सत्यमेव जयते
Goverment Of India

GREEN SKILL DEVELOPMENT PROGRAMME (GSDP)

Programme Report

Wildlife management using geospatial techniques

[07.02.2022-19.03.2022]

Organized By

Department of Geography, University of Madras

and

ENVIS HUB, Department of Environment, Government of Tamil Nadu

Sponsored By

Ministry of Environment, Forest and Climate Change, Government of India

SIX WEEK GREEN SKILL DEVELOPMENT PROGRAMME CERTIFICATE COURSE

WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNOLOGIES

Department of Geography,
University of Madras,
Chennai – 600 025.

ACKNOWLEDGEMENT

The higher educational institutions are meant for providing opportunities to the aspirant learners, communities and enterprises to update and retrain their knowledge in the respective fields or applications. The demand is phenomenal as the technology and strategies change exponentially. Apart from this, the institutions have responsibility to provide quality enriched education, research and training to the candidates when they need it, which is what they expect.

The Department of Geography, University of Madras in conjunction with ENVIS Hub, Department of Environment, Government of Tamilnadu has time and again proved that they are capable of providing higher education, training, discussion boards, research and implementation of prestigious projects. The department has built state of the art laboratories well equipped with GIS, Remote Sensing Analysis, GPS Surveys, Drone infrastructure and Library facilities. The department is the pioneer in GIS training, EIA project management, Geostatistical and Cartographic applications.

ENVIS – HUB sponsored GSDP SIX WEEK CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNOLOGIES is yet another opportunity to lead in the direction of Geospatial Applications in Social and Environmental Sciences. As it is known that in recent years the technology is focused more on Earth and Atmospheric Sciences rather than Environmental Science as a whole and that of Social Sciences. Therefore, there is a need to understand Geospatial patterns of such scenarios in wildlife and environmental (as a whole) context. This Six-Week programme is an initiative in this direction.

We sincerely thank the Ministry of Environment, Forest & Climate Change (MoEF&CC) for providing this opportunity to the department. We thank Dr. Rajeshwari for the financial support which was timely and highly helpful. We also thank Dr. Muthukumar for extending his moral support. We owe our respect and thanks to all the resource persons. The participants are from all over the Indian States. We bow our head to the participants for the hope and respect that they have on the department activities. We try our level best to perform to the expectations.

Thanks, and regards to all.
Sincerely
R.Jaganathan

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1. INTRODUCTION

1.1 MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE (MOEFCC)

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, coordination and overseeing the implementation of India's environmental and forestry policies and programmes. The primary concerns of the Ministry are implementation of policies and programmes relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being.

The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP), and International Center for Integrated Mountain Development (ICIMOD) and for the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Cooperation (SAARC) on matters pertaining to the environment.

The ministry is responsible for planning, promoting, coordinating, and overseeing the implementation of environmental and forestry programs in the country. The main activities undertaken by the ministry include conservation and survey of the flora of India and fauna of India, forests and other wilderness areas; prevention and control of pollution; Indian Himalayan Environment and its sustainable development afforestation, and land degradation mitigation. It is responsible for the administration of the 1947 national parks of India.

Environmental debates were first introduced into the national political agenda during Indira Gandhi's first term as Prime Minister of India. The 4th Five-Year Plan (1969–74), for example, proclaimed "harmonious development on the basis of a comprehensive appraisal of environmental issues." In 1977 (during the Emergency) Gandhi added Article 48A to the constitution stating that:

"The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country." The same decree transferred wildlife and forests from state list to concurrent list of the constitution, thus giving the central government the power to overrule state decisions on that matter. Such political and constitutional changes prepared the groundwork for the creation of a federal *Department of Environment* in 1980, turned into the *Ministry of Environment and Forests* in 1985. Although tackling climate change was already a responsibility of the ministry, its priority was raised when in May 2014 the ministry was renamed to the current title of *Ministry of Environment, Forest and Climate Change*.

The broad objectives of the Ministry are:

- Conservation and survey of flora, fauna, forests and wildlife
- Prevention and control of pollution
- Afforestation and regeneration of degraded areas
- Protection of the environment and
- Ensuring the welfare of animals

These objectives are well supported by a set of legislative and regulatory measures, aimed at the preservation, conservation and protection of the environment. Besides the legislative measures, the National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Forest Policy, 1988; Policy Statement on Abatement of Pollution, 1992; and the National Environment Policy, 2006 also guide the Ministry's work.

1.2 THE ENVIS HUB

The Government of India, in December, 1982, established an Environmental Information System (ENVIS) as a plan programme. The focus of ENVIS since inception has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country. Since environment is a broad-ranging, multi-disciplinary subject, a comprehensive information system on environment would necessarily involve effective participation of concerned institutions / organizations in the country that are actively engaged in work relating to different subject areas of the environment. ENVIS has, therefore, developed itself with a network of such participating institutions / organizations for the programme to be

meaningful. A large number of nodes, known as ENVIS Centers, have been established in the network to cover the broad subject areas of the environment with a Focal Point in the Ministry of Environment & Forests. Both the Focal Point as well as the ENVIS Centres have been assigned various responsibilities to achieve the Long-term & Short-term objectives. For this purpose, various services have been introduced by Focal Point. ENVIS due to its comprehensive network has been designated as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the United Nations Environment Programme (UNEP). In order to strengthen the information activities of the NFP, ENVIS was designated as the Regional Service Centre (RSC) of INFOTERRA of UNEP in 1985 for the South Asia Sub-Region countries.

The Ministry of Environment, Forest and Climate Change (MoEF & CC), being the nodal agency in the administrative structure of the Central Government for the planning, promotion, coordination and overseeing the implementation of India's environmental and forestry policies and programmes, established an Environmental Information System (ENVIS) in 1982 by end of 6th Five year plan as a plan programme which would serve as a hub of Environmental information vital for formulation of environmental management policies and decision making aimed at environmental protection and enrichment for sustaining life. ENVIS is a comprehensive network of environmental information collection, collation, storage, retrieval and dissemination to various users, which include decisionmakers, researchers, academicians, policy planners and research scientists, etc. A large number of nodes, known as ENVIS Centres, have been established in the network to cover the broad subject areas of environment with a Focal Point in the Ministry of Environment & Forests & Climate Change which assists the Environmental Information (EI) Division in coordinating the activities of all the ENVIS network partners by making ENVIS a web-enabled comprehensive information system. ENVIS network at present consists of a chain of 69 network partners out of which 40 are on subject-specific and 29 on State / UT related issues that are located in notable organizations / institutions / State / UT Government Departments / Universities throughout the country.

ENVIS (Environmental Information System) has started implementing the World Bank assisted Environment Management Capacity Building Technical Assistance Project (EMCBTAP) since January, 2002 which aims at structuring the ENVIS scheme by extending its reach through involvement of Institutions/Organizations in State Governments, academia sector, corporate sector, NGO sector, etc. The project also aims at broadening the ambit of ENVIS to include varying

subject areas, themes, local conditions, issues, information/data needs of the country pertaining to environment and planned to be achieved through enlargement of participatory Organizations/Institutions, called EMCB-Nodes in various sectors and through introduction of modern means of Information and Communication Technologies (ICTs). This programme is a continuation of the Sustainable Development Networking Programme, India (SDNP-India), funded jointly by the UNDP and IDRC, Canada.

ENVIS is a decentralized system with a network of distributed subject oriented Centers ensuring integration of national efforts in environmental information collection, collation, storage, retrieval and dissemination to all concerned. Presently the ENVIS network consists of Focal Points at the Ministry of Environment and Forest and ENVIS Centers set up in different organizations/ establishments in the country in selected areas of environment. These Centers have been set up in the areas of pollution control, toxic chemicals, central and offshore ecology, environmentally sound and appropriate technology, bio-degradation of wastes and environment management, etc. ENVIS focal point ensures integration of national efforts in environmental information collection, collation, storage, retrieval and dissemination to all concerned.

The ENVIS Center of the Department of Environment, Government of Tamil Nadu has been functioning since October 2002. The responsibilities of the ENVIS Center are:

- Creation of a web based database on the State of Environment of Tamil Nadu and Related issues.
- Establishment of linkages with all information sources and creation of data bank on selected parameter subject area assigned.
- Identification of Information gaps/ data gaps in the specified areas of environment and action needed to fill these gaps.
- To publish Newsletters, Special issues on the State of Environment.
- To serve as an interface for the users on the assigned subject.

1.3 UNIVERSITY OF MADRAS

University of Madras (informally known as Madras University) is a public state university in Chennai, Tamil Nadu, India. Established in 1857, it is one of the oldest universities in India, incorporated by an Act of the Legislative Council of India under the British government. It is a

collegiate research university and has six campuses in the city: Chepauk, Marina, Guindy, Taramani, Maduravoyal and Chetpet. It offers more than 230 courses under 87 academic departments of post-graduate teaching and research grouped under 18 schools, covering diverse areas such as sciences, social sciences, humanities, management and medicine along with 121 affiliated colleges and 53 approved research institutions.

Madras University is the mother of almost all the old Universities of south India. The University area of jurisdiction has been confined to three districts of Tamil Nadu in recent years. The University imparts both Undergraduate and Postgraduate Education through the Affiliated Institutions which are spread over the districts of Chennai, Thiruvallur and Kancheepuram. Apart from teaching, research activities in Arts, Humanities, Science, Management and Technology shape the academic tenor of the University. A number of institutions affiliated to Madras University concentrate on research activities offering Ph.D Programme in their respective field of specialization. This is consequent to establishment of various universities in the State and demarcation of the University territories.

The National Assessment and Accreditation Council has conferred 'five star' accreditation to the university in the first cycle, and subsequently with its highest 'A' grade. The University of Madras has been given the status of 'University with Potential for Excellence (UPE)' by the University Grants Commission. Madras University is also recognized among the 18 universities in India having the 'Center with Potential for Excellence in Particular Area (CPEPA)' with a focus on drug development and climate change.

University of Madras is the alma mater of two Indian Physics Nobel Laureates, CV Raman and Subrahmanyan Chandrasekhar, five Presidents of India, including A.P.J. Abdul Kalam, and several notable mathematicians including Srinivasa Ramanujan.

1.4 DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF MADRAS

The Department of Geography at the Madras University is one of the oldest Departments in this country and celebrated its Golden Jubilee in the year 1983. The Department has built high traditions of teaching and research in the past 68 years. The academic efforts received a great fillip in 1976 when the faculty was strengthened and new courses for M.Sc. Applied Geography was introduced. The department has periodically updated the curriculum. The department was in the

forefront of implementing the Credit Based Semester System (CBSS).

The Department currently has academic programmes for M.Sc. / M.Tech. and Ph.D. Degrees. The M.Sc. Applied Geography Programme is a very specialized one with heavy inputs on applied aspects of the discipline especially GIS, EIA and Remote Sensing. The intake of students is limited to 20. The success of the training imparted to the students is reflected in their ready absorption in jobs and in specialized programmes. The Ph.D. programme is a specialized one with emphasis on socially relevant research such as agricultural and rural geography, watershed management, integrated area of planning, marketing geography, urban and metropolitan problems, quantitative and spatial analysis in geography, social and area analysis, health care delivery systems and environmental problems.

The Department has been assisting the State Planning Department, Ground Water Department of Tamil Nadu, Water Institute of Government of Tamil Nadu and Institute of Remote Sensing (Anna University) in research programmes and has developed good academic contacts with ISRO, Bangalore; NRSC, Survey of India, Hyderabad, Land and Survey Records of Tamil Nadu, Town and Country Planning of The Government of Tamil Nadu and CMDA, Chennai to name a few. The department of Geography has been striving hard to achieve the following:

- To impart quality education in Geography and Geoinformatics disciplines both in theory and practical aspects.
- To train both the students and teachers in the constituent colleges in areas of Geoinformatics.
- To undertake socially relevant projects both national and international level.
- To adopt deprived areas for extension activities.

The Department has also been active towards strengthening the teaching of geography in the affiliated colleges and to that end, has been organizing Refresher courses, Workshops and Curriculum Development Programmes. In recent years, faculty members are involved in advising and undertaking socially relevant and industry-oriented projects. Some prestigious consultancy projects were successfully completed. Collaborations with overseas scholars, universities and research institutes are progressively added. At present the Department of Geography, University of Madras offers Ph.D., MTech and M.Sc. courses.

1.5 GREEN SKILL DEVELOPMENT COURSE

Most vocational training programmes focus on mechanical / technical skills rather than 'soft' or 'green' skills. Green skills contribute to preserving or restoring environmental quality for a sustainable future and include jobs that protect ecosystems and biodiversity, reduce energy and minimize waste and pollution. In line with the Skill India Mission of Hon'ble Prime Minister, Ministry of Environment, Forest & Climate Change (MoEF&CC) utilizing the vast network and expertise of ENVIS Hubs / RPs, has taken up an initiative for skill development in the environment and forest sector to enable India's youth to get gainful employment and / or self-employment, called the Green Skill Development Programme (GSDP). The programme endeavors to develop green skilled workers having technical knowledge and commitment to sustainable development, which will help in the attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs), as well as Waste Management Rules (2016). The first GSDP course was formulated for skilling Biodiversity Conservationists (Basic Course) and Para-taxonomists (Advance Course) of 3 months duration each, on a pilot basis in ten select districts of the country (covering nine bio-geographic regions). 94 Trainees successfully completed the basic course qualifying as skilled Biodiversity Conservationists and 152 Trainees completed the Advanced Course qualifying as skilled Para-taxonomists. BSI and ZSI were the nodal Centers for the pilot programme. India being the second most populous country in the world is bestowed with a large working population. India has the advantage of reaping this demographic dividend. However, high drop-out rates from school coupled with poor vocational skills may hinder in reaping this dividend. There exists a demand supply gap of skill sets, both cognitive and practical, at various levels in the Environment / Forest fields in India. The candidates completing the Course(s) may be employed gainfully in the zoo's / wildlife sanctuaries / national parks / biosphere reserves / Botanical Gardens / Nurseries / wetland sites / State Biodiversity Boards / Biodiversity Management Committees / Wildlife Crime Control Bureau; industries (involved in production / manufacturing of green products, as ETP operator); tourism (as Nature / Eco-tourist Guides), agriculture (as organic farmers / green practitioners), education & research sectors as well as engage in waste management (in Municipal Corporations / Councils / Urban Local bodies to advise on how to improve sewage, sanitation, land use services / tackle pollution), water management, construction related areas, etc. Some of the courses enable the candidates to become self-employed.

2. SIX WEEKS GREEN SKILL DEVELOPMENT PROGRAMME CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNOLOGIES

2.1 OVERVIEW

The green skill development program on Wildlife management using Geospatial techniques was sponsored by the Ministry of Environment, Forest & Climate Change, Government of India & Jointly organized by the Department of Geography, University of Madras and ENVIS Hub, Department of Environment, Government of Tamil Nadu. The course was conducted over 6 weeks from 7th of February to 19th of March 2022. With the strength of 20 Participants from across the country, spanning across various domains such as Environmental sciences, Zoology, Botany, Geography, Geology etc. The programme was highly multidisciplinary in Nature and relevant to the current trends and needs for management of Wildlife ecosystems.

The schedule was arranged in a well-organized manner so that the participants could be eased through the training programme without any technical difficulties. Various subject experts shared knowledge and experiences and gave their inputs to the participants covering various topics related to wildlife management. The first 2 weeks were purely theoretical discussions that provided a detailed insight into wildlife. Sessions related to Wildlife Forensics, Wildlife Census, Geographic Range, Location Based Services in Wildlife Management, etc. imparted the participants with a new dimension towards the Management of Wildlife. They were given a broad idea about how things work in the field of Wildlife Management and how Geospatial technology can be a key tool in efficient management. The following 4 weeks were technically and practically oriented towards the use of Geospatial techniques in Wildlife management. The basics of Geospatial Technology was introduced to the participants in a simple and efficient way with theory cum lab sessions. The course was not limited to classroom learning alone, it included exciting and highly interactive field works. The course also included virtual reality demonstration to the Participants that will prove to be highly useful in the field of Wildlife management. The course also had well planned assessment methods that included practical sessions, expanding across GIS and Remote Sensing concepts and Presentations by students on their Project Topics that were systematically assessed in the form of rigorous assignments.

Vice Chancellor, University of Madras addressing the participants during the Inaugural function

Dr. R. Jaganathan (Programme Coordinator), Department of Geography, University of Madras addressing the participants during the Inaugural function

Interaction with the TN-ENVIS HUB members

Interaction with the Former HOD of Department of Geography, University of Madras Prof. N. Sivagnanam

2.2 WILDLIFE MANAGEMENT (07.02.2022 - 19.02.2022)

Wildlife management is interdisciplinary that deals with protecting endangered and threatened species and subspecies and their habitats, as well as the non-threatened agricultural animals and game species. The Wildlife Management program emphasizes both applied and basic research in wildlife ecology, management, education and extension. Wildlife management takes into consideration the ecological principles such as carrying capacity of the habitat, preservation and control of habitat, reforestation, predator control, reintroduction of extinct species, capture and reallocation of abundant species and management of “desirable” or “undesirable” species.

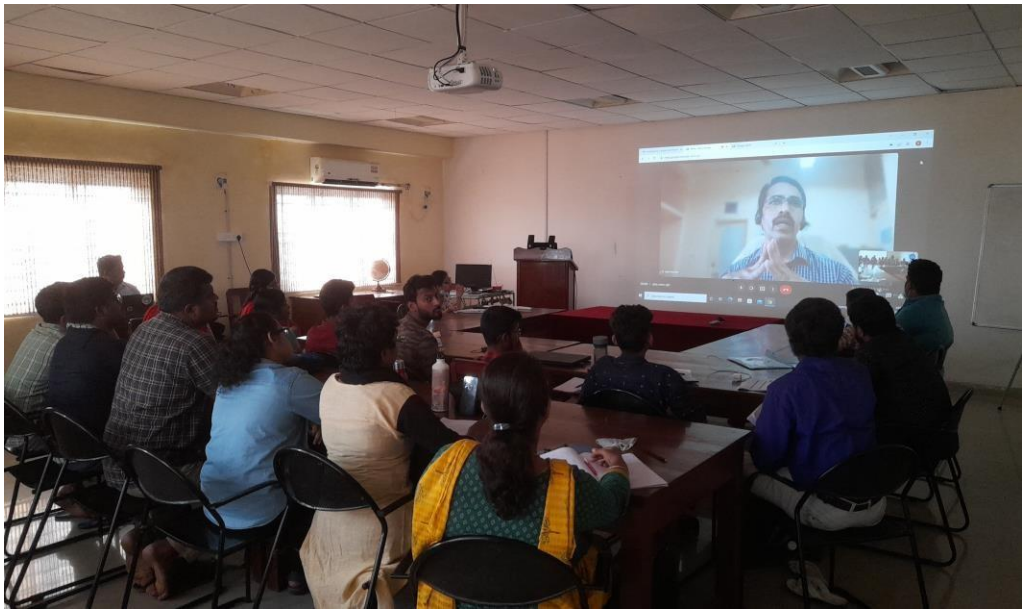
In some sense, wildlife management is not new. Wildlife was managed for subsistence hunting by burning fields to create grass for ungulates, for example by early humans and even perhaps by proto-humans. Game management of animals for sport hunting, in particular, has been traced at least as far back as ancient Egyptian civilizations. Large game fields, managed for sport, were maintained for the recreation of Egyptian royalty. Hunting restrictions which can be thought of as the precursors of modern wildlife management can be traced back to early tribal customs and taboos. Typically game management involved a few species mostly for food and sport, but also for aesthetics in some cases and was practiced over relatively small areas in a decentralized manner. Since the twentieth century, mainly due to a confluence of developments in ecology and society, game management has been supplemented by more comprehensive wildlife management in most developed countries. Game management programs often dominate government wildlife management departments because of their political popularity and because they have, in hunting and fishing license fees, a strong source of revenue. Beginning in the 1920s with the pioneering work of Aldo Leopold, wildlife management took its place next to game programs. Eventually many governments conceptualized game management as one specialization in the broader field of wildlife management, and in the early-twenty-first century most governments include agencies that accept some responsibility for maintaining healthy populations of almost all indigenous species.

Lectures delivered by experts in Wildlife Management 1. Mr. B. Vinoth – Care Earth Trust (Top) 2. Mr. A. Srinivasan – Care Earth Trust (Left) 3. Dr. Kannan. V – Mudumalai Tiger Reserve (Right)

2.2.1 Highlights

a. *Ecological Tools - Dr. S. Jayakumar (Pondicherry University)*

Dr. S. Jayakumar delivered a one hour online lecture (17.02.2022) on the major Ecological Tools available for modeling the environment spatially. The lecture provided the participants with the opportunity to explore the variables and parameters that are involved in the modeling setup of ecology and environment. Certain GIS ecological modeling tools such as the SAGA GIS Ecological modeling tools were being introduced to the participants and the importance of these tools were underlined during the lecture.



b. *Importance of Habitat, Geographic Range and Buffer Zones - Dr. S. R. Ganesh (Snake Park)*

A special lecture was arranged on 18.02.2022 in the Snake Park, Guindy in which Dr. S. R. Ganesh, Scientist and Deputy Director delivered a lecture on the impacts of geographical range. The participants were given a brief understanding about how the various have evolved genetically with change in the geographic range and habitat around them. The importance of geospatial technology in handling the geographical range and buffer zones were explained to the participants. Then a brief explanation on the various reptiles in the Snake Park was given as the participants visited each species. Geographic range describes the spatial area where a species is found. Studies on the processes determining geographic

range patterns address fundamental questions, which are very much at the heart of ecological research, on distribution and abundance of species. Geographic ranges are influenced by both abiotic and biotic factors. Abiotic factors that influence geographic range are often related to climate; prominent examples include air temperature and snow depth. Biotic factors are interactions between species such as competition and predation. Abiotic and biotic factors are often considered across the array of subdisciplines of geographic range: niches, range edges, body size, Rapoport's rule, dispersal, physiology, local range boundaries, heritability, extinction, exotic species, species distribution models, and climate change. The diversity of species and the challenges in studying species over large spatial scales mean that there is still much to be discovered.

c. *Wildlife Census - Care Earth Trust (Theoretical and Practical)*

The objective of census is not only to ascertain the number of the particular species but also to get the knowledge about its density, sex- ratio (male-female ratio), age-ratio and adult-young ones ratio; so that on this basis the indication of the health, increment or decrement of that particular species-population may be obtained. Dedicated lectures were offered to the participants on the various methods of wildlife census such as the General Methods, Quadrate methods, Camera Trapping Method, Line Transect and Point Transect methods. Practical sessions were organized in the field work specifically towards the Line and Point transect sampling method and the participants were given exposure on how these

methods work on field. It may be defined as the enumeration or counting of a particular species in a particular area / habitat in a particular time as well as dividing them into age and sex classes etc. is called wildlife census. It is also called as Wildlife-inventory / Species-inventory / Population-estimation / Game-survey.

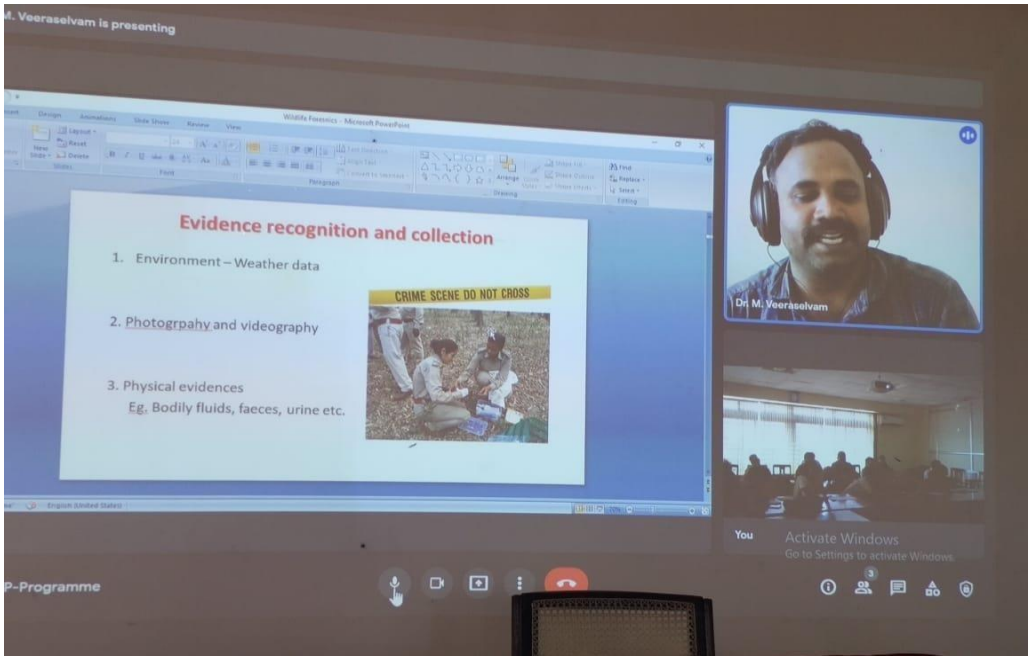
Mr. B. Vinoth, Mr. A. Kalaimani and Mr. A. Srinivas from the Care Earth Trust have been an integral part in imparting the knowledge of Wildlife Census to the participants. The main objective of the census is to find out the density of the population of the species and to procure basic data for its management. Wildlife-population is not always static. Its number increases / decreases at different places means the number of the same species varies from place to place. It also changes yearly and even in different seasons of the year. Hence, only one census is not fully informative from its management point of view, and that is why, census should be regular and periodical and only then it should be analyzed so that the number of the species-population may be accurately obtained in different seasons and situations.

d. Wildlife Laws - Dr. S. Ganapathy (Anna University)

The Wildlife Laws of India is an important topic which plays a major role in Wildlife Management. Throughout the years the Forest and Wildlife have evolved to manage the ever changing dimension of flora and fauna in the country. The lecture on Wildlife laws was delivered by Dr. V. Ganapathy from Anna University. The session gave a brief idea about the various forest and wildlife laws that exist in the country. Further discussions involving the participants were also done on how these laws can be upgraded to provide a safe and healthy environment for the future generations of flora and fauna.

e. Wildlife Forensics - Dr. M. Veeraselvam (VCRI, Orathanadu)

The session on wildlife forensics was handled by Dr. M. Veeraselvam from VCRI, Orathanadu. The session was held on 23.02.2022 and the participants were given an insight on the importance of Wildlife Forensics. The session was very informative and interactive with a lot of questions being raised in the various domains on wildlife forensics.



f. Field Work to Vallam Reserve Forest

The first major field work was carried out on 25.02.2022 to the Vallam Reserve Forest in the Chengalpattu District, India. The participants prior to the field work were given thorough lectures on various aspects of wildlife management for a period of two weeks. In the field, the participants were able to witness the importance of maintaining defined boundaries and specific regulations in terms of the kind of development allowed in and around the forest regions. During the fieldwork the participants were accompanied by resource persons from Geospatial technology domain and forestry domain.

