary

A small bird sanctuary can be created in the southern corner landmass of the campus with a pond. Also, provide nesting, roosting and supplementary feeding for birds. Bird species are mainly found in the northern corner landmass of Apollo. If supplementary feeding and nesting sites or nest boxes can be provided for birds, they are bound to use our garden more often. A small resting park can also be made in this place for employees.

10. Rainwater harvesting structure

A rainwater harvesting structure can be made near to contract employees shed to collect rainwater during rainy season that can be used for other purposes. The overflowed water from the structure can be transferred to already existing recharge pit that helps to replenish groundwater level.

11. Small ponds

Constructing small ponds in the front garden and proposed star garden in the campus will help to attract birds, dragonflies and other organisms. If we provide food availability, water and habitat, the fauna diversity inside the campus will increase. In addition, it increases aesthetic beauty of the gardens and ultimately the campus.

12. Belt of Snake Repellent Plants

According to the employees in the Apollo, snakes are seen at tyre storing and waste disposal areas in the open space of Apollo campus. Usually, these snakes are being killed by employees whether they are venomous snakes or not as people are afraid of poisonous snake bite. To protect employees from snake bite without harming the snake diversity inside the campus, snake repellent plants such as Basil, American mint, *Aristolochia indica, Aristolochia bracteata* and *Aristolochia tagala* can be planted as a belt near road sides, tyre storing areas and waste disposal areas inside the campus. Therefore, it reduces the exposure of snakes to human intervention areas.

5.3.2. Employee Participation and Awareness programs

Employees' participation is needed for the success of biodiversity enhancement programs inside the Apollo campus. Therefore, there is a need of developing attachment and ownership of employees towards the biodiversity inside the campus. Majority of employee interviewees commented that, it is not practical in between the hectic work schedules at Apollo Tyres, and the company gives only priority for the tyre production and. In addition, they have mentioned that even they don't have any recreation area, recreation activities or resting place inside the campus. Therefore, at first Apollo should do welfare activities and awareness programs for employees to increase their involvement in eco- friendly activities inside the campus. Awareness programs about the importance of biodiversity, eco-friendly lifestyle and how to get rid of snakes without harming them should be given to employees. In addition, Apollo can encourage staffs by conducting competitions and giving awards for the "Green Employee of the Year".

5.3.3. Biodiversity Enhancement Programs in the surrounding area of Apollo campus

Limited biodiversity enhancement programmes can be planned in the surrounding area of Apollo campus due to lack of space availability in the surrounding area of Apollo campus as it is located in the urbanized area. Considering the limitations of space availability, a list of the potential activities for the biodiversity enhancement of the study area is discussed below and many of them are developed with the input from the surveyed community members.

1. Restoration and maintenance of water bodies near Apollo Tyres

Ponds and other water bodies were very important in the past as they posed an environmental, ecological and cultural significance. However, today the water bodies

are on the verge of total deterioration due to improper management by the people and change in land use pattern. Many ponds such as Keerikulam, Puliyanakulam and ponds in the paddy fields were converted to infrastructures. Kanjirakulam near Toyota building is the only pond existing near the Apollo Campus Kalamassery, so proper maintainence of the pond can be done in colloraboration with Toyota industry and Municipality. Today, many water bodies have lost its pristine form due to the improper liquid and solid waste dumping and loss of its original ecology. Through a study of water bodies in the surrounding areas of Apollo Tyres, four water bodies are identified. The status and type of fauna depended on them are given below.

Table 5.2: Water bodies in surrounding areas of Apollo Tyres

Sl no	Name of the water body	Present condition	Depended fauna	Significance
1.	Kanjiramkulam near Toyoto	• Moderately polluted • Have some lotus plants inside the pond	Fish: Walking catfish, Giant danio, Olive barb etc Insects: Damsel flies and dragon flies	In past, the local community depended household purpose
2.	Tributary of Periyar	• Polluted with solid wastes, liquid wastes from sewage and unchecked growth of aquatic plants • Proper management is necessary	Fish: Common snakehead, Walking catfish, Giant danio, olive barb etc	• Apollo withdraw water from this river • Water was used for cultivation in the nearby paddy fields in the past
3.	Stream near Rajagiri road	• Highly polluted with liquid waste and chemicals from nearby shops • A clean up is very much needed	Insects: Damselflies and dragonflies	Water was used for cultivation in the nearby paddy fields in the past
4.	Thoomangal stream	Moderately polluted	Fish: Giant danio, olive barb etc	Major water source for households in the past

As stated in the table many of the existing water bodies are polluted and are not in a condition to provide water for various purposes. Therefore, Apollo can take initiatives to clean them and create a small park or resting place on the bank of Kanjira kulam and tributary of Periyar with grass lawn and placing of few benches. Moreover, in Kanjira

kulam, cultivation of some lotus plant and few large fish culture can be done to enhance the aesthetic beauty of the pond. This can be done with the collaboration of municipality, so the linkage of community with company will increase drastically.