As discussed earlier, rigorous work was carried out in the field to perform the Transect sampling method which is a wildlife census method. The participants were divided into four groups and dedicated resource persons were allocated for each group to guide them in marking transects. Guidance was provided by the resource persons in species identification and counting, an important part of the Field work. Then, Forest officers accompanied by Forest Guards provided a general idea about the extent and geographical features in the reserve forest. They provided an account of the flora and fauna in the forest and discussed their encounters with various species in the forest. Finally, they explained the management and development strategies inside the forest which are being carried out to preserve the natural flora and fauna.

2.3 GEOSPATIAL TECHNOLOGIES (20.02.2022 - 19.03.2022)

Geospatial technologies is a term used to describe the range of modern tools contributing to the geographic mapping and analysis of the Earth and human societies. These technologies have been evolving in some form since the first maps were drawn in prehistoric times. In the 19th century, the long important schools of cartography and mapmaking were joined by aerial photography as early cameras were sent aloft on balloons and pigeons, and then on airplanes during the 20th century. The science and art of photographic interpretation and map making was accelerated during the Second World War and during the Cold War it took on new dimensions with the advent of satellites and computers. Satellites allowed images of the Earth's surface and human activities therein with certain limitations. Computers allowed storage and transfer of imagery together with the development of associated digital software, maps, and data sets on socioeconomic and environmental phenomena, collectively called geographic information systems (GIS). An important aspect of a GIS is its ability to assemble the range of geospatial data into a layered set of maps which allow complex themes to be analyzed and then communicated to wider audiences. This 'layering' is enabled by the fact that all such data includes information on its precise location on the surface of the Earth, hence the term 'geospatial'.

Especially in the last decade, these technologies have evolved into a network of national security, scientific, and commercially operated satellites complemented by powerful desktop GIS. High quality hardware and data is now available to new audiences such as universities, corporations, and non-governmental organizations. The fields and sectors deploying these technologies are currently growing at a rapid pace, informing decision makers on topics such as industrial engineering, biodiversity conservation, forest fire suppression, agricultural monitoring, humanitarian relief, and much more.

Lectures delivered by experts in Cartography and Remote sensing 1. Prof. N. Sivagnanam- University of Madras (Top) 2. Dr. G. Baskaran- University of Madras (Bottom)

2.3.1 Highlights

a. *Handheld GPS - In Campus Field work*

As an initial exercise in Geospatial Technology the In Campus Field work was given to the participants on 26.02.2022 by Mr. Shyam Sundar. Exclusive training was given in handheld GPS devices and survey equipment. Other modern surveying equipment were also demonstrated to the participants. Later, the participants were given training on how to import these GPS points into the system and visualize it using the various GIS platforms such as QGIS and Google Earth.

b. *Elephant Corridor - Dr. Tamil Ilakkiya*

Wildlife Corridor Mapping is an extensive application of GIS in Wildlife management. The importance of understanding the corridors helps in narrowing down settlement around these regions to avoid human - wildlife conflicts. Dr. Tamil Ilakkiya delivered an important lecture on 04.03.2022 in the topic Elephant Corridor mapping to the participants. A brief overview into GIS was given initially and then the various datasets which are used in the corridor mapping were explained from a spatial perspective. The importance of the spectral and spatial resolution was outlined explaining the participants about the kind of data required to achieve good and accurate results in terms of corridor mapping. Then the important variables which are required to effectively map the elephant corridor were discussed. On field experiences and GIS data collection methods were well explained and the participants had a great interaction with the resource person.

c. Special Lecture by Mr. Gururaj - L&T

A special lecture was arranged on 09.03.2022 in the topic Geospatial Technology and its latest developments. The lecture was delivered by Mr. Gururaj from L&T who is an expert in the field of Geospatial Technology and has been actively a member of the Geospatial community for the past 20 years. A wide perspective was brought into the field of Geospatial technology with the latest advancements being explained to the participants and how Geospatial technology holds the key for these advancements. A more industrial perspective was shared to the participants exposing them to the level of accuracy and precision in which projects are being carried out. A brief talk on how these advanced technologies can develop the Wildlife management was also given to the participants via an interactive Question and Answer session.

d. Location Based Services - Presentation

A lecture was given initially on the topic Location Based Services and its applications on wildlife management. The topic covered the importance of Location services provided by the latest mobile phones and its working. The LBS is a great boost to the current development in each individual's life. It has provided a wide range of job opportunities in various sectors and domains. LBS applications can be effectively developed by simple logical thinking and precise location which is provided by the mobile devices. Then, participants were given time to explore the various applications of LBS in wildlife management. A presentation was organized for the participants and they were split into four groups. A number of interesting topics and applications were presented by the participants which benefited the wide range of audience and was also a very good forum of discussion for the various technological advances in Geospatial Technology.

e. Change Detection Analysis

One of the greatest challenges in Wildlife Management is to understand the changing dynamics of Land Use and Land Cover. An extensive analysis on how the Landuse and Landcover changes have occurred in the past years is necessary to understand its impact on various aspects. An effective Lab session was set up during the course of the training programme on Change Detection analysis (11.03.2022). The session was handled by Dr. N. Manikandan and extensive hands-on training was given on Change detection analysis

using Landsat - 8 satellite images. The various tools and techniques were introduced to the participants and the interpretation of results were clearly stated by the Resource person.

f. Mini Project and Field work on Thaiyur Reserve Forest

The most important part of the training programme was the Project cum Field work on Thaiyur Reserve Forest which was conducted during the period 12.03.2022 - 17.03.2022. The participants were split into four groups and each group comprises experts from various domains facilitating an exchange of knowledge among the group members. The overall project objective is to do extensive analysis in the Thaiyur Reserve Forest about its Flora, Fauna, Land use Land cover, Elevation, Green cover etc. Subsequently each group was given time to discuss a few topics and four topics were finalized. The project cum field work was split into various phases where the groups had to do literature review and prepare a pre-field list which gives an idea on what is their respective objective when they go to the field. Accordingly field work was planned on 12.03.2022 for a preliminary investigation and data collection by the respective groups for their respective project works. Then after data integration and analysis a second field visit was planned on 16.03.2022 in which data validation was carried out by the participants. Overall the four groups did their projects on diverse topics which helped in extensively studying the Thaiyur RF. Later, on 18.03.2022 presentation and evaluation was conducted by the members of the organizing team in which each team presented its topic and the work was evaluated by a subject matter

expert. The project reports of each group are attached as an ***annexure*** to this document for reference.

g. Spectroradiometer

During the fieldwork to Thaiyur RF the participants were given an introduction to the spectroradiometer which is an instrument used to record the reflection values of the objects. Certain groups have also used the spectroradiometer as a part of their project work and have produced promising outputs. Spectral values of invasive and native species were studied extensively during the course of the project and the values were compared with the satellite based products.

h. Virtual Reality Demo

As a part of the Geo-visualization Lab in the Department of Geography, University of Madras the Oculus Virtual Reality Headsets were demonstrated to the training participants. The importance of these kinds of headsets were explained and the participants were all given a demo on its applications.

3. CONCLUSION

The human-caused disruptions, such as habitat loss, pollution, invasive species introduction, and climate change, are all threats to wildlife health and biodiversity. GIS technology is an effective tool for managing, analyzing, and visualizing wildlife data to target areas where interventional management practices are needed and to monitor their effectiveness. GIS helps wildlife management professionals to examine and envision the following and many more. Habitat requirements and ranges, population patches and linkages, progress of management activities, historical and present wildlife densities. In particular, wildlife management involves management of a complete ecosystem. The quantification and analysis of current impacts on wildlife habitat such as logging, agriculture and road development are vital phases in the process of formulating sound wildlife management policies. Until recently many conventional techniques have been applied for collecting data on natural resources. Relatively large number of ground based studies has been carried out on habitat and corridor use by the wild animals. The role of the geospatial tools such as Remote Sensing and GIS has been emphasized in quick appraisal of habitat attributes, identification of new sites for Protected Areas (PA's) in a particular region and the current scenario of the existing wildlife corridors. Thus the geospatial tools are proved to be very effective in collecting, managing and processing the large spatial datasets. Further, geospatial techniques enable wildlife distributions, movements and habitat use patterns and processes to be mapped and analyzed, which can provide valuable information for development of management and conservation strategies in a particular region. The short duration and meticulous curriculum has

not only benefited the students regarding the importance of wildlife management but also bestowed detailed insights on various methods and techniques through which effective and sustainable wildlife management can be achieved. The major outcome achieved from this zealous course was the inculcation of the urge to protect the environment and wildlife among the students. Furthermore the applicability of geospatial techniques in wildlife management in the light of policy framework and indelible strategies was also taught.

ANNEXURE - I

Wildlife Habitat Suitability Mapping: A Case Study of Thaiyur Forest

Submitted to

Department of Geography, University of Madras and ENVIS HUB, Government of Tamil Nadu

Submitted by

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1.0 INTRODUCTION

Habit and Habitat are very crucial information about any species, which gave us a broad idea of its behavior food, feeding, hunting and many more activities. Different species living in different habitats are the result of the evolution and adaptation from millions of years.

An assessment of habitat suitabilitymeasures the relationship between species and habitat and is based on species fitness. Studying habitat suitability range and making assumptions about how fitness affects occupancy, we can calculate probability of occurrence across a landscape. Evaluation of habitat is crucial to managing wildlife populations and developing conservation policies (Franklin, 2010). An absence of animal traces in a particular location does not mean that the animals have never been there.

Earth has great diversity of species and only one known planate inhabiting life still known with respect to cast diversity related to geographic, climate and topographic zones. Which gave rise to diverse forms of habitat on our mother planet The Earth ranging from polar regions to Tropical rainforest, Alpine forests, Tundra, Deciduous Forest, Fresh water habitats and ocean (estuaries, marine habitats) , each habitat has its own characters from both Spatial and Biological(Biotic and Abiotic) point of view.

India ranks fourth in Asian and tenth among top 17 mega diversity countries, we occur for nearly 11% of world's flora and 2.4% of worlds total land area. India is home for four biodiversity hotspot as follows.

1. Andaman & Nicobar
2. Eastern Ghats.
3. Western Ghats
4. Indo-Burma Region.

Ecological research currently produces plenty of knowledge about the habitat requirements of the various species. Abundance and habitat suitability models, for instance, have been produced for many species (e.g. Ozesmi and Mitsch, 1997; Elmberg and Edenius,1999; Radeloff et al.,

1999; Whigham, 2000). For this an understanding of the relationship between spatial distribution of animals and their habitats plays an important role in conservation and management of many threatened species (Lecis and Norris 2003). Remote sensing and geographic information system (RS and GIS) can be used as a powerful tool for getting information about the habitat preference of the wildlife species rapidly and coast effective manner. RS and GIS also help in monitoring areas of land for their suitability to endangered species, through integration of various habitat variables of both spatial and non-spatial nature (Davis et al. 1990). The outputs of such models are usually simple, easily understandable and can be used for the assessment of environmental impacts or prioritisation of conservation efforts in a timely and cost-effective manner (Kushwaha et al. 2004; Zarri et al. 2008).

The conservation of wildlife species is an important issue. GIS and Remote Sensing Technology plays a vital role in the wildlife analysis. Spatial ecology is the study of patterns and processes occurring in a geographic space or landscape that influence characteristics of plant and animal populations such as densities, distributions and movements (Clark et al. 2008). Remote Sensing techniques and use of GIS for mapping the endangered species can be conducted to help in understand the environmental factors (including land, soil, climatic condition) responsible for the extinction of species.

Ecological knowledge is needed especially to evaluate different forest management alternatives according to their consequences to biodiversity conservation and to evaluate the importance of alternative locations to be set aside from wood production (Eggers et al. 2019).

Understanding the balance points where habitat alteration does not compromise wildlife populations may promote sustainable management of biodiversity, commercial forestry, and other values. Although suggesting appropriate thresholds are widely recognized as a potential tool for sustainable management (Groffman et al. 2006; Qian and Cuffney, 2012.)

Present study deals with the Habitat suitability of Thaiyur forest, Chengalpattu district, Nearby by Chennai coast. Chengalpattu district is part of one among the major mega biodiversity hotspots.

The study exclusively carried out based on extensive field (ground) work. The sampling method for identification of Animal species (birds and Mammals) along with some major Abiotic Factor like soil topography, water bodies, rainfall etc. Further, the satellite based remote sensing data analysis and GIS mapping were carried out.

The purpose of this study is to apply Geospatial tool and techniques along with the scientific study of Biodiversity and effects of anthropogenic activity, effects of exotic flora and availability of water in the reserve forest. This directly or indirectly affects wildlife in and around the study region (Thaiyur forest area).

By using modern geospatial techniques we can analyse the data with very efficient way and also consider land use and land cover data of past and present along with vegetation cover, rainfall, climate data to understand the present situation of the reserve forest and also very precisely predict the future for the wildlife and people depending on forest directly or indirectly, also Geospatial techniques can give very effective and exact mitigation measures which if implemented properly by Forest department and local people we can avoid uncertain results and conserve our wild wealth.

For this case study we chose Thaiyur forest as no previous work was done for the forest patch and we consider the need of work for the betterment of the forest and secure this ecosystem in future.

We also studied the the forest types of Tamil Nadu state as stated by the Forest Department of Tamil Nadu on site (https://www.forests.tn.gov.in/) these are as follow:

Category	Major Forest Type group
1	Tropical wet evergreen
2	Tropical semi evergreen
3	Tropical moist deciduous
4	Littoral and swamp
5	Tropical dry deciduous
6	Tropical thorn
7	Tropical dry evergreen
8	Sub-Tropical Broad-leaved hill
9	Montane wet temperate

Among these forest type Thaiyur come under the sixth category ie. Tropical thorn forest which can be describe in brief as Those forests are found from plains up to 400m the common trees of top storey, Acacia ferruginea Dc ,. *Acacia leucophloea*, *Albizzia amara* and *Azadirachta indica* . Been dry thorny forest the forest is unique in its own species type, we thourly studied the floral and faunal elements of the forest to understand the preference of wildlife amount the protected area.

2.0 Review of literature

1. **Ekwal Imam et.al (2012**) has been studied about Use of Remote Sensing, GIS and Analytical Hierarchy Process (AHP) in Wildlife Habitat Suitability Analysis.The study has been conducted in motichur range of Rajaji National Park, for tiger.For the modeling, topographic sheets, maps of sanctuary , Forest types and Forest density were procured from Forest and Ecology Division.Identification of factors that influence the spatial distribution of animal species is important for developing effective method of conservation planning and habitat suitability evaluation.statistical data from field surveys and suggestions from conservation experts were considered as input data for modelling.From topographic sheets, on screen digitizations of contours were done for generating the digital elevation model (DEM). Further, DEM was used to generate Slope and Aspect maps using ERDAS

IMAGINE software.However, with compare to other study, Motichur range has fairly good patches of forest which can be consider as suitable for tiger.

2. **Ekwal Imam et.al (2012)** has been studied about Modelling of habitat suitability index for Gaur (Bosgaurus) using multiple logistic regression, remote sensing and GIS.The study area is from wildlife wing of forest department of Maharashtra state. For the preparation of Landuse land cover map,geocoded FCC was digitally analyse. The aim of this study is to produce geo referenced ecological information about the suitable habitats available for gaur Bosgaurus in Chandoli tiger reserve, India.whereas15 topographic maps were used for generating the collateral data in a GIS framework. Various layers of different variables such as forest density, Landuse land cover, measures of proximity to disturbances and water resources and a digital terrain model were created from satellite and topographic data. The techniques were used by the location of gaur presence/absence. The 'MLR' techniques were integrated in a GIS environment for modelling the H.S.I. of gaur. The results indicate that approximately 91.80 km the forest of tiger reserve is highly suitable for gaur. The model is potent enough to advocate that the forests of this area are most appropriate for declaring it as are serve, for gaur conservation.
3. **Sreehari Raman et.al (2020**) studied the habitat suitability model of endangered Latidens salimali and the probable consequences of global warming and found out that the factor influencing the distribution of L.salimali are the precipitations of the direct mont, tree density,rain in the coldest quarter canopy height and altitude.
4. **Ron store et.al (2003)** has been studied about A GIS-based multi-scale approach to habitat suitability modeling. This study is to develop a method by means of which it is possible to produce geo referenced ecological information about the habitat requirements of different species. The method relies on the combined use of empirical evaluation models and based on expertise in geographical information system (GIS) environment.GIS was used to

produce the data needed in the models and as a platform to execute the models and to present the results of the analysis. The method is illustrated by a case study in which an integrated habitat suitability map is produced for a group of old-forest species (Kivalo forest).Multi-criteria evaluation methods (MCEs) have been used with cartographic modeling techniques to provide a basis for evaluating a number of alternative choices on the grounds of multiple criteria. Then Constructing habitat suitability models and Producing the data needed in models. Evaluating a target area based on habitat factors and Combining the separate suitability indices. The study is to find out which of these methods are, in practice, best suited to include different kinds of habitat suitability indices to forest management planning.

5. **Fentanesh Haile Buruso (2017)** has studies about Habitat suitability analysis for Hippopotamus (H.amphibious) using GIS and Remote Sensing in Lake Tana and its environs,Ethipia. The main objectives of this study was habitat suitability analysis and find out suitable habitat sites of hippopotamus with in the Lake,Tana and environs using the integrated of GIS and Remote Sensing techniques with MCDM. The software used in this such as arcgis 10.2,Erdass imagine 2010. As the study result showed that in and around Lake Tana, a human factor was considered to be outweighing the physical factors to minimize the habitat for the aforementioned animal. It was shown that 50.88% of the areas under study was disturbed and became unsuitable to hippopotamus. Based on the findings of the present study was concluded that there was high interference of human being in the habitats of hippopotamus especially at the shores of the lake. since the land were looked-for agricultural activities. Therefore, too much proximity of human activities is identified hippopotamus habitats have to be protected and conservation buffer surrounding the Lake

has to be developed. The study analysis result showedthat 36.96% of the Lake Tana environs were not suitable for hippopotamus habitat.

6. **Ying-Chao Piao (2018).**has studied about Modeling Habitat Suitability of Migratory Birds from Remote Sensing Images Using Convolutional Neural Networks. In this the various data acquisition devices, a large number of animal movement data can be used to label and the presence data in remote sensing images and predict species distribution. , a two-stage classification approach for combining movement data and moderate-resolution remote sensing images was proposed.then the density-based clustering method to identify stopovers from migratory birds' movement data and generated classification samples based on the clustering result. In addition the potential habitat locating on surface of the lake seems to be uncommon. Landsat images and can easily be adapted to other input data or study extents, the proposed approach offers good opportunities for species transferability.

3.0 Need for the study

The natural resources forest and its related wildlife are important part of the ecosystem. Recent days due to anthropogenic activities and climate change these are under threat. Flora and fauna of Forest region helps in maintain biodiversity and food chain. Preserving and steps to improve such kind of forests are immediate need.

Scientific approach in conservation and management of natural resources (Forest) is needy and research is a diligent way of attaining it. Research an area with recent advancements (i.e Remote Sensing and GIS) is better way for understanding the issues and suggest management plans.

4.0 Research questions

1. Whether Thaiyur reserve forest is rich in flora and fauna?
2. Water availability in the region is high or poor?
3. Thw Thaiyur reserve forest ability to support fauna (food and fodder)?

5.0 Research gaps

1. No scientific documentation of Thaiyur forest region still now. We are the first to think on this context.

2. Some few research articles on identitifcation of Black bugs (Deer) in the Thaiyur reserve forest other than that nothing is recorded.

3. Remote Sensing and GIS (Geospatial tools) are powerful in mapping and management of flora and fauna of any parts of the world. Continues monitoring also possible with this approach.

6.0 Aim & objectives

6.1 Aim

To understand and evaluate wildlife habitat suitability of Thaiyur reserve forest based on biological and geographical perspective.

6.2 Objective

1. To understand and map the flora and fauna of Thaiyur reserve forest. Spatially plotting the species (both selected flora and fauna) counts using GIS as point layers.

2. To enlist the floral diversity and identify exotic from native species.

3. To study the Avian diversity and to understand the behavioral changes of birds and selected animals in the study area according to the changing conditions.

4. Identification of surface water bodies and river channels. Correlating the species diversity and richness with the wildlife connectivity. GIS analysis for different thematic layers. Integrating field and remote sensing data in habitat suitability mapping

7.0 Study area and its geography

Thaiyur Reserve Forest is located in the southern neighborhood of Chennai, Tamilnadu.It is located in the chengalpattu district. Thaiyur Reserve Forest is a village positioned in Chengalpattu Forest Reserve Block of Chengalpattu district in Tamil Nadu. Around 40 villages and 680 hectors covered whole forest. Normally Thaiyur forest is thorn and shrub forest. It was declared as a Reserve Forest by the Government of Tamil Nadu in 1980.

Blackbucks are free ranging animals which live in open forest areas. Thaiyur reserve forest has a dense blackbuck population, In Thaiyur alone, more than 200 blackbucks were recorded by researchers a few years ago. Three years ago, a research team from Chennai-based biodiversity research organization Care Earth Trust took up a study, where blackbucks were found in large numbers. Blackbucks are listed in the endangered category by IUCN and it stresses the fact that Thaiyur Reserve Forest is a crucial habitat that should be protected with high degree of conservation measures to protect the declining population of Blackbucks. Thaiyur RF is also home to a large range of grass and shrub dwelling organisms. According to Times of India Newspaper Oct 22, 2017, Forest officials in Kancheepuram district are proposing to declare three Reserve Forests (RF) as blackbuck, Antilope cervicapra sanctuaries to protect the endangered Indian antelope. The animals are found in three reserve forests in the Chengalpattu forest division and their numbers range close to 300, Thaiyur forest also been include in this proposal .(Times of India -Indiatimes.com). Thaiyur is a southern neighbourhood of Chennai, Tamil Nadu, India. It is a village located in Chengalpattu district, about 31.46 kilometres (19.55 mi) from Chennai.

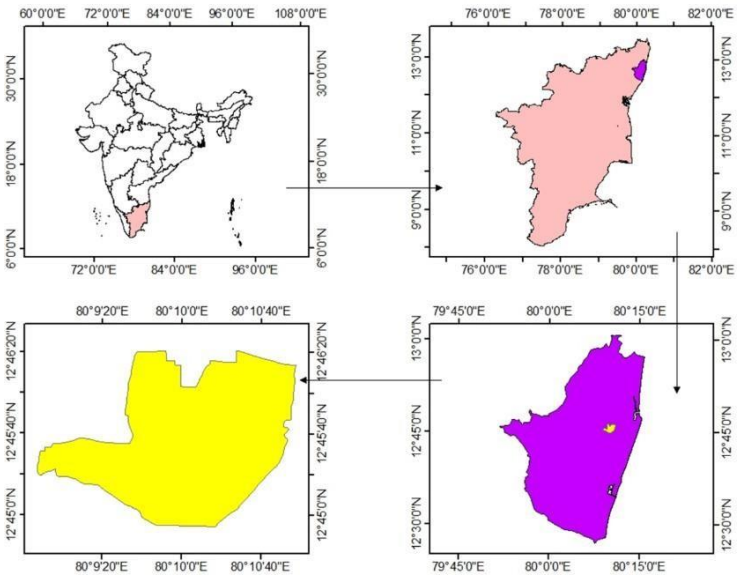

Figure 1. Key map of the study area.