2. Seed distribution

As the space availability is less in the surrounding area of Kalamassery plant, distribution of seedlings to community people for terrace farming can be done under biodiversity enhancement program.

5.2.4. Community Participation

Similarly, community participation can be increased by implementing above mentioned biodiversity enhancement programs for community and organizing a biodiversity study program inside the campus for school and college students without disturbing the normal functioning of the company. Implementation of proposed biodiversity enhancement programs and proper maintenance will help Apollo to make an avenue for linking neighbouring community.

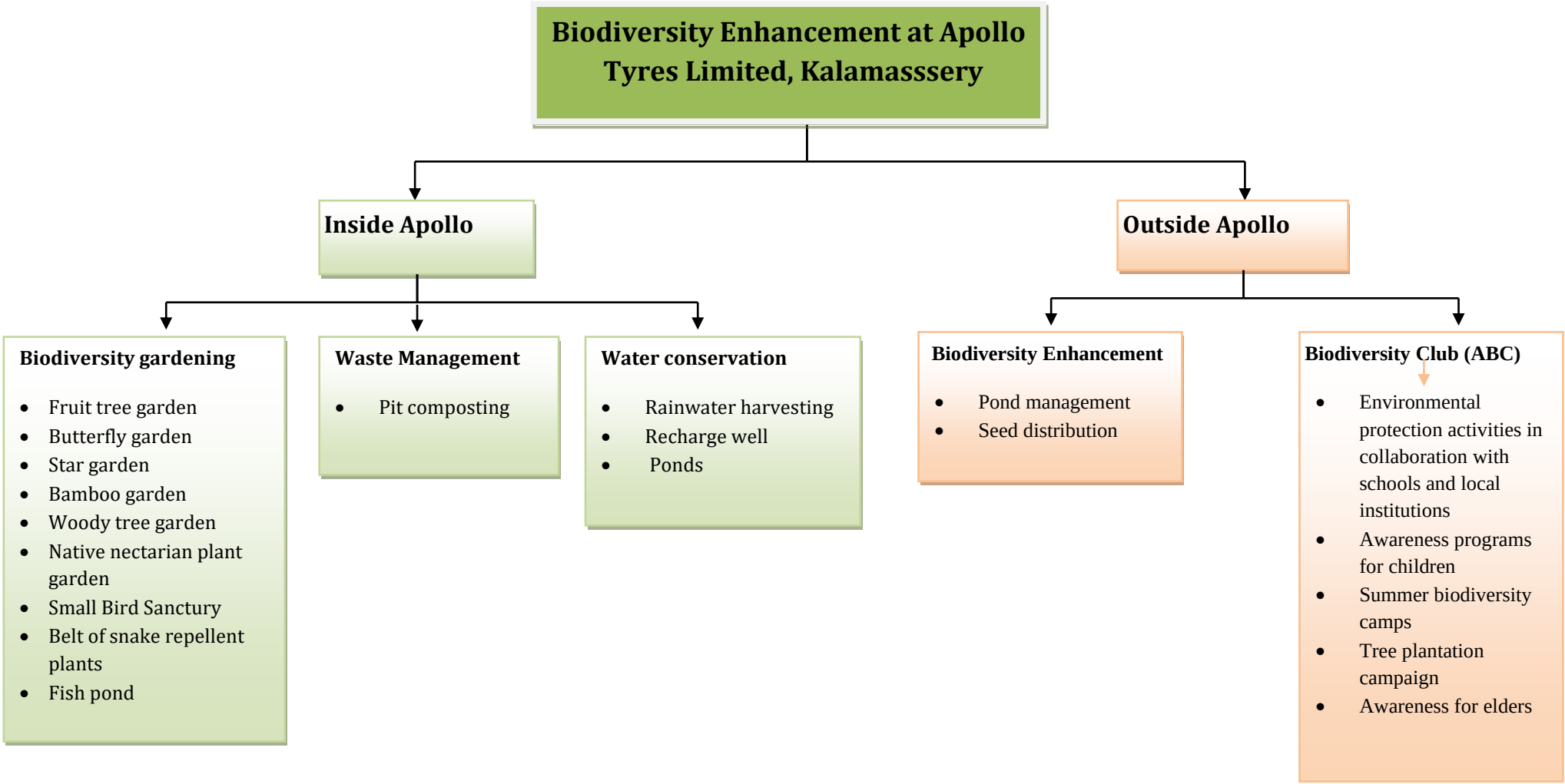
1. Apollo Biodiversity Club (ABC)