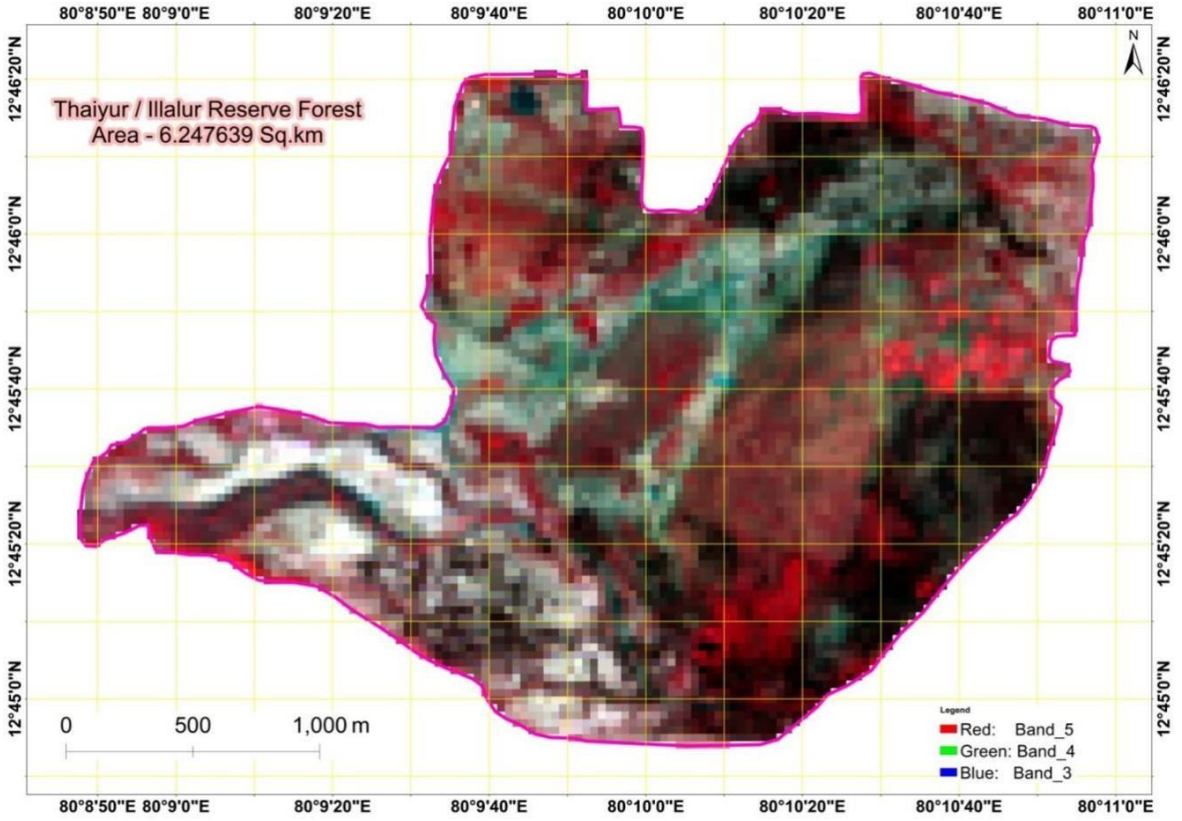

Figure 2. Gridded map for the study region with Landsat 8 OLI as background.

8.0 Material and Methodology

Systematic field visits were done on 12th march 2022 (Saturday) started from Kayar village & 16th march 2022 (Wednesday) Eachangadu village , ensuring each data element in consideration, in these field visits we took geo-tagged photographs and way points ,were taken by using mobile applications ,GPS Essentials for waypoints and Note-cam for image with latitude and longitude, of model (Redmi Note 10 pro max, Redmi 6a, Samsung M32 & Samsung S2) along with the photographs ,extensive knowledge of Taxonomy of Plants and animal been implemented to identify species on the basis of direct sighting, footmarks, dropping, scratch mark etc, this data was written in systematic way in form of field notes. Line transect survey method was been followed to collect the data.

The species and habitat data which has been collected was arranged in the tabular from by using MS Excel and all the rules for nomenclature were followed for this, data was sourt as

1. Checklist of birds and animals, Day 1 & Day 2 respectively followed by the Scientific name, Family, Common name & conservation status has been declared by IUCN.

2. List of native plants species including Scientific name, Family, Common name, Habit, Conservation status has been declared by IUCN , special notes and Specific use by animals to indicate the habitat suitability.

3. List of Exotic Flora in the reserve forest along whit the scientific name, Family, subfamily, common name, Native range &Special notes.

4. An Inventory of all plant Family recorded during the fields.

collect the data.

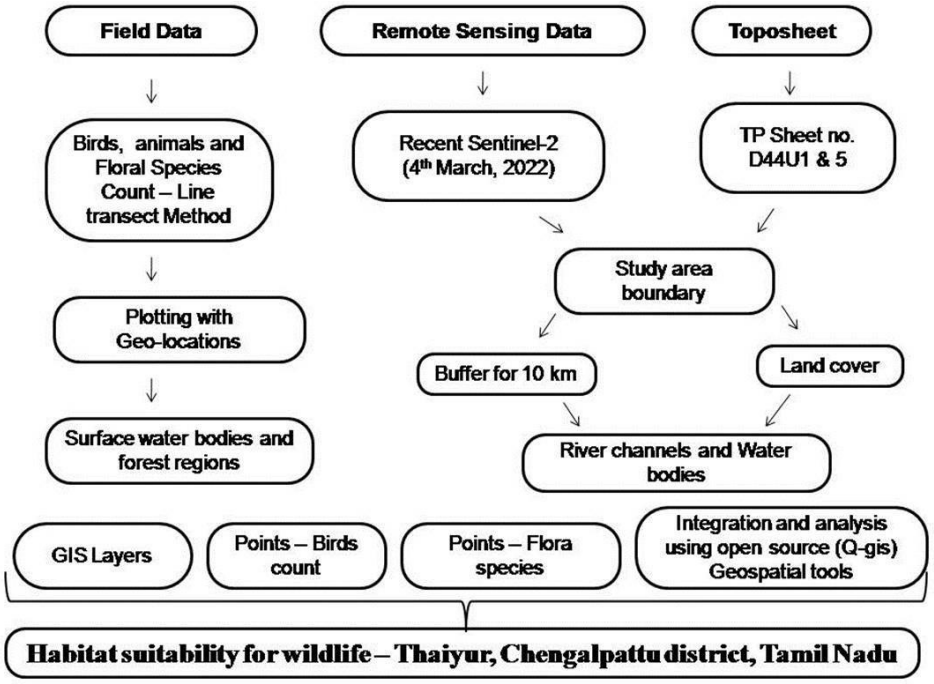

Figure 3. Methodology flow chart

9. Results & Discussion

9.1) Field collection of Wildlife (Birds and selected animals)

- ✓ No.of species of Birds: 62
- ✓ No.of Mammals: 04
- ✓ No.of Reptiles and Amphibians: 03
- ✓ No.of Individuals: 353
- ✓ In these area, Frugivorous, Omnivorous, Carnivorous, Insectivorous birds are present.
- ✓ Among them Insectivorous birds are more when compared to other types. It indicates availability of insects are more like Dragonfly, Damselfly and butterfly and other insects.
- ✓ We also identified some birds nest which are Sunbird, Laughing dove, and Coppersmith barbet.
- ✓ Near threatened birds like Painted stork and Spot billed pelican also present.
- ✓ Mammals, Reptiles and Amphibians also present. Among them critically endangered – Spotted deer (Foot Print) and Schedule-I Black buck (Scat)

Day-1						
S.No	ID	Name of the Species	Scientific name	Count	Family	IUCN Status
1	1	Starting Point	Starting Point			
2	2	Rose Ringed Parakeet	*Psittacula krameri*	7	Psittacidae	Least concern
3	2	Black Drongo	*Dicrurus macrocercus*	12	Dicruridae	Least concern
4	3	Rose Ringed Parakeet	*Psittacula krameri*	3	Psittacidae	Least concern
5	3	Common Tailor Bird	*Orthotomus*	2	Cisticolidae	Least concern

6	3	Purple Sunbird	*Cinnyris asiaticus*	2	Nectariniidae	Least concern
7	3	Purple Rumped Sunbird	*Leptocoma zeylonica*	2	Nectariniidae	Least concern
8	4	White Browed Bulbul	*Pycnonotus luteolus*	3	Pycnonotidae	Least concern
9	4	House Crow	*Corvus splendens*	15+	Corvidae	Least concern
10	4	Large Billed Crow	*Corvus macrorhynchos*	4+	Corvidae	Least concern
11	4	Black Buck (Scat)	*Antilope cervicapra*	-	Bovidae	Least concern (Schedule I)
12	5	Common Myna	*Acridotheres tristis*	9+	Sturnidae	Least concern
13	5	Asian palm Swift	*Cypsiurus balasiensis*	7+	Apodidae	Least concern
14	5	Grey Francolin	*Francolinus pondicerianus*	3	Phasianidae	Least concern
15	5	Tailor Bird	*Orthotomus*	1	Nectariniidae	Least concern
16	5	Rufous Treepie	*Dendrocitta vagabunda*	1	Corvidae	Least concern
17	6	Indian Robin	*Saxicoloides fulicatus*	3	Muscicapidae	Least concern
18	6	White Throated Kingfisher	*Halcyon smyrnensis*	1	Alcedinidae	Least concern
19	6	Brahminy Starling	*Sturnia pagodarum*	2	Sturnidae	Least concern
20	6	Indian Pond Heron	*Ardeola grayii*	4	Ardeidae	Least concern
21	6	Spotted owlet	*Athene brama*	1	Strigidae	Least concern
22	6	Pied Kingfisher	*Ceryle rudis*	1	Alcedinidae	Least concern
23	7	Red wattled Lapwing	*Vanellus indicus*	5+	Charadriidae	Least concern
24	7	Black naped hare (scat)	*Lepus nigricollis*	-	Leporidae	Least concern
25	7	Paddy field crab		2	Gecarcinucidae	Least concern
26	7	Asian Palm civet	*Paradoxurus hermaphroditus*	-	Viverridae	Least concern
27	8	Indian Peafowl	*Pavo cristatus*	2	Phasianidae	Least concern

28	8	Red vented bulbul	*Pycnonotus cafer*	6	Pycnonotidae	Least concern
29	9	Plain Prinia	*Prinia inornata*	5+	Cisticolidae	Least concern
30	9	Rosy Starling	*Pastor roseus*	10+	Sturnidae	Least concern
31	9	Spotted dove	*Spilopelia chinensis*	2	Columbidae	Least concern
32	9	Spotted Deer (Foot Print)	*Axis axis*	-	Cervidae	Least concern
33	10	Red Whiskered Bulbul	*Pycnonotus jocosus*	6+	Pycnonotidae	Least concern
34	10	Large Billed Crow	*Corvus macrorhynchos*	4	Corvidae	Least concern
35	10	Coppersmith Barbet	*Megalaima haemacephala*	2	Megalaimidae	Least concern
36	10	Jerdons Bushlark	*Mirafra affinis*	1	Alaudidae	Least concern
37	10	White browed Wagtail	*Motacilla maderaspatensis*	1	Motacillidae	Least concern
38	11	Cattle Egret	*Bubulcus ibis*	3	Ardeidae	Least concern
39	11	Laughing Dove	*Spilopelia senegalensis*	2	Columbidae	Least concern
40	12	Open Billed Stork	*Anastomus oscitans*	2	Ciconiidae	Least concern
41	12	Oriental Honey buzzard	*Pernis ptilorhynchus*	1	Accipitridae	Least concern
42	12	Little Cormorant	*Microcarbo niger*	2	Phalacrocoracidae	Least concern
43	13	Field Frog	*Fejervarya limnocharis*	10+	Dicroglossidae	Least concern
44	14	Red Wattled Lapwing	*Vanellus indicus*	3	Charadriidae	Least concern
45	15	Garden Lizard	*Calotes versicolor*	2	Agamidae	Not evaluated
46	15	Fan throated Lizard	*Sitana ponticeriana*	1	Agamidae	Least Concern
47	15	Laughing dove	*Spilopelia senegalensis*	1	Columbidae	Least concern
48	15	Zitting cisticola	*Cisticola juncidis*	1	Cisticolidae	Least concern
49	16	Wood Sandpiper	*Tringa glareola*	1	Scolopacidae	Least concern
50	16	Green Bee-eater	*Merops orientalis*	3	Meropidae	Least concern

51	16	Black Bittern	*Ixobrychus flavicollis*	1	Ardeidae	Least concern
52	16	Black Winged kite	*Elanus caeruleus*	1	Accipitridae	Least concern
53	16	Ashy Prinia	*Prinia socialis*	2	Cisticolidae	Least concern
54	17	Shikra	*Accipiter badius*	1	Accipitridae	Least concern
55	18	Common Hawk Cuckoo	*Hierococcyx varius*	2	Cuculidae	Least concern
56	19	Short toed snake Eagle	*Circaetus gallicus*	1	Accipitridae	Least concern
57	20	Laughing Dove (Nest - a pair of chicks)	*Spilopelia senegalensis*	1	Columbidae	Least concern
58	20	Indian Nightjar	*Caprimulgus asiaticus*	2	Caprimulgidae	Least concern
59	20	Eurasian Skylark	*Alauda arvensis*	1	Alaudidae	Least concern
60	20	Jerdon's Bushlark	*Mirafra affinis*	1	Alaudidae	Least concern

Day – 2						
S.No	ID	Name of the species	Scientific name	Counts	Family	IUCN Status
1	1	Starting point	Starting point			
2	1	Common kingfisher	*Alcedo atthis*	1	Alcedinidae	Least Concern
3	1	Asian palm swift	*Cypsiurus balasiensis*	8	Apodidae	Least Concern
4	1	Red wattled lapwing	*Vanellus indicus*	5	Charadriidae	Least Concern
5	1	Cattle egret	*Bubulcus ibis*	2	Ardeidae	Least Concern
6	1	Red vented bulbul	*Pycnonotus cafer*	4	Pycnonotidae	Least Concern
7	1	White browed bulbul	*Pycnonotus luteolus*	2	Pycnonotidae	Least Concern
8	2	Brahminy starling	*Sturnia pagodarum*	9	Sturnidae	Least Concern

9	2	Spotted owlet	*Athene brama*	1	Strigidae	Least Concern
10	2	House crow	*Corvus splendens*	7	Corvidae	Least Concern
11	2	Jerdons bushlark	*Mirafra affinis*	3	Alaudidae	Least Concern
12	2	Large billed crow	*Corvus macrorhynchos*	3	Corvidae	Least Concern
13	2	Pied cuckoo	*Clamator jacobinus*	2	Cuculidae	Least Concern
14	2	Black rumped flame back woodpecker	*Dinopium benghalense*	1	Picidae	Least Concern
15	2	Purple sunbird	*Cinnyris asiaticus*	3	Nectariniidae	Least concern
16	2	Indian pond heron	*Ardeola grayii*	2	Ardeidae	Least concern
17	2	Purple rumped sunbird	*Leptocoma zeylonica*	1	Nectariniidae	Least concern
18	2	Shikra	*Accipiter badius*	1	Accipitridae	Least concern
19	3	Spotted dove	*Spilopelia chinensis*	3	Columbidae	Least concern
20	3	Black drongo	*Dicrurus macrocercus*	5	Dicruridae	Least concern
21	3	Oriental magpie robin	*Copsychus saularis*	2	Muscicapidae	Least concern
22	4	Indian robin	*Saxicoloides fulicatus*	2	Muscicapidae	Least concern
23	5	Indian peafowl	*Pavo cristatus*	2	Phasianidae	Least concern
24	6	Purple sunbird	*Cinnyris asiaticus*	3	Nectariniidae	Least concern
25	6	Pied kingfisher	*Ceryle rudis*	2	Alcedinidae	Least concern
26	6	Indian silverbill	*Euodice malabarica*	2	Estrildidae	Least concern
27	6	Large billed crow	*Corvus macrorhynchos*	3	Corvidae	Least concern
28	7	Sunbird's nest	*Nectariniidae*	1	*Nectariniidae*	Least concern

29	8	Black napped hare	*Lepus nigricollis*	1	Leporidae	Least concern
30	9	Spotted deer's (Scat)	*Axis axis*	-	Cervidae	Critically Endangered.
31	10	Indian peafowl	*Pavo cristatus*	1	Phasianidae	Least concern
32	10	Comon myna	*Acridotheres tristis*	4	Sturnidae	Least concern
33	10	Black drongo	*Dicrurus macrocercus*	5	Dicruridae	Least concern
34	10	Black napped hare	*Lepus nigricollis*	1	Leporidae	Least concern
35	10	Indian roller	*Coracias benghalensis*	1	Coraciidae	Least concern
36	10	Rufous treepie	*Dendrocitta vagabunda*	2	Corvidae	Least concern
37	10	Black buck's (Scat)	*Antilope cervicapra*	-	Bovidae	Least concern
38	10	Rock dove	*Columba livia*	1	Columbidae	Least concern
39	10	Red wattled lapwing	*Vanellus indicus*	2	Charadriidae	Least Concern
40	11	Green bee eater	*Merops orientalis*	3	Meropidae	Least concern
41	11	Indian peafowl	*Pavo cristatus*	2	Phasianidae	Least concern
42	11	Indian robin	*Saxicoloides fulicatus*	2	Muscicapidae	Least concern
43	11	Grey francolin	*Francolinus pondicerianus*	2	Phasianidae	Least concern
44	12	Wild boar (Scat)	*Sus scrofa*	-	Suidae	Least concern
45	13	Grey francolin	*Francolinus pondicerianus*	1	Phasianidae	Least concern
46	13	Collared dove	*Streptopelia decaocto*	1	Columbidae	Least concern
47	13	Purple sunbird	*Cinnyris asiaticus*	2	Nectariniidae	Least concern
48	13	Purple rumped sunbird	*Leptocoma zeylonica*	1	Nectariniidae	Least concern
49	13	Indian Crested Porcupine (Scat)	*Hystrix indica*	-	Hystricidae	Least concern
50	14	Green bee eater	*Merops orientalis*	2	Meropidae	Least concern
51	15	Little egret	*Egretta garzetta*	1	Ardeidae	Least concern

52	15	Greater coucal	*Centropus sinensis*	1	Cuculidae	Least concern
53	16	Western koel	*Eudynamys scolopaceus*	2	Cuculidae	Least concern
54	16	Coppersmith barbet	*Megalaima haemacephala*	2	Megalaimidae	Least concern
55	17	Booted eagle	*Hieraaetus pennatus*	1	Accipitridae	Least concern
56		House sparrow	*Passer domesticus*	2	Passeridae	Least concern
57	17	Yellow billed babbler	*Argya affinis*	5	Leiothrichidae	Least concern
58	17	Red vented bulbul	*Pycnonotus cafer*	2	Pycnonotidae	Least concern
59	17	Blue faced malkoha	*Phaenicophaeus viridirostris*	1	Cuculidae	Least concern
60	18	Common tailorbird	*Orthotomus sutorius*	2	Cisticolidae	Least concern
61	18	Shikra	*Accipiter badius*	1	Accipitridae	Least concern
62	18	Rose ringed parakeet	*Psittacula krameri*	4	Psittacidae	Least concern
63	18	Rufous treepie	*Dendrocitta vagabunda*	1	Corvidae	Least concern
64	19	Pied cuckoo	*Clamator jacobinus*	2	Cuculidae	Least Concern
65	19	Yellow billed babbler	*Argya affinis*	6	Leiothrichidae	Least concern
66	19	Indian golden oriole	*Oriolus kundoo*	2	Oriolidae	Least concern
67	19	Spotted owlet	*Athene brama*	1	Strigidae	Least concern
68	19	Spot billed pelican	*Pelecanus philippensis*	9	Pelecanidae	Near threatened
69	19	Painted stork	*Mycteria leucocephala*	4	Ciconiidae	Near threatened
70	19	Common myna	*Acridotheres tristis*	7	Sturnidae	Least concern

NAME: GREEN BEE EATER

SCI.NAME: *Merops orientalis*

LAT:12°44'57"

Long:80°10'14"

NAME: SPOT BILLED PELICAN

SCI.NAME: *Pelecanus philippensis*

LAT:12°45'3"

Long:80° 10'36"

NAME: PAINTED STORK

SCI.NAME: *Mycteria leucocephala*

LAT:12°45'3"

Long:80° 10'36"

Figure 3. Location of selected bird species found within Thaiyur reserve forest.

9.2 Field Collection of Species & Diversity (Native & Invasive)

- ✓ Total 100 species of flowering plants were reported during the field visits among which 80 are native species and 20 are exotic one.

- ✓ Among all the 43 plant families are reported, among which Rutaceae ,Fabaceae, Moraceae ,Pandanaceae, capparidaceae were seen prominent.

- ✓ Among the exotic flora Fabaceae, Cactaceae, Euphorbiaceae, cleomaceae, Casuarinaceae families were seen prominent.

- ✓ According to the habitat and the soil type Thayiur forest is open thorn forest and along with trees and shrubs seasonal herbs are more prominent here.

- ✓ But the extensive plantation and encroachment of exotic flora is creating a hurdle for all the native species , with respect to competition for resources and allelo-chemicals.

Native Species							
ID	**Scientific name**	**Family**	**Common name**	**Habit**	**Special notes**	**Conswervation status**	**Specific use by aminals**
1	*Vachellia leucophloea (roxb.) Maslin, seigler & ebinger*	Fabaceae lindl.	White bark acacia	Tree	Decidious tree, prefers decidious habitat	Lc	
2	*Borassus flabellifer l.*	*Arecaceae bercht. & j.presl, nom. Cons.*	Palmyra palm	Plam	State tree of tamil nadu, grows well in sedimentory soil .	Lc	Fruits are eaten also has high market demand
3	*Azadirachta indica a.juss.*	*Meliaceae juss.*	Neem	Tree	Planted in large quantity in forest , decidious tree which grows well in decidious habitats	Lc	Fruits are eaten
4	*Corypha umbraculifera l.*	*Arecaceae bercht. & j.presl, nom. Cons.*	Talipot palm		Native to eastern and southern india and sri lanka, grows well in sedimentory soil.	data deficient	Fruits are eaten
5	*Syzygium cumini (l.) Skeels*	*Arecaceae bercht. & j.presl, nom. Cons.*	Flour palm	Plam	They are found in lowlands, ridges and on hills, also a good riperian palm not more than 5 meters in height.	data deficient	Fruits are eaten
6	Thespesia populnea (l.) Sol. Ex correa	*Malvaceae juss.*	Indian tulip tree	Tree	Planted as plantation plant	Lc	

7	*Syzygium cumini (l.) Skeels*	*Myrtaceae juss.*	Jamun	Tree	Imporatant native riperian tree ,also planted in forest	Lc	Fruits are eaten by birds ,mammals and also has high market demand
8	*Terminalia arjuna (roxb.) Wight & arn.*	*Combretaceae r.br.*	Arjuna tree	Tree	the arjuna is seen across the indian subcontinent, and usually found growing on river banks or near dry river beds	Lc	Seeds are highly prefered by arboreal mammals , and tree is prefered by sloth bear , birds and bees
9	*Terminalia bellirica (gaertn.) Roxb.*	*Combretaceae r.br.*	Baheda	Tree	Large deciduous tree with high medicinal values , found gron along streams and river in cluster	Lc	Mfruits are highly prefered by birds , mammals and also have high market value , flowering occours in summer and can be senced by its typical foul smell of flowers. Flowers are

							pollinated by flies and bees.
10	*Limonia acidissima l.*	*Rutaceae juss.*	Wood apple	Tree	Limonia acidissima is a large tree growing to 9 metres (30 ft) tall, with rough, spiny bark.	Lc.	Fruits are prefered ny mammals ,specially by monkeys and deers sp.
11	Psydrax dicoccos gaertn.	*Rutaceae juss.*	Ceylon box wood	Tree	It is an unarmed, smooth shrub or small tree , with extermely variable leaves	Vu	Flowers are pollinated by bees , have odour ,fruits are dispersed by birds.
12	Ixora pavetta andrews	*Rutaceae juss.*	*Torch tree*	Medium size tree	Medium size tree in citrus family found in forest of southern india	data deficient	Flowers are highly odorus and pollinated bybees , fruits are prefered by birds

13	*Tarenna asiatica(l.) Kuntze ex kschum.*	*Rutaceae juss.*	Kottam	Large shrub or medium size tree	Medium size tree in citrus family found in forest of southern india , generally confused with ixora pavetta but easly differentiate by the leaves and flowers. Calyx persistant	data deficient	Flowers are highly odorus and pollinated bybees , fruits are prefered by birds
14	*Benkara malabarica (lam.) Tirveng.*	*Rutaceae juss.*	Pidathi	Small tree	Trees in dry evergreen to semi-evergreen forests up to 600 m.,armed with spines.	data deficient	Flowers pollinated by insects and brightly coloured berry is prefered by birds hence despersed.
15	Catunaregam spinosa (thunb.) Tirveng.	*Rutaceae juss.*	Attadika arai	Medium sized branched tree	Small trees with small straight axillary spines. Fruits are extensively use as fish poison	data deficient	Fruits are prefered by some animals
16	Atalantia monophylla (roxb.) A. Dc.	*Rutaceae juss.*	Kattu elumeachi	Small tree		data deficient	
17	*Zanthoxylum asiaticum (l.) Appelhans, groppo & j.wen syn.toddalia asiatica (l.) Lam.*	*Rutaceae juss.*	Orange climber	Liana	Plant cover with hooks even on the adaxial surface also.	data deficient	Fruits are eaten by birds.

18	Canthium coromandelicum l.	*Rutaceae juss.*	Coromandle boxwood	Suffrosticose shrub, known for pecular arrangment of spines.	Sufferusticose shrub with pecular arrangement of spines	data deficient	
19	Oldenlandia corymbosa l.	*Rutaceae juss.*	Flat-top mille graines	Herb	Ground cover herb	Lc	
20	Spermacoce articularis l.f.	*Rutaceae juss.*	Nattai-c-curi	Herb	Ground cover herb	Lc	
21	*Maytenus emarginata (willd.) Ding hou*	*Celastraceae r.br.*	Red spike thorn	Shrub	Red spike thorn is a stout, very thorny shrub up to 2 meters high, with intricate branches.	Lc	
22	*Diospyros ferrea (willd.) Bakh.*	*Ebenaceae gürke*	Black ebony	Small tree	Small trees to 4 m tall; bark dark grey, fissured, rough. Leaves alternate	data deficient	Flowers are pollinated by insects, fruits are eaten by birds
23	*Dodonaea viscosa jacq.*	Sapindaceae juss.	Hopbush	Shrub	Xerophytic shrub can grow in barran land and in harsh condition	data deficient	Seeing the anther lobes and reduce priyanth one can clearly see flowers are insect pollinated , bisexual flowers.

24	*Dolichandrone falcata seem.*	*Bignoniaceae juss.*		Tree	Decidious tree endemic to india	data deficient	Flowers are night blooming, pollinated by insects and are highly odours
25	*Heliotropium indicum l.*	*Boraginaceae juss.*	Heilotrope flower	Herb		Lc	Plants attract male butterfly from nymphalidae families due to precsence of alchoids
26	*Heliotropium bracteatum r. Br.*	*Boraginaceae juss.*	Heilotrope flower	Herb		Lc	Flowers are pollinated by insects.
27	*Ehretia microphylla lam. Syn. Carmona retusa (vahl) masamune*	*Boraginaceae juss.*	Philippine tea tree	Shrub	Shrub growing to 4 m height, with long, straggling, slender branches. It is deciduous during the dry season.	data deficient	Gread plant to creat bussy habitat for small mammels and birds.
28	*Manilkara hexandra (roxb.) Dubard*	Sapotaceae juss.	Kannupala	Tree	Evergreen trees, to 20 m high, bark blackish-grey	Lc	Great cannopy tree, fruits and flowers are prefered .
29	Madhuca longifolia (j.konig) j.f.macbr.	Sapotaceae juss.	Moha	Tree	Large decidious tree ,with high economic value	Lc	Tree is greatly supports

							great range of birds , mammals , reptiles.
30	*Ziziphus xylopyrus* (retz.) Willd.	Rhamnaceae juss.	Stone jujube	Tree	Tree with full if hooks , fruits have market demand	Lc	Flowers are pollinated by files sp., fruits are highly preffered by birds and mammals.
31	*Ziziphus oenoplia (l.) Mill.*	Rhamnaceae juss.	Jackal jujube	Climbing shrub	Wood climbers which shiny ovate leaves.	Lc	Flowers are pollinated by files sp., fruits are highly preffered by birds and mammals. As the name common name suggeswt the fruits are eaten by jackels and can be seen in the scat.

32	Ventilago denticulata willd.	Rhamnaceae juss.	Hopbush		Large, woody, climbing shrubs; prominent on hill slopes and plain lands.	Lc	Flowers are pollinated by bees and seeds have meachism to get disperse.
33	Capparis sepiaria l.	Capparaceae juss.	**Hedge cape**	Shrub	*Capparis sepiaria* is a prickly, evergreen shrub growing to 3 to 5 meters tall	Lc	Floers are attractive ,for birds and larvel host plant for tips and pioneer butterfly
34	*Maerua oblongifolia forssk. (a.rich.)*	Capparaceae juss.	**Desert caper**.	Climbing shrub	Is a low woody bushy under-shrub	Lc	Floers are attractive ,for birds and larvel host plant for tips and pioneer butterfly
35	Osbeckia aspera blume.	Melastoma l.	Rough osbeckia	Herb	Leaves are elliptic-lanceolate, base attenuate with more or less velvet-hairy on both sides.	Lc	Flowers are pollinated by bees.
36	*Corallocarpus epigaeus (rottl.) C.b.clark*	Cucurbitaceae juss.	Red fruit creeper	Climber	Succulent rhizomatous plant with fruits having medicinal value.	Lc.	Fruits are eaten by birds and rhizome are eaten by wlidboar

37	Pandanus odorifer (forssk.) Kuntze	Pandanaceae r.br	*Kewda*	palm-like dioecious tree	Great riperian plant	Lc.	Provides a gread hide out for mammals and birds.
38	*Acacia ferruginea dc.*	Fabaceae lindl.	White rusty acacia	Decidious tree	Key species ,gives id to the forest type.	Lc.	Flowers are pollinated by bees.
39	Albizia amara (roxb.) Boiv.	Fabaceae lindl.	Krishna siris	Decidious tree	Key species ,gives id to the forest type.	Lc.	Flowers are pollinated by bees.provides good canopy.
40	Lindernia crustacea (l.) F.muell.	Linderniaceae borsch, kai müll., & eb.fisch.	Malaysian false pimpernel.	Herb	Herb grows around wet soil, some times in stones cracks	Lc.	
41	Aponogeton natans (l.) Engl. & k.krause[	Aponogetonaceae planch.	E cape-pondweed	Aquatic rihziomatous herb		Lc.	Flowers are pollinated by bees.provides good canopy.
42	Rivea hypocrateriformis (desr.) Choisy	Convolvulaceae juss.	Morning glory	Climber	Leaves are eaten as vegetable	Lc.	Flowers bloom at night , sweet sented ,pollinated by insects.
43	Stenosiphonium russellianum nees	Acanthaceae juss.		Herb		data deficient	
44	Rhynchosia minima (l.) Dc.	Fabaceae lindl.	Jumby-bean	Climber	Helps in nitrogen fixation	Lc.	Flowers are pollinated by bees.

45	Blepharis integrifolia (l. Fil.) E. Mey. & drege	Acanthaceae juss.	Narrow leaf bleoharis.	Herb	Pseudo whorls can ealisy recognised	Lc.	
46	Blepharis maderaspatensis (l.) B.heyne ex roth	Acanthaceae juss.		Herb	Pseudo whorls can ealisy recognised	Lc.	
47	Lepidagathis willd. Sp.	Acanthaceae juss.		Herb		Lc.	
48	Ruellia l. Sp.	Acanthaceae juss.		Herb		Lc.	
49	Hemidesmus indicus (l.) R.br.	Apocynaceae juss.	Indian sarsaparilla	Perrinal climber	Highly medicinal plant.	Lc.	Larval host for plain tiger butterfly
50	Cassytha filiformis l.	Lauraceae juss.	Love-vine	Obligate parasitic vine	Native parasitic plant	data deficient	Fruits are extensively dispersed by birds.
51	Leucas aspera (willd.) Link	Lamiaceae martinov	Thumbai	Herbs	Vertisilaster type of infloresence	Lc.	Flowers are pollinated by bees
52	Alangium salviifolium (l.f.) Wangerin	Cornaceae	Sage-leaved alangium,	Tree	Riperian tree	data deficient	Flowers are pollinated by bees
53	Limnophila heterophylla (roxb.) Benth.			Aquatic herb	Consist 8 types of leaves	data deficient	
54	Blumea axillaris (lam.) Dc.	Asteraceae bercht. & j.presl	Ruderal species.	Herb	Aromatic weed	Lc.	
55	Canavalia gladiata (jacq.) Dc.	Fabaceae lindl.	Sword bean	Climber	Cultivated plant exscaped in wild.	Lc.	

56	Ruellia patula jacq.	Acanthaceae juss.	Spreading ruellia	Shrubless	Spreading ruellia is an erect, hoary velvet-hairy, much branched shrubless	Lc.	Flowers open in early morning, pollination by bees.
57	Alysicarpus monilifer (l.)Dc.	Fabaceae lindl.	Alyce clover	Herb	Prosted to sub erect ,much branched herb	Lc.	Fixes nitrogen , excellent ground cover.
58	Alysicarpus vaginalis (l.) Dc.	Fabaceae lindl.	Alyce clover	Herb	Prosted to sub erect ,much branched herb	Lc.	Fixes nitrogen , excellent ground cover.
59	Sida spinosa l.	Malvaceae juss.	Sida	Herb	] is a perennial or sometimes annual plant	Lc.	
60	Phyllanthus reticulatus poir.	Phyllanthaceae martynov	Mirrinymir riny	Shrub	Sub erect shrib whit light green foliage	Lc.	Pollinated by moths.
61	Passiflora foetida l.	Passifloraceae juss. Ex rousse	Stinking passionflo wer	Climber	Exotic invasive climber.	Lc.	Tawny coaster butterfly lay eggs on the plant.
62	Tinospora cordifolia (thunb.) Miers	Menispermaceae juss.	Heart-leaved moonseed	Perrinal climber	Highly medicinal climber	Lc.	Seeds are eaten by birds.
63	Ammannia baccifera l.	Lythraceae j.st.-hil.	Monarch redstem	Annual herb	Aquatic herb	Lc.	
64	Bergia ammannioides roxb.	Elatinaceae dumort		Annual herb	Aquatic herb	Lc.	

65	Achyranthes aspera l.	Amaranthaceae juss.	Prickly chaff flower	Annual herb	Medicinal plant	Lc.	Seedsw are dispersed by animals as the seeds get pricked in the skin
66	Amaranthus viridis l.	Amaranthaceae juss.	Slender amaranth	Annual herb	Some time eaten as vegetable	Lc.	
67	Dendrocalamus strictus (roxb.) Nees	Poaceae barnhart	Calcutta bamboo	Grass	Highly valuable grass species	data deficient	Very important grass for maintating the habitat, prefered by all wild animals.
68	Tribulus terrestris l.	Zygophyllaceae r.br.	Gokharu	Annual herb	Medicinal plant	Lc.	
69	Diospyros melanoxylon roxb.	Ebenaceae gürke	Coromandel ebony	Tree	Plant with slow growth , fruits and leaves are medicinal	Lc.	Fruits are eaten by mammals and birds.
70	Eragrostis tenella (a. Rich.) Hochst. Ex steud.	Poaceae barnhart		Grass		Lc.	Ground cover.
71	Ficus religiosa l.	Moraceae gaudich	Pepal tree	Tree	Have relegious significance , also seen growing as strangler tree.	Lc.	Key stone species.
72	Ficus benghalensis l.	Moraceae gaudich	Banyan fig	Tree	Have relegious significance , also	Lc.	Key stone species.

					seen growing as strangler tree.		
73	Ficus racemosa l.	Moraceae gaudich	Red river fig	Tree	Have relegious significance , also seen growing as strangler tree.	Lc.	Key stone species.
74	Ficus tinctoria g.forst.	Moraceae gaudich	Humped fig	Tree	Strangler fig	Lc.	Key stone species.
75	Ficus hispida l.f.	Moraceae gaudich	**Opposite leaf fig**	Tree	Riperian fig	Lc.	Key stone species.
76	Grona triflora (l.) H.ohashi & k.ohashi	Fabaceae lindl.	Creeping tick trefoil	Herb	Ground cover herb	Lc.	Imp for butterflies
77	Dregea volubilis (l. F.) Benth. Ex hook. F.	Apocynaceae juss.	Green milkweed climber	Climber		Lc.	Imp for butterflies
78	Tephrosia villosa (l.)Pers.	Fabaceae lindl.	Hairy tephrosia	Shrub	Fix nitrogen in soil	Lc.	Imp for butterflies
79	Hoppea dichotoma b.heyne ex willd.	Gentianaceae juss.	Hoppea.	Herb		Lc.	
80	Canscora sp.	Gentianaceae juss.	Sangupushpi	Herb	Prefers cold and wet soil.	Lc.	

Exotic Species							
ID	Scientific Name	Family	Sub family	Common name	Habit	**Native range**	Special Notes.
1	Leucaena leucocephala (Lam.) De Wit	Fabaceae Lindl.	Caesalpinioideae DC.	White leadtre**e**	Tree	**Southern Mexico and northern Central America**	Very fast growing tree , can produce hundereds of seeds within one flowering season , now acquiring all the bog area and forest lands, very weak tree.
2	Acacia holosericea A.Cunn. Ex G.Don	Fabaceae Lindl.	Caesalpinioideae DC.	Soapbush wattle	Tree	**Northern Australia**	Extermely xerophytic tree, having phyllode instead of leaves , due to abcense of any natural predator produces huge amound of seeds, flowers are brightly coloured and attract many insect for pollination , self pollination also seen.
3	Acacia auriculiformis A.Cunn. Ex Benth.	Fabaceae Lindl.	Caesalpinioideae DC.	Australian Acacia	Tree	**Australia, Indonesia, and Papua New Guinea.**	Extermely xerophytic tree, having phyllode instead of leaves , due to abcense of any natural predator produces huge amound of seeds, flowers are brightly coloured and attract many insect for pollination , self pollination also seen. Also produces very bad foul odour.

4	Prosopis juliflora (Sw.) DC.	Fabaceae Lindl.	Caesalpinioideae DC.	Vilayati babul	Tree	**Mexico, South America**	Previously introduce in india for firewood and later exceped in wild , now seen every where in forest, very fast growth,produces huge amount of flowers and seeds.extermly xerophytic .
5	Opuntia sp.	Cactaceae Juss.	Cactoideae Eaton	Pear cactus	Succulent Herb		Xerophytic succulunt species escape in wild now seen very common .
6	Eucalyptus sp.	Myrtaceae Juss.	Myrtoideae	Forest Red Gum	Tree	**Australia**	Brought in india fro plantation, also cultivated for medicinal purpose,but plantation in wild creats dusrtibunce in wild habitats.
7	Casuarina equisetifolia L.	Casuarina ceae R.Br.		Australian pine tree	Tree	**Northern Australia and the Pacific Islands**	Once brought for ornamental use but later been extensively use for plantation in forest creating a great disturbance in wild habitats.
8	Typha angustifolia L.	Typhaceae Juss.		Cattail typha	Perrinal rhizomatous herb	**Europe to North America.**	Perrinal rhizomatous herb with stolon ,now dominating all the wetlands of india, produces huge amount of seeds and cover all the wetlands.
9	Ipomoea carnea Jacq.	Convolvul aceae Juss.		Pink morning glory	Perrinal or annual shrub	**North America**	Fast growing auqatic ipomea ,seeds are toxic, covers all the wetland with in very short time.

10	Passiflora foetida L.	Passiflora ceae Juss. Ex Rousse		Stinking passionflower	Perrinal climbers	**Southwestern United States**	Highly invasive climber, fully covery by glabdular tricomes and have foul smell.
11	Xanthium strumarium L.	Asteracea e Bercht. & J.Presl[		Common cocklebur	Anuual or perrinal herb.	**North America**	Xerophytic plant , produces large amount of flowers and seeds are disperse animals due to presence of hooks on seed.
12	Alternanthera ficoidea (L.) Sm.	Amaranth aceae Juss.		Joseph's coat	Annual herb	**Caribbean and South America**	Very fast growth , high seeds production, ground cover .
13	Euphorbia antiquorum L.	Euphorbia ceae Juss.		Euphorbia of the Ancients	Perrinal Succulent plant	**Wild origin is obscure**	Acquiring wild area very fast, once been planted in wild.
14	*Agave sp.*	Asparagac eae Juss.[	Agavoideae Herb	Century plant	Perrinal succulent plant	**Mexico and the United States**	Been planted in forest in past time, has viviapry, also cultivated for fiber.
15	Cleome viscosa L.	Cleomace ae Bercht. & J.Presl		Asian spiderflower	Anuual herb		Bright flowers ,plant is full covered with glandular tricome and alkaloids.
16	Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae Martinov		Wild Spikenard	Anuual herb	**Mexico, Central, the West Indies.**	Plant with aleochemicals which hinders our native flora.

17	Ricinus communis L.	Euphorbiaceae Juss.	Acalyphoideae	Castor oil plant	Perrinal or annual shrub	**Mediterranean Basin, Eastern Africa**	Cultivated for seeds and oil but escapedin wild
18	Croton bonplandianus Baill.	Euphorbiaceae Juss.	Crotonoideae	Ban Tulsi	Anuual herb	**Tropical America**	
19	Ocimum americanum L.	Lamiaceae Martinov		American basil	Anuual herb	**Africa**	Plant with aleochemicals which hinders our native flora.
20	Coccinia grandis (L.) Voigt	Cucurbitaceae Juss.		Scarlet gourd	Perrinal rhizomatous climber.	**Africa to Asia**	Escaped from wild, now seen in ttransition zone of forest and villages
21	Canavalia gladiata (Jacq.) DC.	Fabaceae Lindl.		Sword bean	Climber	Lc.	Cultivated plant exscaped in wild.

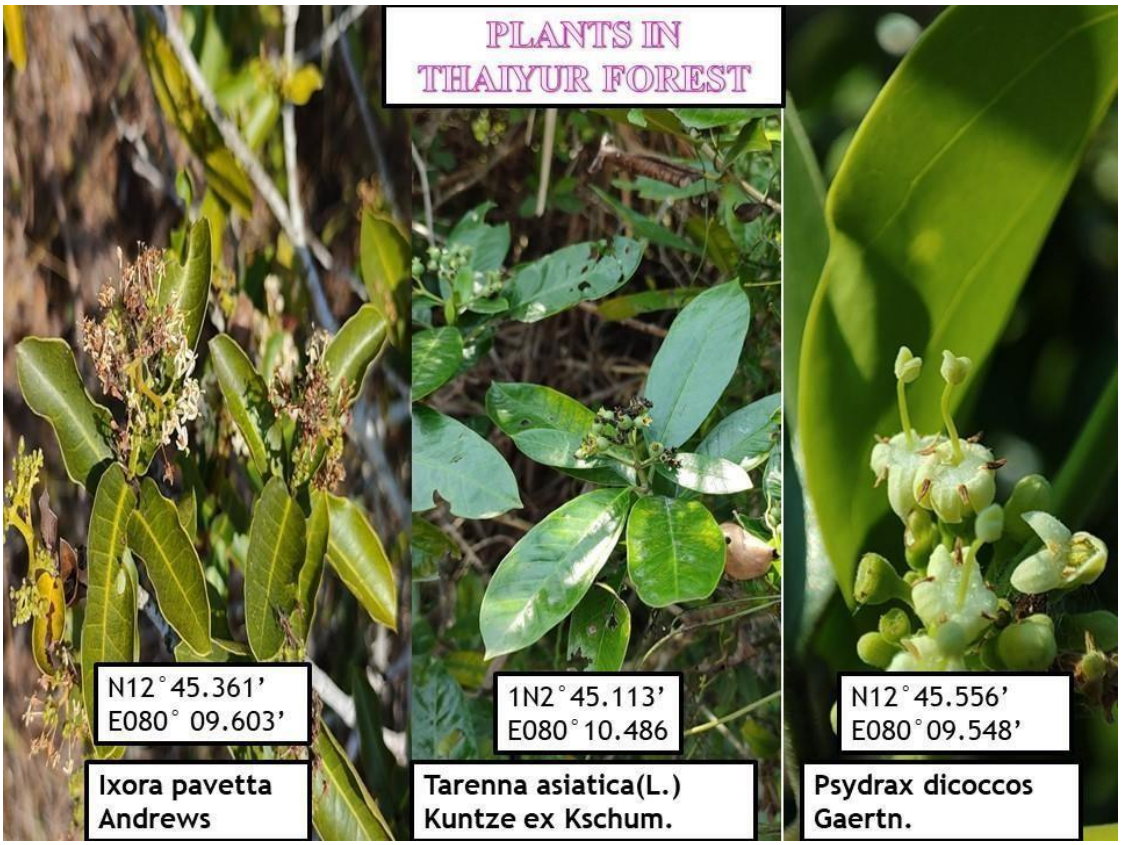

Figure 4. Locations of selected fauna types

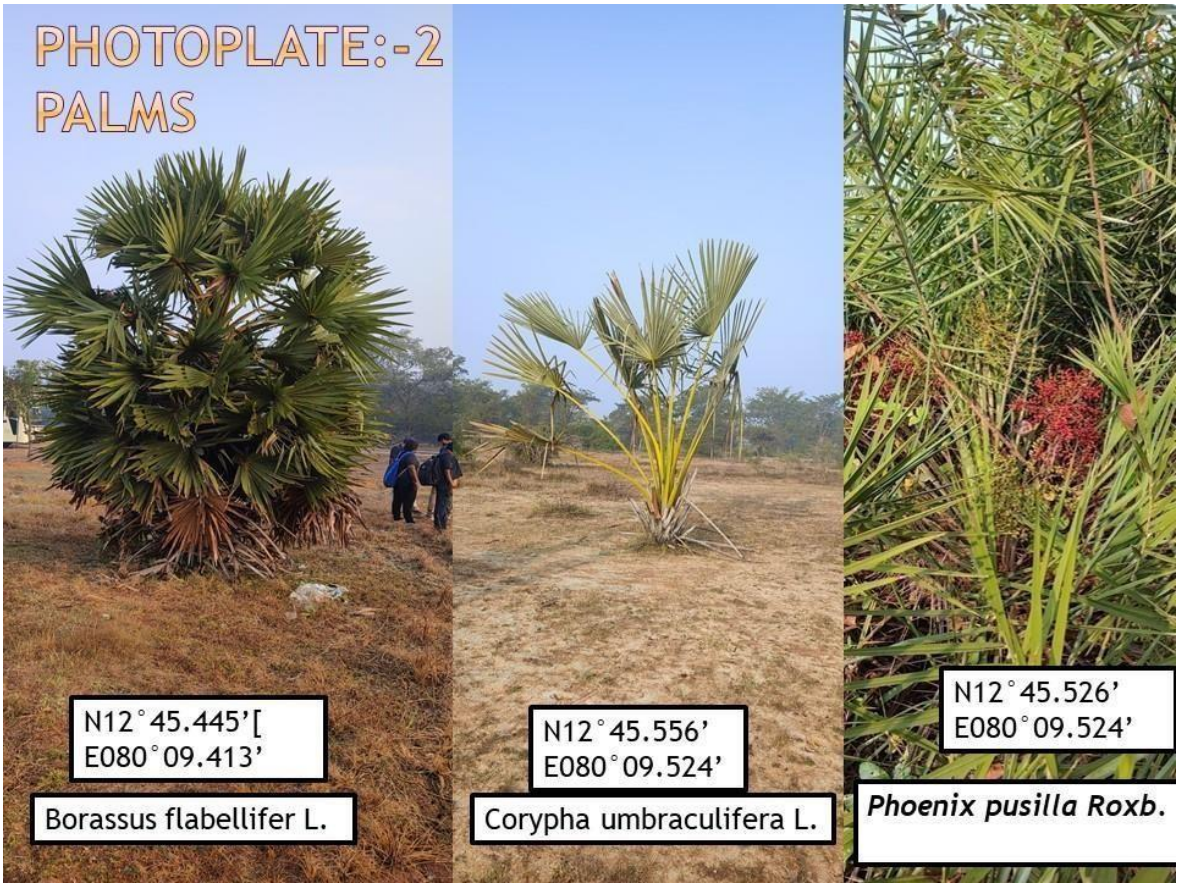

Figure 5. Locations of selected fauna types

9.3 Remote Sensing and GIS Results

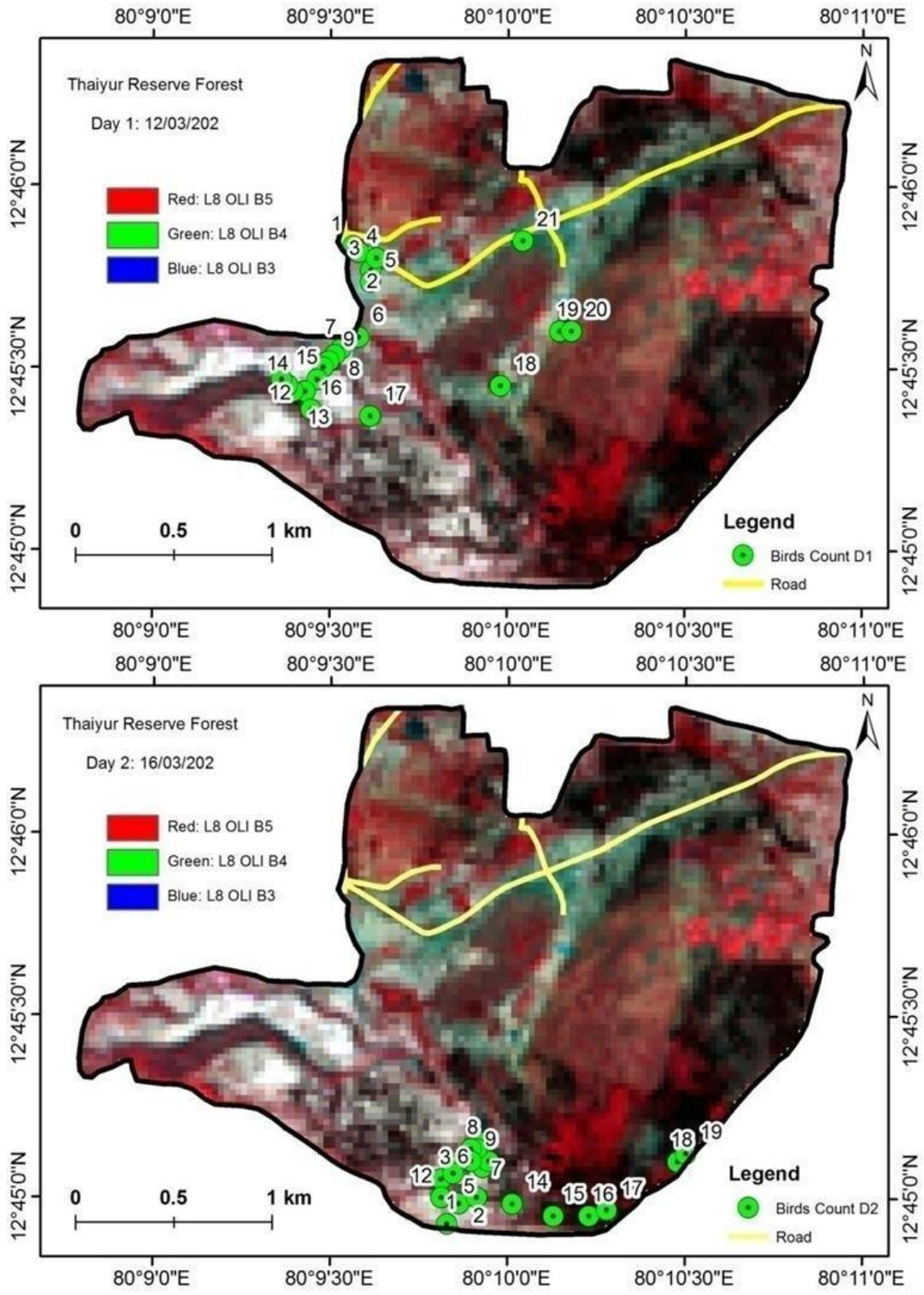

Figure 6. Locations of Fauna species

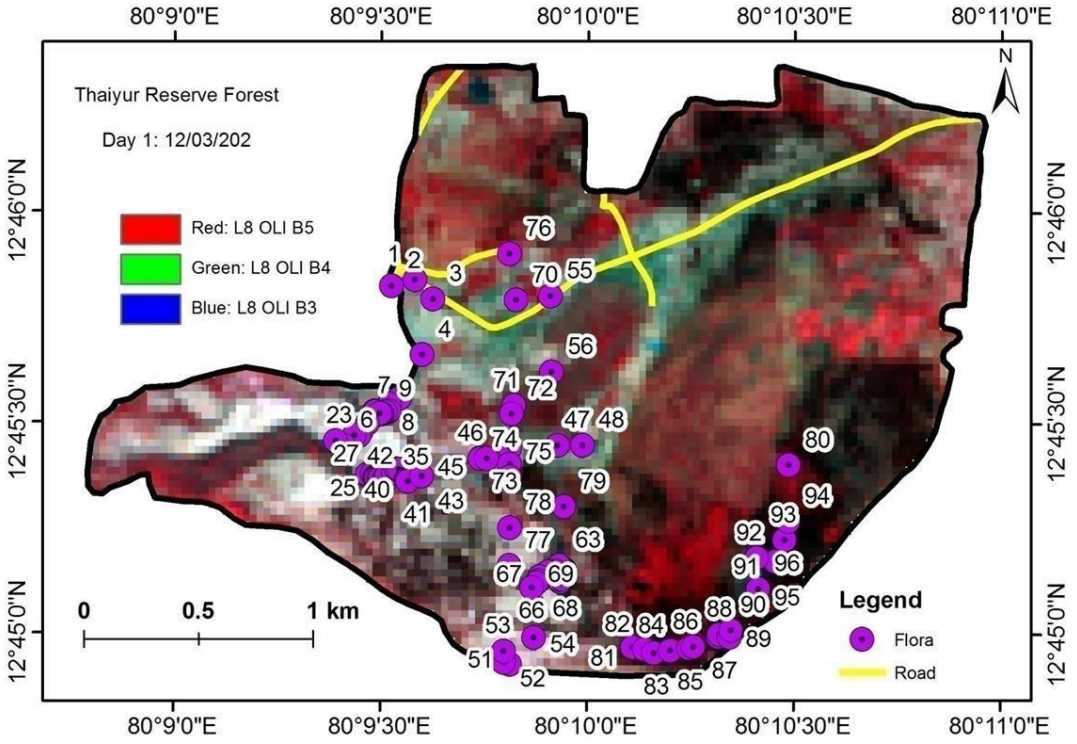

Figure 7. Locations of Fauna species

10 km buffer zone is taken for the regional land cover mapping. The Thaiyur reserve forest surface water is very low but nearby it has many such landforms. So the animals and birds need connectivity to travel that spots. The connected river channels to nearby surface water bodies should not be encroached in future. Nearby reserve forest also should be maintained in extent as well as species richness.