Apollo Biodiversity Club (ABC) can be done in collaboration with school and college students. Students from schools and colleges can take part in this club as their project and can visit the factory to learn more about the local biodiversity and associated biodiversity enhancement programmes. Therefore, initiating biodiversity enhancement programs with children and schools will have much more long lasting effect in the community. In addition, an environmental education officer can be appointed in the Apollo to invite school and college students into the campus and for its coordination. Through the ABC, the students will get the opportunity to experience the following:

1. Learn about the importance of biodiversity through the biodiversity enhancement programs in Apollo.
2. Tree plantation campaign in collaboration with nearby schools
3. Awareness programs for women and men about biodiversity conservation

Fig. 5.4. Suggested logo for Apollo Biodiversity Club (ABC)

Fig. 5.5. Summary of Biodiversity Enhancement Programmes suggested for Kalamassery plant



BIODIVERSITY ENHANCEMENT PROGRAMME - PROPOSED PROJECTS AT APOLLO TYRES KALAMASSERY PLANT

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Tentative Schedule of Biodiversity Enhancement Programs at the Campus and Surrounding Areas of Apollo Kalamassery Plant

Biodiversity Enhancement Programs	Inside Apollo Campus												Outside Apollo		
	Butterfly Garden	Fruit Tree Garden	Star Garden	Bamboo Garden	Native nectarian plant garden	Woody tree belt	Fish pond in STP releasing water	Small bird sanctur y	Belt of Snake Repellent Plants	Pit Compost	Small ponds	Rainwater Harvesting	Pond Management	Seed distribution	Apollo Biodiversity Club Activities
1 year															
2 years															
3 years															
4 years															
5 years	Achievement of biodiversity rich and ecofriendly environment inside and sourrounding area of Apollo campus														
6 years															
7 years															
8 years															
9 years															
10 years	Achievement of good reputation of the company by maintaining the biodiversity enhancement programs and Apollo biodiversity club activities														

Legend:

	Period of implementation
	Period of management
	Benchmark years
	Achievement

5.4. Other Activities to Make People Biodiversity Friendly

Tree naming campaign – All trees and plants in both campuses will be tagged with permanent boards showing their scientific, common and Malayalam names; medicinal or special uses/ peculiarities *etc*.

Avenue boarder plants – All internal roadsides of both campuses will be demarcated and planted with selected garden plants of little maintenance

Habitat Apollo biodiversity boards – In front of the campus (both Kalamassery and Perambra), biodiversity educational boards can be placed. These boards can be utilized to make a route map of all the biodiversity restoration initiatives taken by the company. Along with the route map, information on the aim of Apollo in enhancing the green cover at the campus as well as the mission of Habitat Apollo can be mentioned. A brochure with the same information can also be made to give to the visitors and also to place in different office locations.

Coffee Table book – Biodiversity register for each campus will be prepared and based on that coffee table book can be prepared to highlight the conservation initiatives of the company to protect nature within their campuses.

Open market of biodiversity resources – A sales and information counter will be set up in both campuses, for the sale of organically grown vegetables, fruits, honey, coffee table books, pamphlets and also to provide the information on the Biodiversity conservation activities to the staff and visitors.

Awards and incentives – Special incentives in the form of awards or other suitable modes should be introduced to promote the participation of employees.

Biodiversity-corporate gifts – Products such as honey from the campus, coffee table books, field guides to the biodiversity of the campus can be produced as gift editions.

Sensitization workshops – For employees, staff, their family members and local community. Programmes may include seminar/workshop on food biodiversity, homestead gardening, home remedies for local ailments, fruits from home yard, folk toy camp for children *etc*.

Conclusion

The biodiversity impact assessment at Apollo Tyres, Cochin plants point out changes in the pattern of biodiversity inside the campus and study area. Though there is a significant change in biodiversity of the surrounding area of Apollo campus, it is resulted from a collective impact of different drivers of change such as change in land use pattern, industrialization including Apollo and associated developments. However, inside the Apollo campus, the change in biodiversity occurred mainly because of the infrastructure developments without giving priority to biodiversity. The proposed programes will make the Apollo campuses into more biodiversity rich and eco-friendly at every respect and improves the biodiversity in the region naturally. However, for the successful implementation, input from community members and employees should be collaborated with it. For that, a proper green policy should be made for the company and then it should be closely followed.