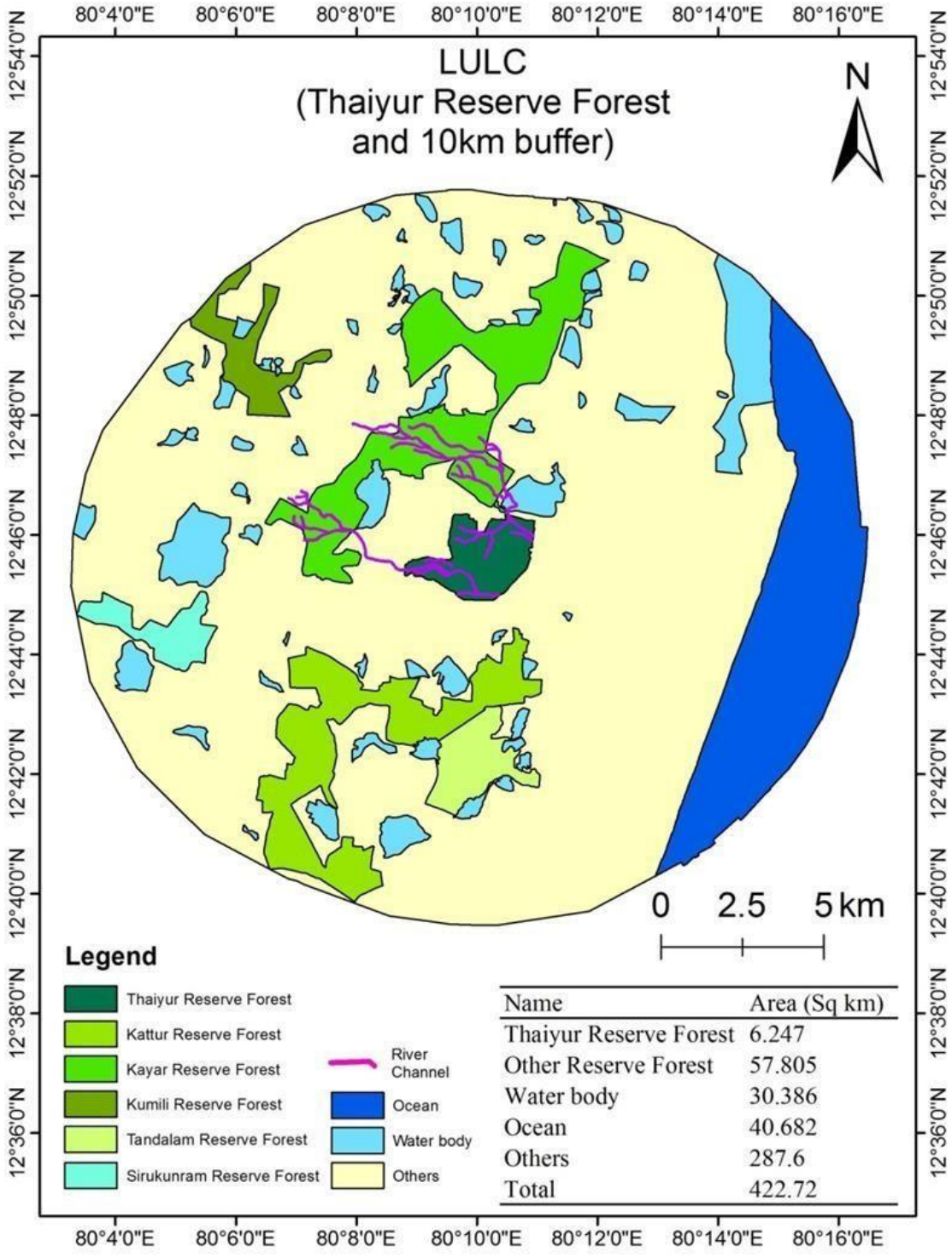

Figure 8. 10 km buffer land cover types of Thaiyur reserve forest

10.0 Conclusion

1. Field visit given valuable information on Flora and fauna diversity of Thaiyur forest

2. GPS – GPS essential and Google earth gives Geo-location values perfectly

3. Thematic maps were prepared in GIS (Q-gis) open source software and overlapping can be done for different layers by Geo-referenced images.

4. GIS is powerful tool for Habitat suitability mapping and diversity mapping

5. Abundance of floral elements and fauna in the forest indicate its species richness.

6. Early time plantation are causing a major threat to ecosystem.

7. Barren land patches are seen due to anthropogenic activity.

8. Presence of hooks, spines to major plants in the forest indicates the evolutionary history a line with other faunal species related to their adaptation.

11.0 References

1. Imam, E., & Kushwaha, S. P. S. (2013). Habitat suitability modelling for Gaur (Bos gaurus) using multiple logistic regression, remote sensing and GIS. Journal of Applied Animal Research, 41(2), 189-199.DOI: https://doi.org/10.1080/09712119.2012.739089
2. Ali and Ripley, 2007 S. Ali, S.D. Ripley **Handbook of the birds of India and Pakistan** Bombay Natural History Society and Oxford University Press (2007).
3. Imam, E., & Tesfamichael, G. Y. (2013). Use of remote sensing, GIS and analytical hierarchy process (AHP) in wildlife habitat suitability analysis. Journal of Materials and Environmental Science, 4(3), 460-467.DOI:
4. Store, R., & Jokimäki, J. (2003). A GIS-based multi-scale approach to habitat suitability modeling. Ecological modelling, 169(1), 1-15.DOI:https://doi.org/10.1016/S0304-3800(03)00203-5
5. Raman, S., Shameer, T. T., Charles, B., & Sanil, R. (2020). Habitat suitability model of endangered Latidens salimalii and the probable consequences of global warming. Tropical ecology, 61(4), 570-582.
6. Buruso, F. H. (2018). Habitat suitability analysis for hippopotamus (H. amphibious) using GIS and remote sensing in Lake Tana and its environs, Ethiopia. Environmental Systems Research, 6(1), 1-15.
7. Su, J. H., Piao, Y. C., Luo, Z., & Yan, B. P. (2018). Modeling habitat suitability of migratory birds from remote sensing images using convolutional neural networks. Animals, 8(5), 66.DOI: https://doi.org/10.3390/ani8050066
8. Franklin, J. (2010). Mapping species distributions: spatial inference and prediction. Cambridge University Press
9. Eggers, J., Holmgren, S., Nordström, E. M., Lämås, T., Lind, T., & Öhman, K. (2019). Balancing different forest values: Evaluation of forest management scenarios in a multi-criteria decision analysis framework. Forest Policy and Economics, 103, 55-69.
10. Menon, V. (2014). Indian mammals: a field guide. Hachette India.

BUTTERFLY SPECIES DIVERSITY AND ITS HABITAT PREFERENCE IN THAIYUR RESERVE FOREST IN TAMILNADU

Submitted to
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1. INTRODUCTION

BIODIVERSITY

The term biodiversity refers to the diversity of living organisms derived from all sources, and the ecological networks they comprise. It includes the diversity within species, between species, and across ecosystems. The world is currently experiencing its greatest ever biodiversity crisis. Globally, wildlife is facing a number of threats including habitat loss, overgrazing, over-hunting, pollution, and overpopulation. Biodiversity study is one of the cornerstones of sustainable development. Biogeographically, India lies at the junction of three realms, namely Afro-tropical, Indo-Malayan, and Paleo-arctic, and therefore exhibits characteristics of each. India is located in south Asia, between latitudes 8°4'N to 37°6'N and longitudes 68°7'E to 97° 25'E, which makes it a country with rich and diverse biological diversity. The Indian landmass of about 3029 million hectares is bounded by the Himalayas in the north, the Bay of Bengal in the east, the Arabian Sea in the west, and the Indian Ocean in the south.

Biogeographically, India is divided into ten Biogeographic zones. The diverse physical characteristics and climatic conditions have resulted in an array of ecological habitats. In India, richness in biodiversity is attributed to an enormous variety of climatic and Altitudinal conditions as well as varied ecological habitats. With its vast geography, India also boasts a sizable percentage of endemic animals and plants.

ECOSYSTEM

Ecosystems provide a variety of services that humans and other organisms need for survival and well-being. Ecosystem services include provisioning (production of food, fiber, water, etc.), cultural (recreation, spiritual, aesthetic values), and supporting (primary production, pollination, decomposition and soil formation necessary for resource production) and regulating biological control and other feedback mechanisms that maintain relatively consistent delivery of services.

As well as producing "disservices", ecosystems also produce biological hazards, such as diseases and animal attacks, allergenic and poisonous organisms, and geophysical hazards, such as floods and storms. In many cases, these disservices are caused by management practices such as deforestation and crop concentration. Insects have a variety of impacts on ecosystem services, both positive and negative.

Ecosystem components are generally being divided into two groups: biotic (living) and abiotic (non-living). Trees, shrubs, vines, grasses, mosses, algae, fungi, insects, mammals, birds, reptiles, amphibians, and microorganisms are the biotic components of an ecosystem. Apart

from being the major species of all organisms, they also play a critical role in the functioning of all ecosystems. Documentation of biodiversity is a basic need for management planning for conservation.

THREATS TO WILDLIFE

Deforestation and forest fires are widely considered the greatest threats to insects. Insects comprises the largest group of organisms. There are several anthropological activities that are threatening various ecosystems and some the major reasons are deforestation, habitat loss, poaching, hunting, road kill, rail track, electric fence electrocuted, plastic pollution, feral dogs, dumping ground, forest destruction in India, urban wildlife, wildlife conflict and many more.

CONSERVATION LAWS IN INDIA

Several laws have been enacted in the country to conserve and protect Wildlife and its habitat. Schedule-I to Schedule-VI. Some of the laws pertaining to Protection of Environment are as follows,

- Indian forest Act, 1927
- Forest Conservation Act, 1970
- Wildlife protection Act, 1972
- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act, 1981
- Environmental Impact Assessment, 1986
- Biodiversity Act, 2002
- Forest Rights Act, 2006
- The National Green Tribunal Act, 2010

Wild Life Protection Act, 1972 was enacted by the Parliament of India in order to conserve animals, birds, plants connected therewith in 1972. It's enacted for the protection of plants and animal species. It has six schedules which give varying degrees of protection.

RESERVE FOREST

Reserve forests are the most restricted forests and are constituted by the State Government on any forest land or wasteland which is the property of the Government. In reserved forests, local people are prohibited, unless specifically allowed by a Forest Officer in the course of the settlement. This concept was introduced in the Indian Forest Act of 1927. After the independence of the nation, the Government of India retained the status of the reserved and protected forests.

A protected forest is land notified under the provisions of the Indian Forest Act or the State Forests Act. In protected forests, all activities are permitted unless they are expressly prohibited. A protected forest is land that is a reserved forest, and over which the government has property rights, as declared by a state government under section 29 of the Indian forest act 1927.

Tamil Nadu has been a pioneer State in Protected Area management and development of forest resources and wildlife. The total area under the protected area management is 7,072.95 sq. km. which comes to 30.92% of the State's Forest area. The Protected Areas in the State includes 5 National parks, 15 Wildlife sanctuaries, 15 bird sanctuaries and 2 conservation reserves besides 5 Tiger Reserves.

These Protected Areas have been established under Wildlife (Protection) Act, 1972. Further Tamil Nadu also has the distinction of having 3 Biosphere Reserves are Nilgiris, Gulf of Mannar and Agasthiarmalai, these are internationally acclaimed for their rich and unique biodiversity.

THAIYUR RESERVE FOREST

Thaiyur Reserve Forest is located in the southern neighborhood of Chennai, Tamil Nadu. It is located in the Chengalpattu district. Thaiyur Reserve Forest is a village positioned in Chengalpattu Forest Reserve Block of Chengalpattu district in Tamil Nadu. Around 40 villages and 680 hectares covered whole forest. Normally Thaiyur forest is thorn and shrub forest. It was declared as a reserve forest by the Government of Tamil Nadu in 1980.

Blackbucks are free ranging animals which live in open forest areas. Thaiyur reserve forest has a dense black buck population, In Thaiyur alone, more than 200 blackbucks were recorded by researchers a few years ago. Three years ago, a research team from Chennai-based biodiversity research organization Care Earth Trust took up a study, where blackbucks were found in large numbers. Black bucks are listed in the Endangered category by IUCN and it stresses the fact that Thaiyur Reserve Forest is a crucial habitat that should be protected with high degree of conservation measures to protect the declining population of Blackbucks. Thaiyur RF is also home to a large range of grass and shrub dwelling organisms.

WILDLIFE AND ITS IMPORTANCE

Wildlife traditionally refers to undomesticated animal species, but has come to include all organisms that grow or live wild in an area without being introduced by humans. Wildlife can be found in all ecosystems. India is home to several well-known large animals, including the Indian elephant, Indian rhinoceros, Bengal tiger, Asiatic lion, Indian leopard, snow leopard, and clouded leopard. The importance of wildlife can be categorized as ecological, economic and investigatory importance as well as conservation of biological diversities etc. Animals have also been highly useful to us in providing food, clothing and source of income. Our life is almost impossible without the support of wildlife.

GIS

A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data with all types of descriptive information. It uses data that is attached to a unique location.

GIS system can handle critical information related to land use land cover transportation, utilities and other infrastructure facilities. The attributes of different types of geospatial data such as land ownership, roads bridges, buildings, lakes and river, counties or congressional districts can each constitute a layer or theme in GIS.

GIS technology is an effective tool for managing, analyzing, and visualizing wildlife data to target areas where interventional management practices are needed and to monitor their effectiveness. GIS helps wildlife management professionals examine and envision wildlife movement and habitat ranges.

Ground Data Collected from the Surface of the forest can be tracked. Type and Volume of previous forest fires could be tracked and real time sensors could be fixed with built Location Based Service (LBS) Geo fencing for animals and a constant temporal monitor could be done avoid trafficking and poaching and wild animals.

INSECTS

Insects provide useful services to mankind and the environment in a number of ways. They keep pest insects in check, pollinate crops we rely on as food, and act as sanitation experts, cleaning up waste so that the world doesn't become overrun with dung. Most insects are not only helpful critters, but they're essential to life on Earth. Bees and butterflies help plants produce seeds, ladybugs eat devastating pests and have even saved citrus crops, and centipedes keep the bug population in your home down. Deforestation and forest fires are widely considered the greatest threats to insects. Insects comprise the largest group of organisms. Apart from being the major species of all organisms, they also play a critical role in the functioning of all ecosystems.

Documentation of biodiversity is basic need for management planning for conservation. Insects perform valuable tasks to sustain an ecosystem, such as pollination and pest control. Many people perceive all insects as pests, but insects are vital to their ecosystems.

DRAGONFLIES (ANISOPTERA)

Dragonflies can hover in one place, fly extremely fast, and even fly backwards. They are some of the fastest flying insects in the world reaching speeds of over 30 miles per hour. Dragonflies come in a variety of colors including blue, green, yellow, and red. They are some of the most colorful insects on the planet. They are considered beneficial to humans. "Dragonflies are predators in the insect world and feed on many small-to-medium-sized bugs, eating things like mosquitoes, flies, moths and midges. Dragonflies eat their own weight, or even more, in harmful insects on a daily basis."

DAMSELFLIES (ZYGOPTERA).

Damselflies are flying insects of the suborder Zygoptera in the order Odonata. They are similar to dragonflies, which constitute the other odonata suborder, Anisoptera, but are smaller and have slimmer bodies. Dragonflies have been a symbol of purity, activity, and swiftness for some Native Americans. The indication of purity comes from both the pure water in healthy aquatic habitats where dragonflies thrive and from the fact that they eat their food right out of the wind.

MOTHS (LEPIDOPTERA)

Moths are a paraphyletic group of insects that includes all members of the order Lepidoptera that are not butterflies, with moths making up the vast majority of the order. There are thought to be approximately 160,000 species of moth, many of which have yet to be described. Moths can carry substantial amounts of pollen and cover great distances between successively visited plants, making them good pollinators of widely spaced trees. Butterflies, by contrast, are rare pollinators of trees, although they do pollinate certain species-rich genera, e.g., Eugenia.

BUTTERFLIES (LEPIDOPTERA)

Butterflies and moths are the insects that entice novice entomologists the most, thanks to their vibrant colours and ever-changing patterns. Butterflies and moths are members of the Insects class, which is part of the Arthropoda phylum. Moths and butterflies have tiny scales covering their wings. Butterflies and moths are the insects that entice novice entomologists the most, thanks to their vibrant colours and ever-changing patterns. Butterflies and moths are members of the Insects class, which is part of the Arthropoda phylum. Moths and butterflies have tiny scales covering their wings. The Lepidoptera suborder Rhopalocera is distinguished by its clubbed antennae, which is one of the most distinguishing features of butterflies. The Greek word rhopa

means "club." Lepidoptera is the second biggest insect order, with over 150,000 species documented in literature, 17,820 of which are butterflies. There are 1501 butterfly species in India. From Peninsular India, Kunte (2000) identified 271 species of butterflies. Butterflies evolved some 150 million years ago, around the same time as blooming plants did. Since they were discovered fossilized together in the same layers in the early cretaceous, it is likely that wild plants and butterflies have co-evolved continuously. Butterflies and plants have a close relationship, and their lives are closely interwoven. Insects and wild plants have always co-evolved. All brightly coloured flowers are dyed to attract insects. Colorful wildflowers aren't pollinated unless they recruit and use insects' help. Among insects, bees and flies are the most important pollinators. Butterflies come to plants for four reasons: to drink nectar, to lay eggs, and hide from predators or for poor weather. Adult butterflies rely on nectar as a source of nutrition. The majority of the researchers have been drawn to a single food source for butterflies: nectar from flowers. This is a mutualistic relationship between butterflies and flowering plants. The plant is pollinated, and the butterflies consume the nectar. When butterflies visit flowers, they transport pollen grains from one plant to another. Both behavioral and physical aspects influence flower visiting and nectar consumption by butterflies. Nectar feeder butterflies have much longer proboscis than other butterflies, and their length tends to correspond to the plant. This is important because many butterflies only visit flowers that are directed up words, while only a few visit flowers that are directed down words, and it may be interesting to study butterflies that never exploit it. Other sources of food, such as tree sap, rotting fruits, decomposing animals, animal droppings, and so on, were also consumed by a larger number of butterflies. Drinking in moist soil patches is a crucial feeding activity for many butterflies. This tendency could be linked to a salt deficiency. Both sexes of newly emerging individuals normally have sufficient sodium reserves in their bodies. During copulation, the females replenish their salt reserves by receiving sperm from the males. Males compensate for their salt loss by drinking contaminated water, urine, and excreta from wet areas. In such patches, a huge number of different butterfly species can be spotted. Mud puddling is the term for this type of action. Only male butterflies are supposed to participate in mud puddling.

Butterflies (Lepidoptera) occur throughout the world, except for the Polar Regions. There are about 18000 species of butterflies in the world (Kehimkar, 2014). Though they are far more numerous and diversified in the tropics, some species survive at the limits of polar vegetation. There are many species in nearby every environment from arid desert and High Mountain tops to marshes and tropical rainforest. Butterflies play a important and main role in all terrestrial ecosystems. Their short generation times produce rapid population responses to a wide range of biotic and abiotic environment making them vitally important for ecological study (Lewis et al., 1998). Butterflies (Lepidoptera) Butterflies subsist entirely upon the nectar of flowers, juice of over ripe fruits, honey dew and other liquid substances including minerals. They obtain all these from the habitat by visiting flowers, bird droppings, and rotten fruits and from mud puddling in suitable areas. They are mainly diurnal, but some of them are found to fly at night too, like Dark

Evening Brown (Melanities phedima Cramer) of the family Nymphalidae (Adler and Pearson, 1982).

Butterflies play a key role in nature. They are important component in the food chain of birds, spiders and other predatory insects. They also act as pollinators. Butterflies (Lepidoptera) are the most tantalizing beautiful creatures and one of the most plant dependent groups of insects compared to the other groups of insects. Butterflies are beneficial as they serve as pollinators and indicators of environmental quality and are appreciated for their aesthetic value (Chakravarthy et al., 1997). Lepidopterans, in particular butterflies often serve as a good "flagship" species for biodiversity inventories (Lawton et al., 1998). They are important pollinators and they serve as food and host for multiple other organisms at higher trophic levels (Summerville and Crist, 2001; Summerville et al., 2004). The old relationship between the man and butterflies is today going through a period of great stress as human by their activities are directly or indirectly threatening the 12 existences of butterflies. The presence of butterflies depends upon the variety of factors including climate, suitable foods, suitable areas for flight and courtship and in some instances, the presence of certain symbiotic species, notably ants. They are also good indicator in terms of anthropogenic disturbance and habitat quality as they are sensitive to changes in the environment.

IMPORTANCE OF BUTTERFLY

- Butterflies have been used in population dynamic. They have yielded some of the most interesting results including the fast that local population are often not permanent but regularly go extinct followed by spontaneous re-introduction.

- Butterflies have been used in studying evolution of plants by co-evolution of insects. As such plants have evolved new and more toxic deterrents and butterfly larvae have become increasingly adopted at overcoming them.

- Butterflies have been found to be vital geographical and ecological indicators; they form communities which are specific to each of the geographical sub-regions and to different types of ecological conditions.

- Butterflies are also good indicators of environmental changes as they are sensitive and are directly affected by changes in the habitats, atmospheric temperature and the weather conditions.

2. REVIEW OF LITERATURE

Conservative estimates suggest that 50–90% of the existing insect species on Earth have still to be discovered, yet the named insects alone comprise more than half of all known species of organism. With such poor baseline knowledge, monitoring change in insect diversity poses a

formidable challenge to scientists and most attempts to generalize involve large extrapolations from a few well-studied taxa. Butterflies are often the only group for which accurate measures of change can be obtained. Four schemes, used successfully to assess change in British butterflies that are increasingly being applied across the world. Comparisons with similarly measured changes in native bird and plant species suggest that butterflies have declined more rapidly that these other groups in Britain; it should soon be possible to test whether this pattern exists elsewhere. It is also demonstrated that extinction rates in British butterflies are similar to those in a range of other insect groups over 100 years once recording bias is accounted for, although probably lower than in aquatic or parasitic taxa. It is concluded that butterflies represent adequate indicators of change for many terrestrial insect groups, but recommended that similar schemes be extended to other popular groups, especially dragonflies, bumblebees, hoverflies and ants. Given institutional backing, similar projects could be employed internationally and standardized. Finally, a range of schemes designed to monitor change in communities of aquatic macro-invertebrates is described. Although designed to use invertebrates as a bio-indicator of water quality for human use, these program/mm es could be extended to monitor the 2010 biodiversity targets of the World Summit on Sustainable Development (Thomas, 2005).

2.2. INTERNATIONAL CONTEXT

Riparian ecosystems play an important role in modulating a range of ecosystem processes that affect aquatic and terrestrial organisms. Butterflies are a major herbivore in terrestrial ecosystems and are also common in riparian ecosystems. Since butterflies use plants for larval food and adult nectar sources in riparian ecosystems, butterfly diversity can be utilized to evaluate riparian ecosystems. Compiled butterfly data from 33 sites in three riparian ecosystem types across the country and compared butterfly diversity in terms of number of species and quality index in relation to riparian environmental variables. Number of butterfly and plant species was not different among three riparian habitat types. Additionally, there was no significant ecological variable to distinguish the butterfly communities on three riparian habitats. Non-metric multi-dimensional scaling ordination showed that butterfly communities in three riparian ecosystem types differed from each other, and butterfly riparian quality index was the main variable for butterfly assemblages. Five indicator species for moor and another five species for riverine riparian ecosystems were identified. Three and one indicator species for moor and riparian ecosystems, respectively, were plant specialists, while 44 butterflies were general feeders, feeding on a wide range of host plants in several habitats. These results suggest that butterfly species use actively riparian habitats for nectar and larval food, and the butterfly riparian quality index can be employed to track faunal change in riparian habitats, which are frequently threatened by disturbances such as water level and climate changes, and invasive species (An & Choi, 2021).

2.3. NATIONAL CONTEXT

Choudhury (2020) also documented the alpha diversity of butterfly diversity in Guma Reserve Forest of western Assam, India. Total 239 species of butterflies belonging to six families were recorded. The relative abundance and the butterflies listed in the schedules of the Wildlife (Protection) Act, 1972 have also been discussed. Mud-puddling activity was observed among the butterflies. Habitat destruction, fragmentation, illegal tree felling and forest fire were recorded as the potential threat to their survival in the study area. Though the habitat conditions of Guma Reserve are suitable for the propagation of butterflies but certain anthropogenic activities like illegal tree felling for fire wood and timber, agricultural practice, cattle farms and illegal forest fires have taken a heavy toll on butterfly population in the region.

Trishna wildlife sanctuary in northeast India was explored for species richness and diversity of butterflies. A six-month-long study revealed the occurrence of 59 butterfly species that included 21 unique species and 9 species listed in the threatened category. The mixed moist deciduous mature forest of the sanctuary harbored greater species richness and species diversity (39 species under 31 genera) than other parts of the sanctuary, which is comprised of regenerated secondary mixed deciduous forest (37 species under 32 genera), degraded forests (32 species under 28 genera), and open grassland with patches of plantations and artificial lakes (24 species under 17 genera). The majority of these species showed a distribution range throughout the Indo-Malayan region and Australasia tropics, and eight species were distributed in the eastern parts of South Asia, including one species, Labadea martha (F.), which is distributed in the eastern Himalayas alone. Estimator Chao 2 provided the best-predicted value of species richness. The steep slope of the species accumulation curve suggested the occurrence of a large number of rare species, and a prolonged gentle slope suggested a higher species richness at a higher sample abundance. The species composition of vegetation-rich habitats showed high similarity in comparison to vegetation-poor habitats (Majumder et al., 2013).

2.4. State context

The giant grizzled squirrel wildlife sanctuary (Western Ghats) is one of the wildlife sanctuaries in Tamil Nadu, located 485 square kilometres, it is bordered on southwest by the Periyar Tiger reserves and south of Palghat gap. The detailed survey of butterfly was conducted during January 2013 to December 2013. A total of 59 species with 41 genera of butterflies were recorded under 5 families. The family Nymphalidae and Pieridae were found dominant with 23 species and 12 species followed by Lycaenidae 10 species, Papilionidae 5 species and 4 species from the family Hesperiidae. The number of genera was the highest in Nymphalidae (13) followed by Pieridae (10), Lycaenidae(10), Papilionidae (4) and Hesperiidae (4). Of the 59 species of butterflies, seven scheduled species were seen in the study area under wildlife protection act 1972. Some

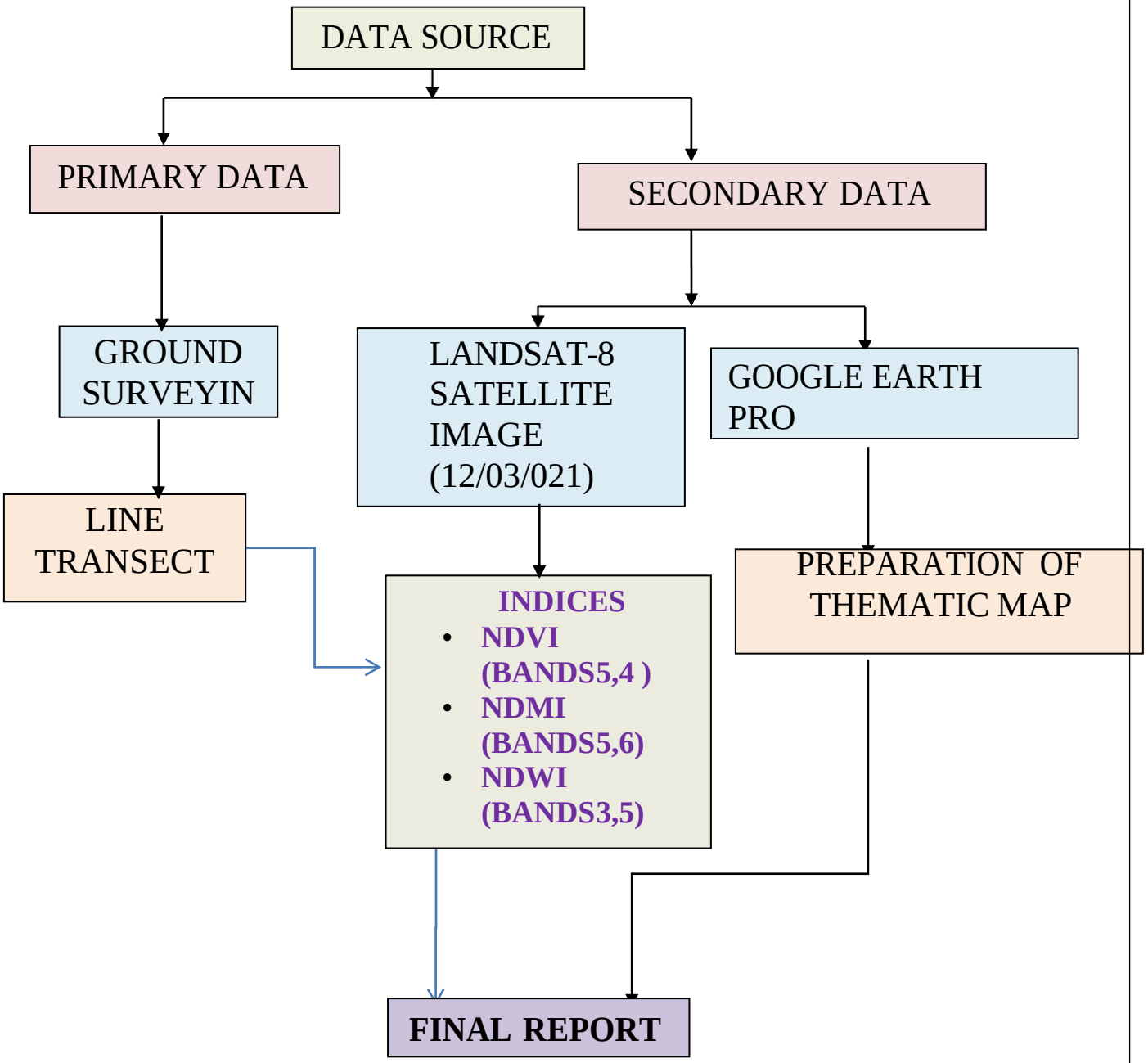
species has shown adaptation to the food plants and egg laying habitats phenomenon, many others have been pushed to extinction or near extinction. Such impacts are directly or indirectly affect the crop pollination leads to reduce the yields. The knowledge of Lepidopteron faunal diversity and distribution in habitats is not even and still scanty from different parts of India (Kumar et al., 2014).

Studies also conducted in another reserve forest of Tamil Nadu was Adukkam Forest, Dindigul district. The study recorded 72 species of butterflies, encompassing 17 species of Hesperiidae, 23 species of Lycaenidae, 19 species of Nymphalidae, six species of Papilionidae, six species of Pieridae and one species of Riodinidae. Four species of butterflies reported in this study were endemics to the Western Ghats, while five were protected under various schedules provided in the Wildlife (Protection) Act, 1972. The threats faced by this forest from road expansion projects has been discussed in this work, and a possible solution to a common way forward for humans and butterflies was also described. They suggested that The forest is cut through by the Kodai-Kudumbanar Road, and thus is at risk from road expansion projects and other encroachment activities. The extraction of water from the stream must also be regulated by the local government, in order to avoid the exploitation of this water resource, which could disturb the ecosystem of this forest. Further studies are required on the influence of human disturbances, at this location, as well at other parts of the Palni Hills (Vikas, 2020). From these previoius studies we chose objectives given below.

3. OBJECTIVES

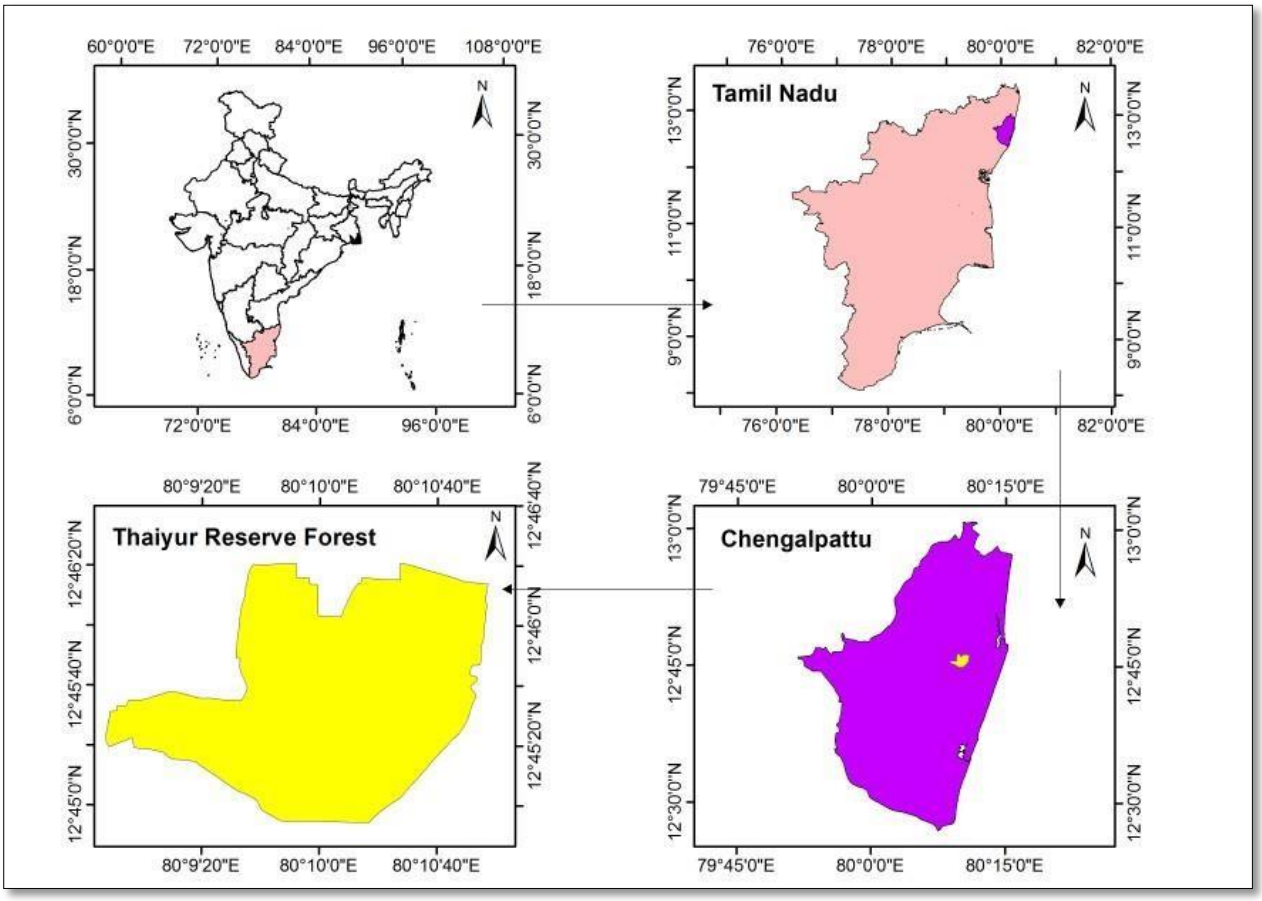
A. To study Insect's species in Thaiyur Reserve Forest
B. To find out distribution pattern of butterfly species.
C. To check the habitat preference of high abundant butterfly species.

4. METHODOLOGY



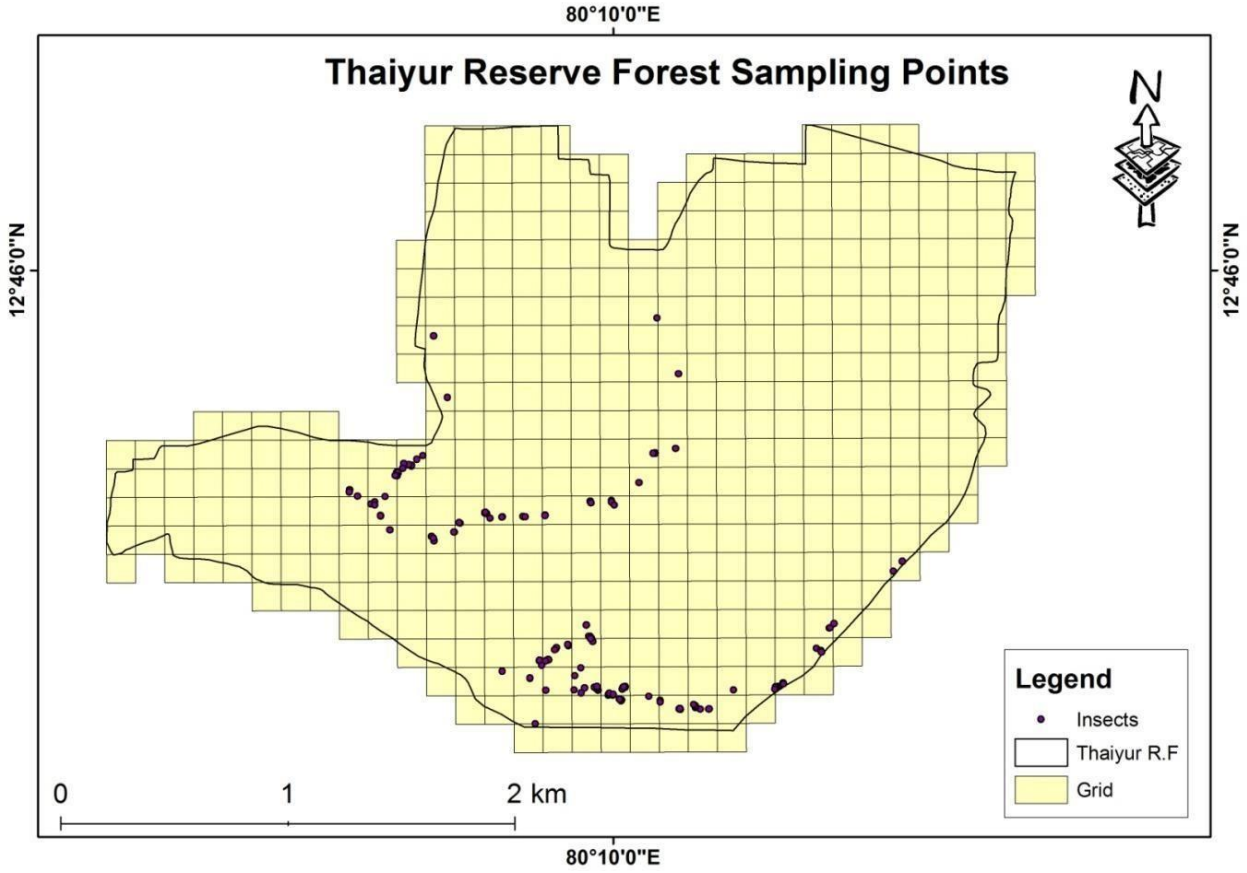
Flowchart describing methodology

4.1. Study Area



Map 1: Study area – Thaiyur Reserve Forest

Thaiyur Reserve Forest is located in the Chengalpattu District of Tamil Nadu. It has a total area of approximately 680 hectares.



Map 2: Butterfly species sited points in Thaiyur Reserve Forest

Survey was carried out for two days at two different paths inside the Thaiyur RF. The points on the Western side of the map was the first day line transact mapping and the points on the South-east side of the map are the points taken from the second survey. Further habitat type on the two places are described clearly in the below indices.

Table 5.2 List of other insects documented in the Thaiyur Reserve Forest

SNO	COMMON NAME	SCIENTIFIC NAME	COMMON GROUP
1.	Blue Pansy	*Junonia orithya (Linnaeus, 1758)*	Pansies
2.	Yellow Pansy	*Junonia hierta (Fabricius, 1798)*	Pansies
3.	Peacock Pansy	*Junonia almana (Linnaeus, 1758)*	Pansies
4.	Blue Tiger	*Tirumala limniace (Cramer, [1775])*	Brush-footed
5.	Common Tiger	*Danaus chrysippus (Linnaeus, 1758)*	Brush-footed
6.	Striped Tiger	*Danaus genutia (Cramer, [1779])*	Brush-footed
7.	Common Crow	*Euploea core (Cramer, 1780)*	Brush-footed
8.	Tawny Coster	*Acraea terpsicore (Linnaeus, 1758)*	Brush-footed
9.	Joker	*Byblia ilithyia (Drury, 1773)*	Brush-footed
10.	Common Leopard	*Phalanta phalantha (Drury, 1773)*	Brush-footed
11.	Baronet	*Euthalia nais (Forster, 1771)*	Brush-footed
12.	Common Gull	*Cepora nerissa Fabricius, 1775*	Whites and Yellows
13.	Small Salmon Arab	*Colotis amata (Fabricius, 1775)*	Whites and Yellows
14.	Common Psyche	*Leptosia nina (Fabricius, 1793)*	Whites and Yellows
15.	Common Jezebel	*Delias eucharis (Drury, 1773)*	Whites and Yellows
16.	Common Emigrant	*Catopsilia pomona (Fabricius, 1775)*	Whites and Yellows
17.	Mottled Emigrant	*Catopsilia pyranthe (Linnaeus, 1758)*	Whites and Yellows

18.	Common Sailor	*Neptis hylas (Linnaeus, 1758)*	Whites and Yellows
19.	Common Mormon	*Papilio polytes Linnaeus, 1758*	Swallowtails
20.	Crimson Rose	*Pachliopta hector (Linnaeus, 1758)*	Swallowtails
21.	Pioneer	*Belenois aurota (Fabricius, 1793)*	Whites and Yellows
22.	Common Pierrot	*Castalius rosimon (Fabricius, 1775)*	Blues
23.	Banded Pierrot	*Discolampa ethion (Westwood, 1851)*	Blues
24.	Dark Grass Blue	*Zizeeria karsandra (Moore, 1865)*	Blues
25.	Tiny Grass Blue	*Zizula hylax (Fabricius, 1775)*	Blues
26.	Gram Blue	*Euchrysops cnejus (Fabricius 1798)*	Blues
27.	Common Banded Awl	*Hasora chromus (Cramer, 1782)*	Skippers
28.	Common Bush Brown	*Mycalesis perseus (Fabricius, 1775)*	Skippers
29.	Grass Jewel	*Freyeria trochylus (Freyer, 1845)*	Blues
30.	Oriental Grass Jewel	*Freyeria putli (Kollar 1844)*	Blues
31.	Common Grass Yellow	*Eurema hecabe (Linnaeus, 1758)*	Whites and Yellows
32.	Tiny Grass Yellow	*Eurema brigitta (Cramer, 1780)*	Whites and Yellows
33.	Three Spotted Grass Yellow	*Eurema blanda Boisduval, 1836*	Whites and Yellows

Table 5.1: List of Butterfly species from Thaiyur Reserve Forest, Chengalpattu, Tamil Nadu

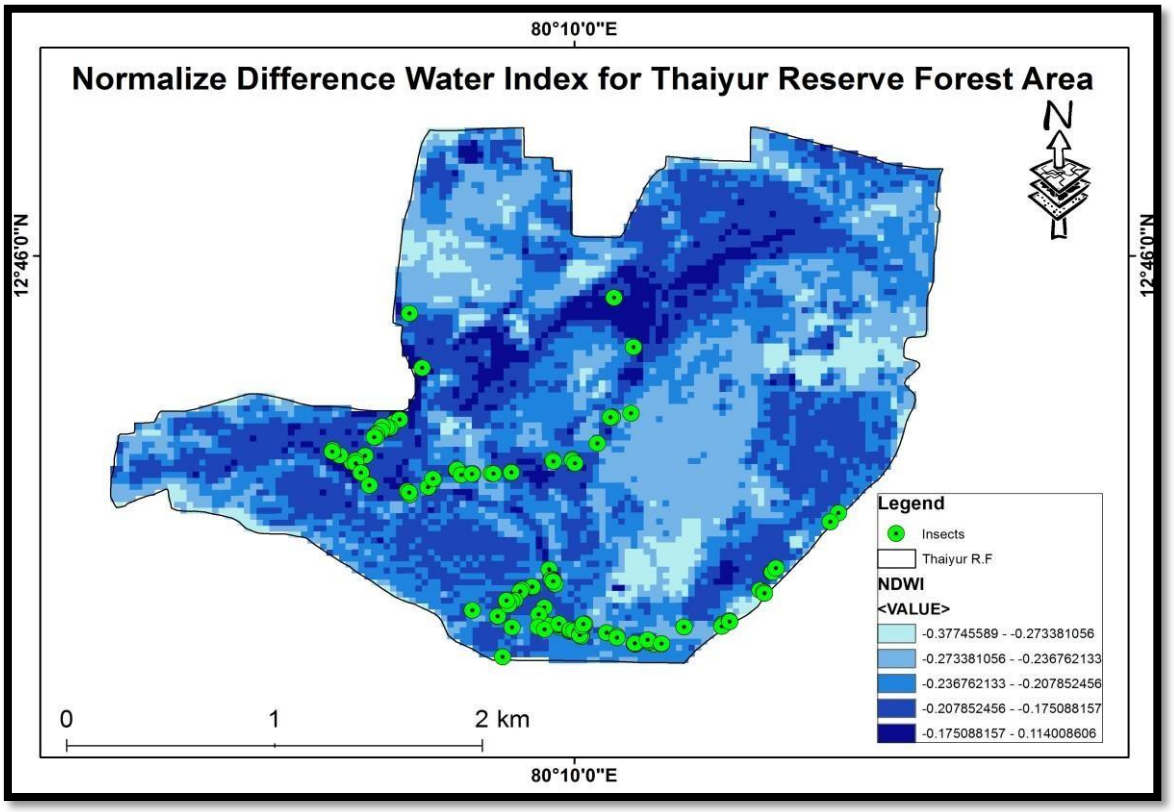
SNO	COMMON NAME	SCIENTIFIC NAME	ORDER	CATEGORY
1.	Common Picture Wing	*Rhyothemis variegata (Linnaeus, 1763)*	Lepidoptera	Dragonfly
2.	Chalky Percher	*Diplacodes trivialis (Rambur, 1842)*	Lepidoptera	Dragonfly
3.	Scarlet Marsh Hawk	*Aethriamanta brevipennis (Rambur, 1842)*	Lepidoptera	Dragonfly
4.	Ditch Jewel	*Brachythemis contaminata (Fabricius, 1793)*	Lepidoptera	Dragonfly
5.	Scarlet Skimmer	*Crocothemis servilia (Drury, 1773)*	Lepidoptera	Dragonfly
6.	Club Tail Dragonfly	*Gomphus vulgatissimus (Linnaeus, 1758)*	Lepidoptera	Dragonfly
7.	Long Legged Marsh Glider	*Trithemis pallidinervis (Kirby, 1889)*	Lepidoptera	Dragonfly
8.	Senegal Golden Darlet	*Ischnura senegalensis (Rambur, 1842)*	Lepidoptera	Damselfly
9.	Coromandel Marsh Dart	*Ceriagrion coromandelianum (Fabricius, 1798)*	Lepidoptera	Damselfly
10.	Little Blue Dartlet	*Amphiallagma parvum (Selys, 1876)*	Lepidoptera	Damselfly
11.	Saffron Faced Dartlet	*Pseudagrion rubriceps Selys, 1876*	Lepidoptera	
12.	Crimson Speckled Moth	*Utetheisa pulchella (Linnaeus, 1758)*	Lepidoptera	Moth
13.	Bagworm Moth	*Psychidae spp.*	Lepidoptera	Moth
14.	Carpenter Ants	*Camponotus spp.*	Hymenoptera	Ants
15.	Weaver ants	*Oecophylla spp.*	Hymenoptera	Ants
16.	Plant Hopper	Unknown	Hemiptera	Hoppers
17.	Praying Mantis	Unknown	Mantodea	Mantis
18.	Stick Insect	Unknown	Phasmatodea	Phasmids
19.	Funnel-webbed Spider	Unknown	Araneae	Arachnids

Totally fifty-two insect species were record in two days line transect walk. Among fifty-six species, butterfly species - 33 were abundant than Dragon fly -07, Damselfly – 04, Moth – 02 and other species – 06. List of butterfly species were given in table 5.1. Hence check habitat preference for butterfly species.