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APPENDIX – I - Questionare 1

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Study of Changing Patterns of Urban Biodiversity in Perambra and Kalamassery

1. Name :
2. Age :
3. Sex :
4. Are you a permanent resident in this locality?
5. How long have you been staying here?
6. How many generations of your ancestors were born and brought up here?
7. What was your occupation?
8. Can you remember how was this area looked like before 30 or 40 years?
9. How was the tree cover in this area?
10. What were the dominant plants and trees in this area?
11. Have you noticed any significant increase or decrease in the number of any particular plant species in the area?
12. Can you tell about the dependency of plants and other home yard items at that time?
13. How was the house density and population in this locality at that time?
14. How far were the nearby shops?
15. Which were the roads present in the area before 30 years? What were the main modes of transport at the time? How many new roads have been added after that?
16. Can you brief the history of NH and railway line? (If any of them are present in the area)
17. Have you noticed any significant increase in the development activities and settlement of township after NH and/or Railway line came to the area?
18. Can you list the water bodies in the area
    a. 30 years ago
    b. 20 years ago
    c. 10 years ago
    d. At present
19. Was there any cultural practices or rituals related to rivers? Please explain.
20. How was the quality of water in the nearby water bodies in the past?
21. Did you use to use the water from these water bodies for domestic purpose? What were the day to day activities for which it was used?
22. What about now? If not using, Why?

23. Did you use to fish in the nearby water bodies? How frequently? How much fish did you use to catch? What about now?
24. Were there any paddy fields and other cultivations in the area before? What happened to them now?
25. Did you have any domestic animals in your home? How dependent were you on them for food and other purposes? What about now?
26. Have you noticed or heard about any incidents in which wild or exotic animals being seen or caught in the area? When was it? How about any recent incidents?
27. Trend of following populations in the past and now. Please elaborate. If possible, name the common species present in the area.
    a. Snakes
    b. Birds
    c. Mammals
28. What are the major sources of pollution in this area?
29. How much waste is generated in your house per day? What are the types of waste?
30. How do you dispose those wastes?
31. Is there any waste management practices initiated by the government or other organizations?
32. Have you noticed any factories dumping wastes to the nearby communities? If so, what are the problems faced by community dwellers due to that?
33. Can you remember any eco-friendly or community development activities that were planned and initiated by any organizations? How successful were they?
34. Do you have any suggestions for the enhancement of biodiversity in this area? □

APPENDIX – II- Questionare 2

TROPICAL INSTITUTE OF ECOLOGICAL SCIENCES

Biodiversity Status Survey for Company Staffs at Apollo Campus, Perambra and Kalamassery

1. Name :
2. Age :
3. Sex
4. Education :
5. Designation at Apollo :
6. Address and Phone number :
7. How long have you been working at Apollo tyres?
8. Do you think that the tree cover within the campus has increased, decreased or is constant over the last 2-3 decades? Please elaborate on any notable changes.
9. What about the diversity of plant species within the campus?
10. Do you think the green cover in the periphery and nearby communities have changed over the years?
11. Are there many birds sighted within the factory premise? Have the number and types of birds changed over years? What were the species of birds seen in the past? What about now?
12. Are there many mammals sighted within the factory premise? Have the number and types of mammals changed over years? What were the species of mammals seen in the past? What about now?
13. Have you had the experience of seeing or hearing about any snakes inside the campus? What are the species? Did the number of snakes seen in the past reduced or increased over the years?
14. What are the major threats on biodiversity in this area (construction, roads, gardens etc)?
15. What are the solutions to preserve biodiversity in this area?
16. Have Apollo undertaken any steps to enhance the biodiversity within the campus and the neighbouring communities in the past? How successful were they? Is it being continued still?
17. What do you think about giving ownership to the employees regarding the protection of trees within the campus? Will you be interested in participating in it? How many hours will you be able to spend per week for this kind of eco-friendly activities?
18. What do you think Apollo should do in making the premise and neighbouring communities much greener and eco-friendly?

APPENDIX – III- Offices Approached for Secondary Data Collection

I. Municipalities

1. Chalakkudy Municipality
2. Eloor Municipality
3. Kalamassery Municipality

II. Panchayaths

1. Alur Panchayath
2. Choornikkara Panchayath
3. Kodakara Panchayath
4. Mattathur Panchayath
5. Muriyad Panchayath

III. Agricultural Offices

1. Alur Chalakkudy Agricultural Office
2. Chalakkudy Agricultural Office
3. Choornikkara Agricultural Office
4. Eloor Agricultural Office
5. Kalamassery Agricultural Office
6. Kodakara Agricultural Office
7. Mattathur Agricultural Office
8. Muriyad Agricultural Office

IV. District Pollution Control Boards

1. Ernakulam District Pollution Control Board
2. Thrissur District Pollution Control Board

V. PWD offices

1. Aluva PWD offices
2. Chalakkudy PWD offices

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