All these species sited were taken for the Indices Analysis to find out the habitat preference of high abundant butterfly species.

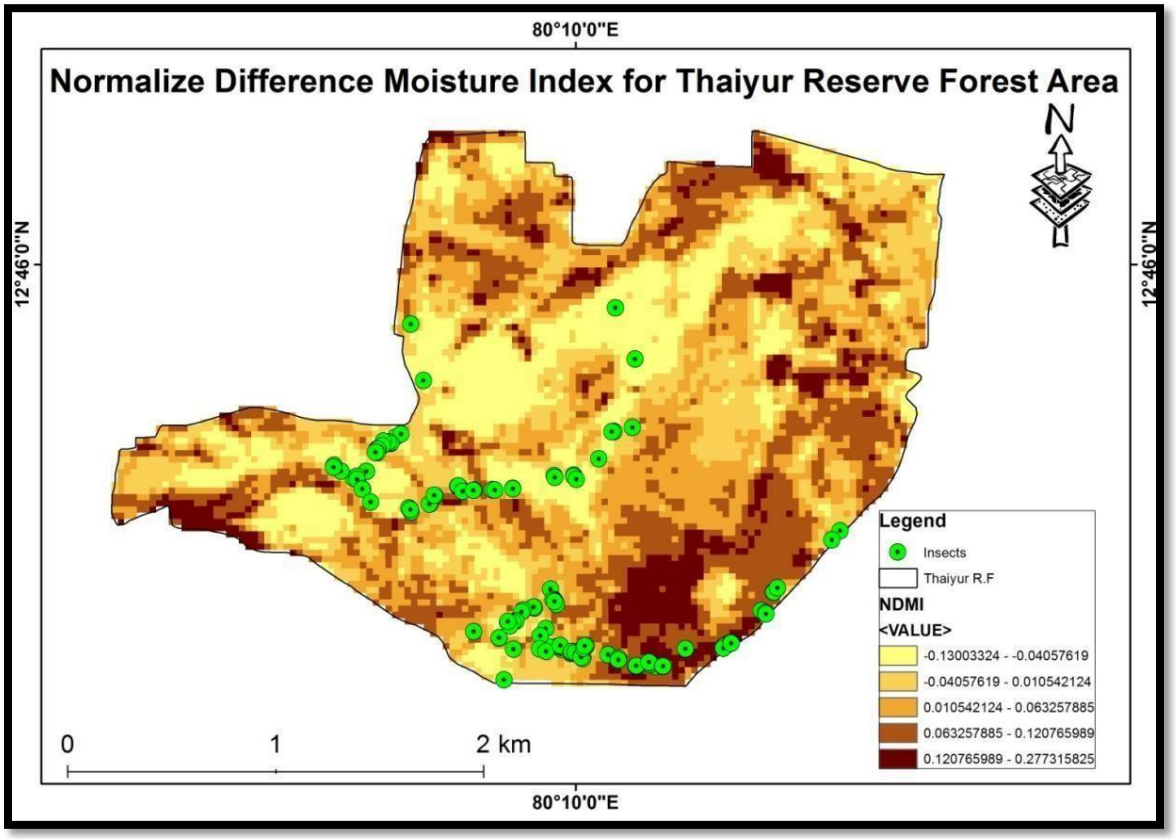
5.1 Normalize Difference Water Index (NDWI) for butterfly species in Thaiyur Reserve Forest.

NDWI analysis shows that the butterfly species chose nearby water areas in two days sittings. The maximum water index was 0.11 and the minimum was -0.377.



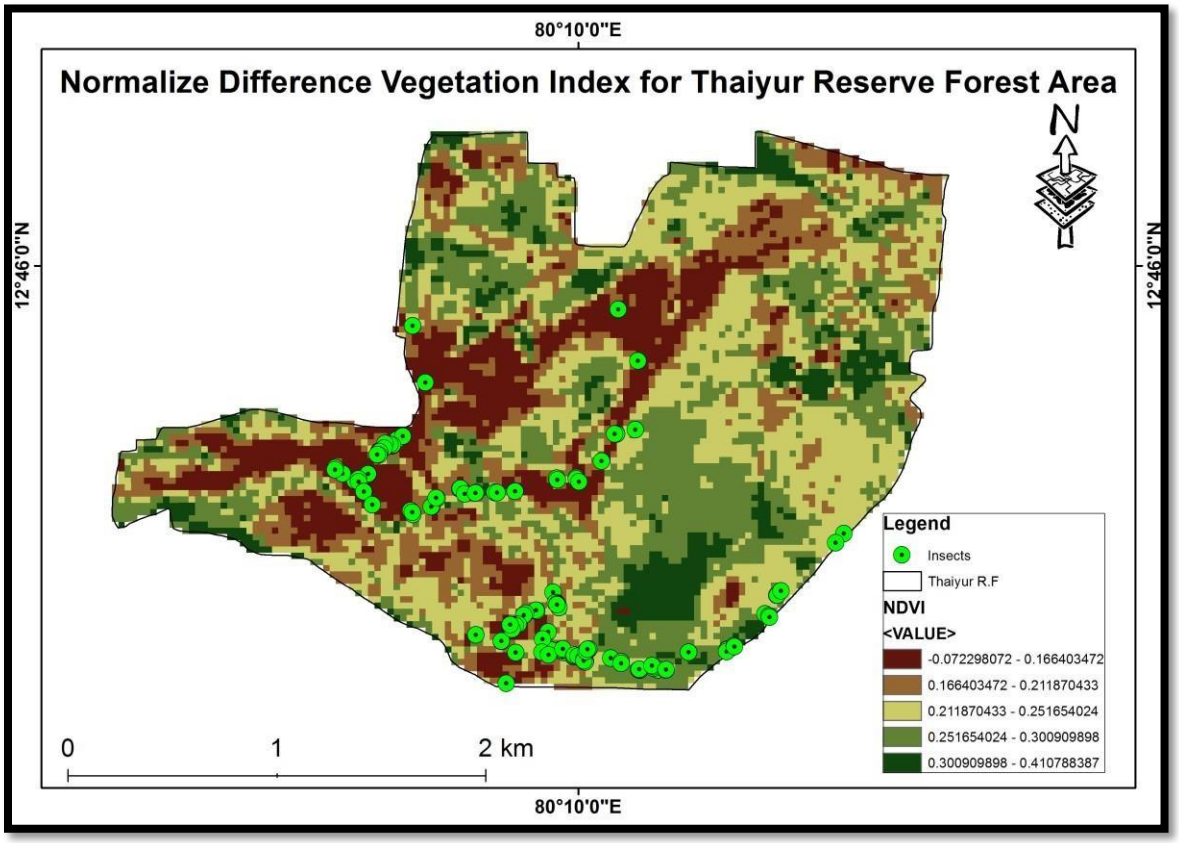
5.2 Normalize Difference Moisture Index (NDMI) for butterfly species in Thaiyur Reserve Forest.

NDMI analysis shows that the some of the butterfly species such as Plain Tiger (*Danaus genutia*), Stripped Tiger (*Danaus genutia*) and Common Leopard (*Phalanta phalantha*) prefer also less moisture areas.



5.3 Normalize Difference Vegetation Index (NDVI) for butterfly species in Thaiyur Reserve Forest.

Surprisingly NDVI analysis shows that butterfly and moth species such as Crimson speckled moth (*Utetheisa pulchella*), Common Pierrot (*Castalius rosimon*) and Common Bush Brown (*Mycalesis perseus*) prefers dry areas than high vegetation areas.



INFERENCE

Butterfly distribution were noted in the area where the *Striga* species and *Desmodium triflorum* both the plant species were distributed.

All these findings shows that these two days sited not able to confirm the habitat preference of particular species even though, we can say butterflies randomly distributed. Butterflies use plants for larval food and adult nectar sources in riparian ecosystems, butterfly diversity can be utilized to evaluate riparian ecosystems (Anu and Choi, 2021). Moreover, Environmental factors such as season, temperature, Moisture, plant species and species breading season also plays a role in habitat preference (Rajagopal et al., 2011; Shobana et al., 2012; Dhivyasree, & Lekeshmanaswamy, 2020). Some of the previous studies from different habitat also supporting our current study (Kalaivani and Gunasekaran 2017; Suhirtha Muhil & P. Pramod 2019). Hence need a long-term monitoring study to confirm the particular species habitat preference.

REFERENCE

1. An, J. S., & Choi, S. W. (2021). Butterflies as an indicator group of riparian ecosystem assessment. Journal of Asia-Pacific Entomology, 24(1), 195-200.

2. Capinera, John L. (2008). "Butterflies and moths". Encyclopedia of Entomology. Vol. 4 (2nd ed.). Springer. pp. 626–672. ISBN 9781402062421. Archived from the original on 24 June 2016. Retrieved 22 September 2016.

3. Dhivyasree, V., & Lekeshmanaswamy, M. (2020). ELEVATIONAL SURVEY AND DIVERSITY OF BUTTERFLY SPECIES IN KALLAR REGION, COIMBATORE, TAMIL NADU, INDIA. Journal of Advanced Scientific Research, 11(01), 198-201.

4. Grimaldi, D., Engel, M. S., Engel, M. S., & Engel, M. S. (2005). Evolution of the Insects. Cambridge University Press.

5. Kalaivani, P., & Gunasekaran, C. (2017). Studies on the Diversity of Butterfly fauna in and around Kotlli Hills, Namakkkal district, Tamilnadu. International Journal of Advanced Research in Biological Science, 4(12), 45-50.

6. Kumar, P., S. Ramarajan and A.G. Murugesan (2014). Butterflies of Pillavakkal Dam of Giant Grizzled Squirrel Wildlife Sanctuary, Srivilliputtur Tamil Nadu India. World Journal of Zoology 9 (1): 46-51.

7. Kushal Choudhury (2020) Butterflies of Guma Reserve Forest of Western Assam, India. International Journal of Advanced Research in Biological Sciences.7(12).

8. Madhav Nagarajan Vikas (2020) A preliminary checklist of butterflies from Adukkam forest in Dindigul district, Tamil Nadu, India Journal of Entomology and Zoology Studies. 8(4): 632-637.

9. Muhil, M. S., & Pramod, P. (2017). Odonates of Coimbatore District, Tamil Nadu, India. Journal of Threatened Taxa, 9(2), 9814-9828.

10. Priya, T. M. (2004) Solid waste a case study of chennai.

11. Rajagopal, T., Sekar, M., Manimozhi, A., Baskar, N., & Archunan, G. (2011). Diversity and community structure of butterfly of Arignar Anna Zoological Park, Chennai, Tamil Nadu. Journal of Environmental Biology, 32(2), 201-207.

12. Wadatkar, J. Biodiversity and Habitat Associations of Butterflies in Satpuda.

13. https://timesofindia.indiatimes.com/city/chennai/proposal-to-declared-3-reserveforestsas-blackbucksanctuaries/articleshow/61166913.cms?utm_source=contentofinterest&amp&utm_medium=text&utm_campaign=cppst

14. https://www.forests.tn.gov.in/pages/view/Introduction-wild

15. https://wii.gov.in/campa_gis

Spatial Distribution of Invasive Vs Native Species at Thaiyur Forest

Introduction

India is considered as one of the mega diverse country, for its varied habitat type and ecosystem services that it offers. Though geographically India accounts for 2.4% of world area, it hosts nearly 8% of floral and faunal species found in the world (NR6). Forest is the most valuable resource for the existing life on earth. Richness of ecosystem is characterized by diverse habitat or biodiversity, tropical forest is one such ecosystem (Whitmore 1990). By studying the nature of forest and its species, it is likely possible to evaluate the overall health of the particular ecosystem. Forest is been classified based on canopy density as viz., very dense forest, moderately dense forest, open forest, scrub and Non-forest (FRI)

Among the ecosystems of the south-west coast of India are coastal sand dunes, mangroves, estuaries, bays, islands, freshwater marshes, sacred groves, scrub jungles, and plantations. In India's south-west coast, small to medium sized mountain ranges are accompanied by lateritic scrub jungles caused by wind erosion during the south-west monsoon season. Large tracts of these jungles are used to harvest leaf litter, green manure, and firewood. Hilly escarpments support scrub jungles that can be used for developing plantations (e.g., Areca, Anacardium, Cacao, Casuarina, Cocos, Hevea). Depending on the quality of the laterite, scrub jungles are converted into quarries. The sparseness of species in scrub jungle is the favourable condition for invasive species to compete with native vegetation (Greeshma 2016).

A species that invades an ecosystem can alter the functioning of both the land and aquatic ecosystems (Asner J.P 2008). Currently, invasive plants are known to have significant impacts on native communities, as they cause their displacement, resulting in a degradation

of the natural ecosystem(Pimentel, D., S. McNair, J. Janecka, et al. 2001). Consequently, monocultures of invasive plants develop in the alien environment due to this imbalance (Kohli, R. K., 2004). In the colonized territories between the 15th and 19th centuries, the European powers introduced a large number of alien species for food, fodder, energy and ornamentation. (Pyšek 2008 and Malik 2012). Various factors account for the success of these species in the alien and new environment, including accidental invasion as well as deliberate introductions of some species on purpose (Kohli, R. K., 2004). The introduction of a new species does not necessarily make it invasive in its new environment. Specifically, an introduced species is considered invasive when it spreads rapidly across landscapes with or without aid from humans or natural disturbances (e.g., fire, deforestation, hurricanes) (Asner J.P 2008). Invasive species are non native organisms (disease-causing pathogens, parasites, plants, animals) that begin to spread or expand their range from their origin sites and have the potential to damage the environment, the economy, or human health.

Invasive species can

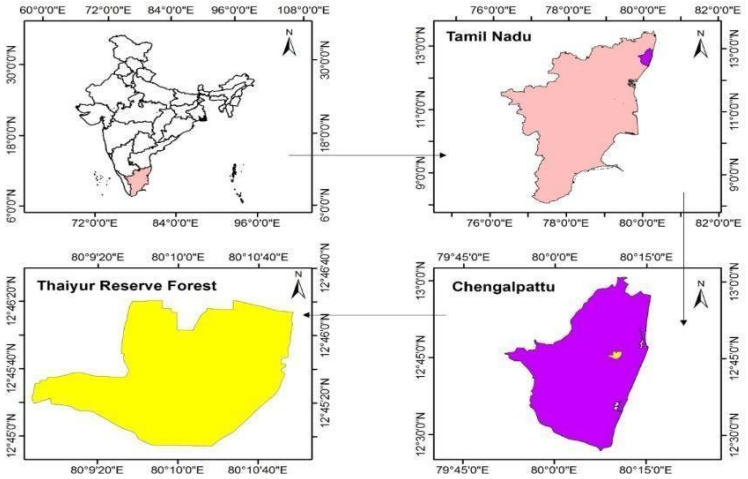
- reduce soil productivity
- impact water quality and quantity
- degrade range resources and wildlife habitat
- threaten biodiversity
- alter natural fire regimes
- Introduce diseases

Invasive species eradication is a costly procedure and even when it’s eradicated, the spread of it is uncontrollable. Tropical Forests, Montane Subtropical Forests and Montane Temperate Forests are the major forest types in Tamilnadu. According to the moisture anD physiogenomic variation, nine sub types are being categorized as Tropical wet evergreen,

Tropical semi evergreen, Tropical moist deciduous, Littoral and swamp, Tropical dry deciduous, Tropical thorn, Tropical dry evergreen, Sub- tropical broad leaved hill and montane wet temperate (https://www.forests.tn.gov.in/). The major landscape of Chennai and its surrounding sub-urbans, are typically tropical dry deciduous forest which are under the canopy characterization are placed under thorn scrub forest. The present study was carried in scrub jungle in chengalpattu district. level (Andersen et al. 2004; Leung et al. 2005).

For the generation of effective ecological conservation policies, the development of management and control efforts, and to study the dynamics of ecosystem, information about the distribution of exotic plant population is essential (Bradley and Mustard 2006). With the help of Remote Sensing , distribution of plant species can be detected.

Study Area



The Thaiyur R. F. village is located in Chengalpattu taluka of Kancheepuram in Tamil Nadu, India. The census code of this vill is 629551. The total geographical area of Thaiyur R. F. village is 386.35 Hectares / 3.86 KM^2. The nearest police station is located in Chengalpattu tahsil.

Need for the study

Thaiyur forest is one of the most significant open shrub forest. There was no proper scientific study on this forest before. An attempt to study on the spectral values of two native species (Phoenix pusilla Roxb; Pandanus odaratissimus Kewda) and four invasive species (Acacia holosericea A.Cunn. ex G. Don; Casuarina equisetifolia L.; Prosopis juliflora (Sw.) DC.; Acacia auriculiformis) is carried out to know the spatial distribution of invasive Vs Native at the Thaiyur Forest.

Review of Literature

- Invasive Species in Forests and Rangelands of the United States: A Comprehensive Science Synthesis for the United States Forest Sector; Author(s): Therese M. Poland, Toral Patel-Weynand ,Deborah M. Finch, Chelcy Ford Miniat, Deborah C. Hayes, Vanessa M. Lopez; This open access book describes the serious threat of invasive species to native ecosystems. Invasive species have caused and will continue to cause enormous ecological and economic damage with ever increasing world trade. This multi-disciplinary book, written by over 100 national experts, presents the latest research on a wide range of natural science and social science fields that explore the ecology, impacts, and practical tools for management of invasive species. It covers species of all taxonomic groups from insects and pathogens, to plants, vertebrates, and aquatic organisms that impact a diversity of habitats in forests, rangelands and grasslands of the United States. It is well-illustrated, provides summaries of the most important invasive species and issues impacting all regions of the country, and includes a comprehensive primary reference list for each topic. This scientific synthesis provides the cultural, economic, scientific and social context for addressing

environmental challenges posed by invasive species and will be a valuable resource for scholars, policy makers, natural resource managers and practitioners.

- The evolutionary impact of invasive species; Author(s):H. A. Mooney and E. E. Cleland; Since the Age of Exploration began, there has been a drastic breaching of biogeographic barriers that previously had isolated the continental biotas for millions of years. We explore the nature of these recent biotic exchanges and their consequences on evolutionary processes. The direct evidence of evolutionary consequences of the biotic rearrangements is of variable quality, but the results of trajectories are becoming clear as the number of studies increases. There are examples of invasive species altering the evolutionary pathway of native species by competitive exclusion, niche displacement, hybridization, introgression, predation, and ultimately extinction. Invaders themselves evolve in response to their interactions with natives, as well as in response to the new abiotic environment. Flexibility in behavior, and mutualistic interactions, can aid in the success of invaders in their new environment.

- Risk Assessment for Invasive Species; Author(s): Mark C. Andersen,Heather Adams,Bruce Hope,Mark Powell; Although estimates vary, there is a broad agreement that invasive species impose major costs on the U.S. economy, as well as posing risks to nonmarket environmental goods and services and to public health. The domestic effort to manage risks associated with invasive species is coordinated by the National Invasive Species Council (NISC), which is charged with developing a science-based process to evaluate risks associated with the introduction and spread of invasive species. Various international agreements have also elevated invasive species issues onto the international policy agenda. The World Trade Organization (WTO) Sanitary and Phytosanitary (SPS) Agreement establishes rights and obligations to adhere to the discipline of scientific risk assessment to ensure that SPS measures are

applied only to the extent required to protect human, animal, and plant health, and do not constitute arbitrary or unjustifiable technical barriers to trade. Currently, however, the field of risk assessment for invasive species is in its infancy. Therefore, there is a pressing need to formulate scientifically sound methods and approaches in this emerging field, while acknowledging that the demand for situation-specific empirical evidence is likely to persistently outstrip supply. To begin addressing this need, the Society for Risk Analysis Ecological Risk Assessment Specialty Group and the Ecological Society of America Theoretical Ecology Section convened a joint workshop to provide independent scientific input into the formulation of methods and processes for risk assessment of invasive species to ensure that the analytic processes used domestically and internationally will be firmly rooted in sound scientific principles.

- Update on the environmental and economic costs associated with alien-invasive species in the United States; Author(s): David Pimentel Rodolfo Zuniga Doug Morrison; Invading alien species in the United States cause major environmental damages and losses adding up to almost $120 billion per year. There are approximately 50,000 foreign species and the number is increasing. About 42% of the species on the Threatened or Endangered species lists are at risk primarily because of alien-invasive species.

- Five Potential Consequences of Climate Change for Invasive Species; Author(s):Jessica j. Hellmann, james e. Byers, britta g. Bierwagen, jeffrey s. Dukes; Scientific and societal unknowns make it difficult to predict how global environmental changes such as climate change and biological invasions will affect ecological systems. In the long term, these changes may have interacting effects and compound the uncertainty associated with each individual driver. Nonetheless,

invasive species are likely to respond in ways that should be qualitatively predictable, and some of these responses will be distinct from those of native counterparts. We used the stages of invasion known as the “invasion pathway” to identify 5 nonexclusive consequences of climate change for invasive species: (1) altered transport and introduction mechanisms, (2) establishment of new invasive species, (3) altered impact of existing invasive species, (4) altered distribution of existing invasive species, and (5) altered effectiveness of control strategies. We then used these consequences to identify testable hypotheses about the responses of invasive species to climate change and provide suggestions for invasive-species management plans. The 5 consequences also emphasize the need for enhanced environmental monitoring and expanded coordination among entities involved in invasive-species management.

- Assessing the Effects of Climate Change on Aquatic Invasive Species; Author(s): Frank j. Rahel,julian d. Olden; Different components of global environmental change are typically studied and managed independently, although there is a growing recognition that multiple drivers often interact in complex and nonadditive ways. We present a conceptual framework and empirical review of the interactive effects of climate change and invasive species in freshwater ecosystems. Climate change is expected to result in warmer water temperatures, shorter duration of ice cover, altered streamflow patterns, increased salinization, and increased demand for water storage and conveyance structures. These changes will alter the pathways by which non-native species enter aquatic systems by expanding fish-culture facilities and water gardens to new areas and by facilitating the spread of species during floods. Climate change will influence the likelihood of new species becoming established by eliminating cold temperatures or winter hypoxia that currently prevent survival and by increasing the construction of reservoirs that serve as hotspots for invasive species.

Climate change will modify the ecological impacts of invasive species by enhancing their competitive and predatory effects on native species and by increasing the virulence of some diseases. As a result of climate change, new prevention and control strategies such as barrier construction or removal efforts may be needed to control invasive species that currently have only moderate effects or that are limited by seasonally unfavorable conditions. Although most researchers focus on how climate change will increase the number and severity of invasions, some invasive coldwater species may be unable to persist under the new climate conditions. Our findings highlight the complex interactions between climate change and invasive species that will influence how aquatic ecosystems and their biota will respond to novel environmental conditions.

- Are Invasive Species The Drivers Or Passengers Of Change In Degraded Ecosystems?; Author(s): Andrew S. MacDougall,Roy Turkington; Few invaded ecosystems are free from habitat loss and disturbance, leading to uncertainty whether dominant invasive species are driving community change or are passengers along for the environmental ride. The “driver” model predicts that invaded communities are highly interactive, with subordinate native species being limited or excluded by competition from the exotic dominants. The “passenger” model predicts that invaded communities are primarily structured by noninteractive factors (environmental change, dispersal limitation) that are less constraining on the exotics, which thus dominate. We tested these alternative hypotheses in an invaded, fragmented, and fire-suppressed oak savanna. We examined the impact of two invasive dominant perennial grasses on community structure using a reduction (mowing of aboveground biomass) and removal (weeding of above- and belowground biomass) experiment conducted at different seasons and soil depths. We examined the relative importance of competition

vs. dispersal limitation with experimental seed additions. Competition by the dominants limits the abundance and reproduction of many native and exotic species based on their increased performance with removals and mowing. The treatments resulted in increased light availability and bare soil; soil moisture and N were unaffected. Although competition was limiting for some, 36 of 79 species did not respond to the treatments or declined in the absence of grass cover. Seed additions revealed that some subordinates are dispersal limited; competition alone was insufficient to explain their rarity even though it does exacerbate dispersal inefficiencies by lowering reproduction. While the net effects of the dominants were negative, their presence restricted woody plants, facilitated seedling survival with moderate disturbance (i.e., treatments applied in the fall), or was not the primary limiting factor for the occurrence of some species. Finally, the species most functionally distinct from the dominants (forbs, woody plants) responded most significantly to the treatments. This suggests that relative abundance is determined more by trade-offs relating to environmental conditions (long-term fire suppression) than to traits relating to resource capture (which should most impact functionally similar species). This points toward the passenger model as the underlying cause of exotic dominance, although their combined effects (suppressive and facilitative) on community structure are substantial.

- Can invasive species facilitate native species? Evidence of how, when, and why these impacts occur; Laura F. Rodriguez; Although the predatory and competitive impacts of biological invasions are well documented, facilitation of native species by non-indigenous species is frequently overlooked. A search through recent ecological literature found that facilitative interactions between invasive and native species occur

in a wide range of habitats, can have cascading effects across trophic levels, can re-structure communities, and can lead to evolutionary changes. These are critical findings that, until now, have been mostly absent from analyses of ecological impacts of biological invasions. Here I present evidence for several mechanisms that exemplify how exotic species can facilitate native species. These mechanisms include habitat modification, trophic subsidy, pollination, competitive release, and predatory release. Habitat modification is the most frequently documented mechanism, reflecting the drastic changes generated by the invasion of functionally novel habitat engineers. Further, I predict that facilitative impacts on native species will be most likely when invasive species provide a limiting resource, increase habitat complexity, functionally replace a native species, or ameliorate predation or competition. Finally, three types of facilitation (novel, substitutive, and indirect) define why exotic species can lead to facilitation of native species. It is evident that understanding biological invasions at the community and ecosystem levels will be more accurate if we integrate facilitative interactions into future ecological research. Since facilitative impacts of biological invasions can occur with native endangered species, and can have wide-ranging impacts, these results also have important implications for management, eradication, and restoration.

Aim, Objective and Methodology

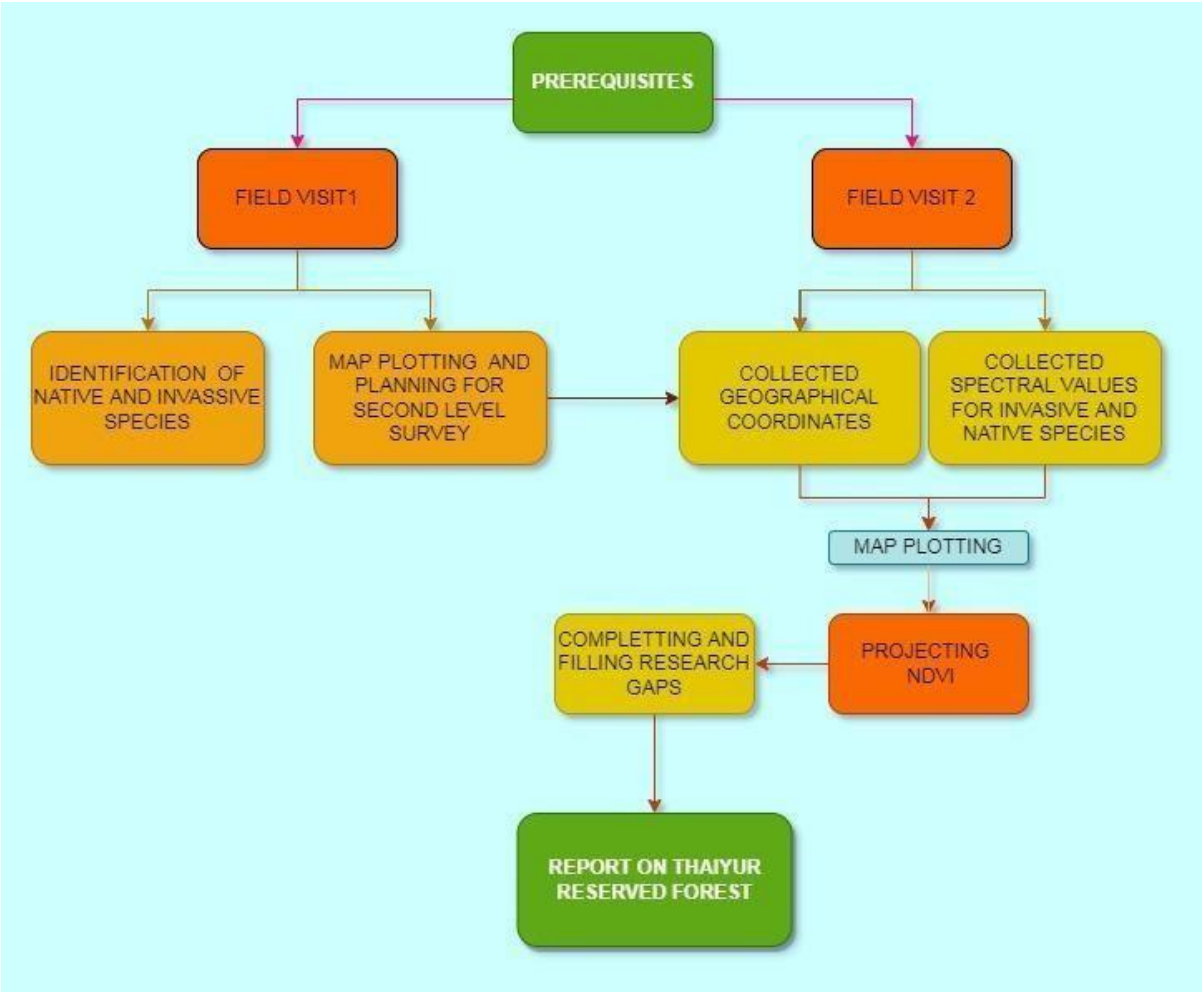
Aim

The main aim of the study is to spatially determine invasive and native species spread at Thaiyur Reserve forest.

Objectives

- To project the variation in spectral values of native and invasive using spectral data obtained from Spectral radiometer readings and Landsat Data separately.
- To identify how invasive is dominant over native species using Geospatial Tools.

Methodology



Results and discussions

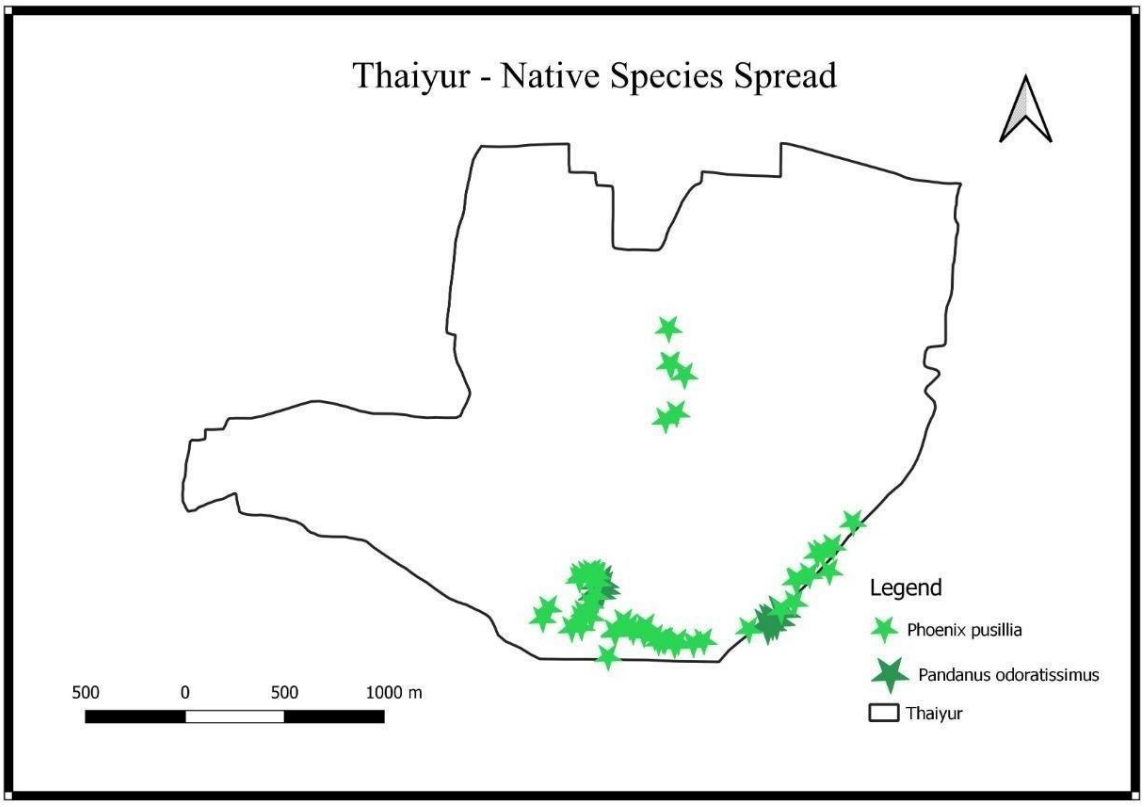
Native Species plotted

***Phoenix pusilla* Roxb.** Tamil name : Eecha maram; Distribution : Southern India and India; Attributes: Drought tolerant and grows slowly

***Pandanus odaratissimus* Kewda.**

Tamil name : Thazham poo; Distribution : Indo-Malaysian coast from India and Srilanka throughout Asia to Taiwan, the Ryukyu Island and Micronesia; Attribute : It grows in tropical climate, where it can withstand drought and strong wind. Mostly found near the banks of waterbed.

Plotted Native Species Spread



Invasive Species

Characteristics of Invasive Alien Species

- Non-indigenous
- Originating from a similar climate
- Abundant in natural range history of invasiveness outside that range
- No natural enemies
- Adaptability and wide distribution in different habitats
- Invasive, competitive, sometimes allelopathic or parasitic
- Rapid reproduction, seed dormancy
- Fast growth and early maturity
- High and efficient dispersal ability

Invasive Plotted

***Acacia holosericea* A.Cunn. ex G. Don**

- Tamil Name- Maan Kaadhu
- Distribution : Found in northern parts of Australia in Western Australia, the Northern Territory and Queensland
- Attributes : fast-growing, short-lived species. Forms communities along watercourses, its allelopathic potential could have implication on agriculture and ecological management.

***Casuarina equisetifolia* L.**

- Tamil Name- Savukku
- Distribution : found in Myanmar, Vietnam and Australia
- Invasive in : Florida, South Africa, India and Brazil.
- Attributes : fast growing species with prolific seeding ability. it may form dense, low biodiversity stands with negative impacts on native flora, fauna, soil character and dynamics.

***Prosopis juliflora* (Sw.) DC.**

- Tamil Name- Seemai karuvelam
- Distribution : Mexico, South America and Caribbean
- Invasive in : Africa, Asia and Australia
- Attributes : A mature plant can produce hundreds of thousands of seeds. Seeds remain viable for up to 10 year. Roots are able to grow to a great depth in search of

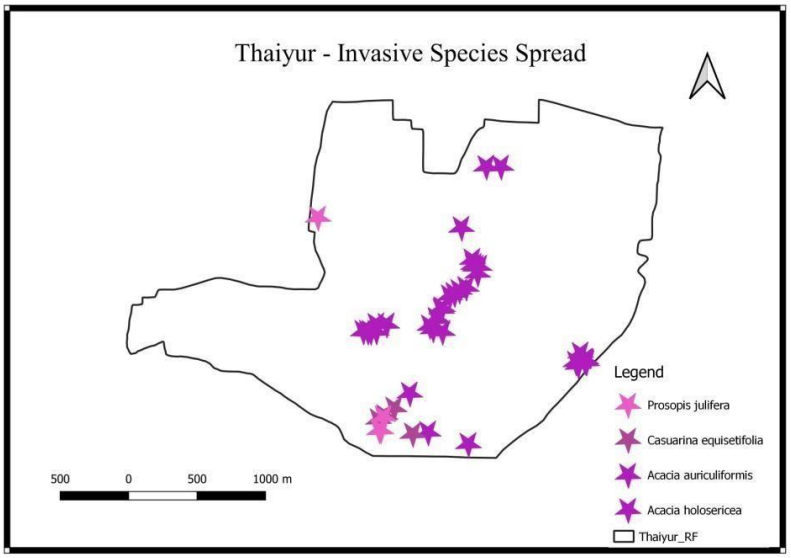
water. It causes land erosion due to the loss of the grasslands that are habitats for native plants and animals.

During the 1960s the state government of Tamil Nadu encouraged the planting of *Prosopis juliflora* to overcome the shortage of firewood faced by the state at the time, it was also grown as a fence to protect agricultural fields from animals.

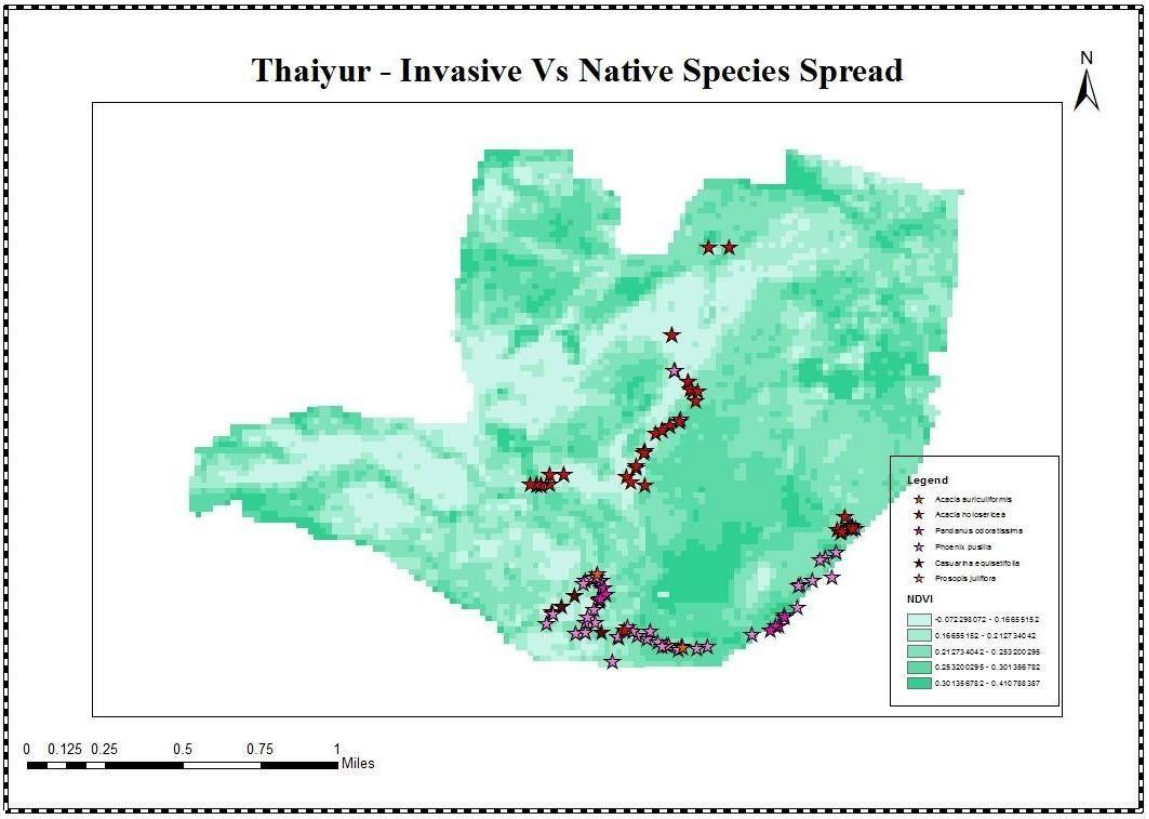
Acacia auriculiformis

- Tamil Name – Karuvealam
- Distribution : SE Asia, Indonesia, Papua New Guinia and Australia.
- Invasive in: Asia (Bangladesh, Singapore), Africa (Comoros, Mayotte, Tanzania), North America (Florida, USA), the Caribbean (Bahamas) and Oceania (Cook Islands, Federated States of Micronesia, Guam)
- Attributes : evergreen tree with compact spread and multi stemmed; its roots are very strong and can break through concrete and driveways, pushing other vegetation.

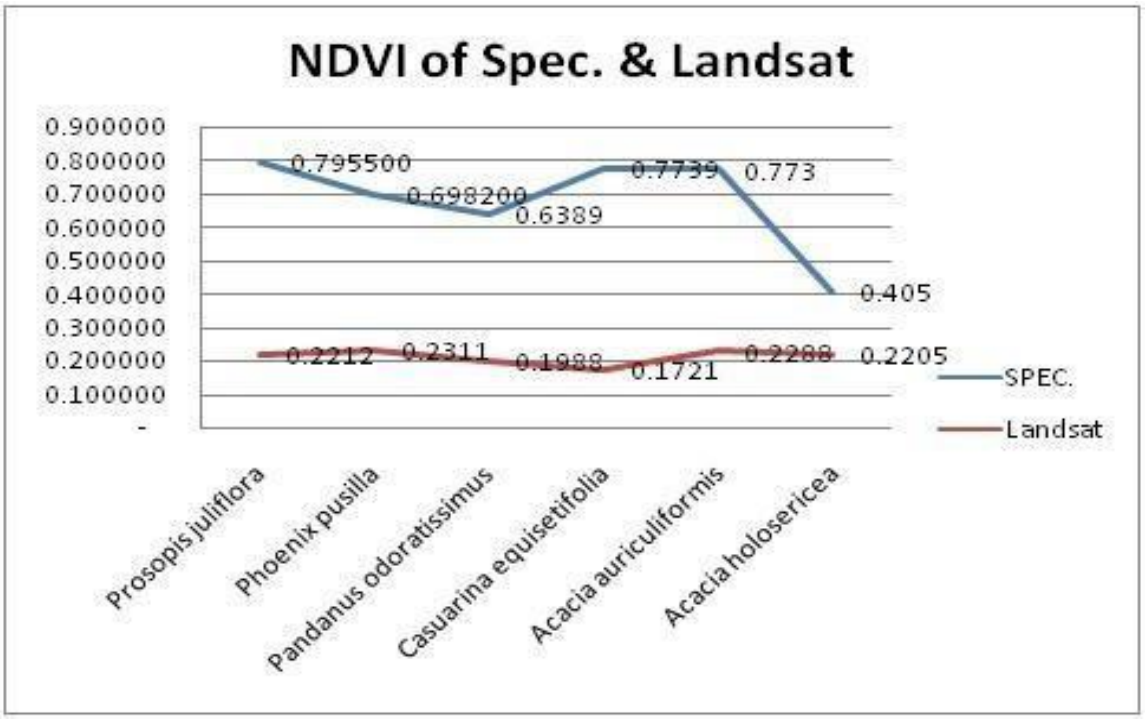
Invasive species spread



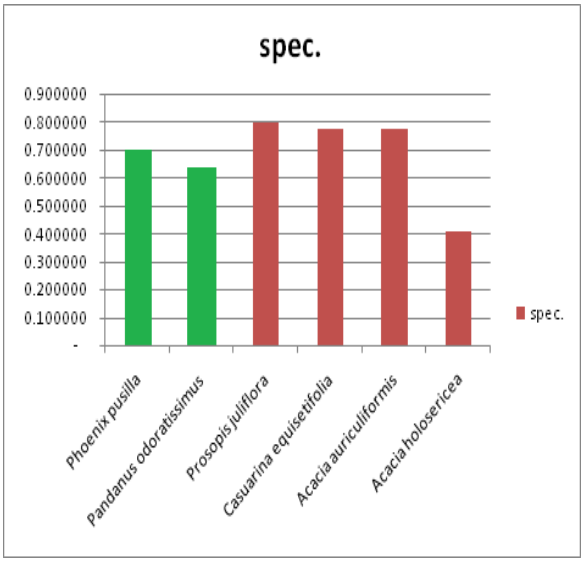
NDVI Map with Invasive Vs Native Spread



NDVI Chart



Spectral Values Vs Landsat 8



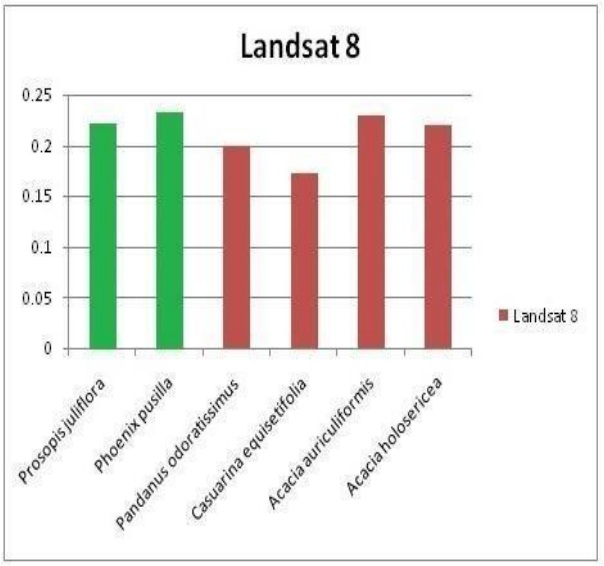
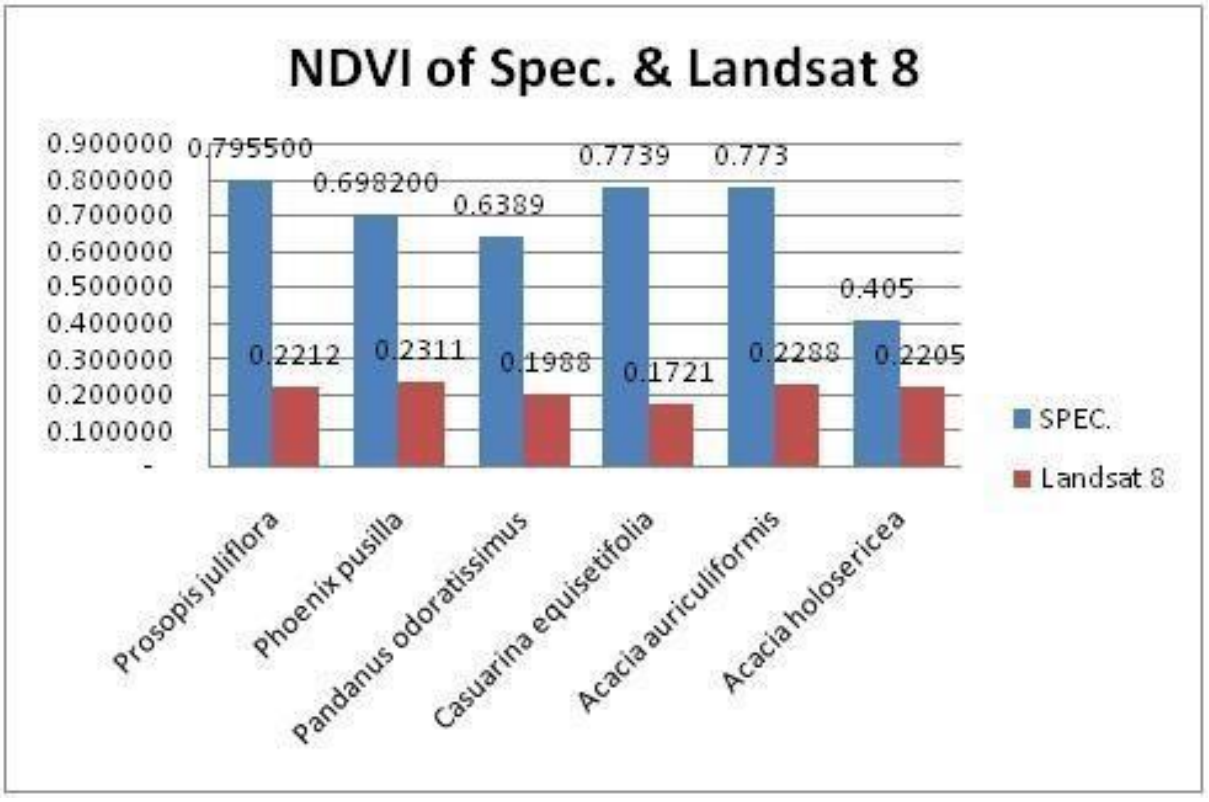


Chart of Native and Invasive NDVI



Findings

- Invasive species are dominating native species.

- Native seems sparse compared with the invasive.
- NDVI values did not match. (Primary datas are centimeter wide and the satellite imagery are meters wide).
- Invasive *Prosophis juliflora, Acacia holosericea* is distributed in sparse areas.
- The spectral values observed using spectroradio meter, shows differences in the NDVI values of Invasive and Native Species.

Solution

1. Proper management for controlling the spread of invasive vegetation.
2. Native species must be planted by proper displacement of invasive species.
3. Constant need for intensive study for further investigation and to manage the existing ecosystem.

Study Recommended

- Requirement of drone mapping and extensive field work (drone mapping alone might not be effective as Forest covers have layers).
- Carbon sequestration capacity of native vs invasive species at Thaiyur Forest would give more accuracy.

Reference

- Narasimmarajan, K., & Thomas, M. (2015). A little-known blackbuck population in Chennai's suburban forests. *Oryx*, *49*(1), 15-15.

- Srinivasulu, C., Srinivasulu, B., & Kaur, H. (2015). The rare Kolar leaf-nosed bat. *Oryx*, *49*(1), 15-16.
- Jiang, Z. (2015). China renews its vertebrate Red List. *Oryx*, *49*(1), 14-15.
- Janani, S., Maheshwaran, E. G., Leenu, J., Samuel, T., & Raveen, R. (2016). Diversity of snakes rescued at Chennai, Tamil Nadu, India. *International Journal of Fauna and Biological Studies*, *3*(5), 81-86.
- Poland, T. M., Patel-Weynand, T., Finch, D. M., Miniat, C. F., Hayes, D. C., & Lopez, V. M. (2021). *Invasive Species in Forests and Rangelands of the United States: A Comprehensive Science Synthesis for the United States Forest Sector* (p. 455). Springer Nature.
- Mooney, H. A., & Cleland, E. E. (2001). The evolutionary impact of invasive species. *Proceedings of the National Academy of Sciences*, *98*(10), 5446-5451.
- Andersen, M. C., Adams, H., Hope, B., & Powell, M. (2004). Risk assessment for invasive species. *Risk Analysis: An International Journal*, *24*(4), 787-793.
- Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological economics*, *52*(3), 273-288.
- Hellmann, J. J., Byers, J. E., Bierwagen, B. G., & Dukes, J. S. (2008). Five potential consequences of climate change for invasive species. *Conservation biology*, *22*(3), 534-543.
- Rahel, F. J., & Olden, J. D. (2008). Assessing the effects of climate change on aquatic invasive species. *Conservation biology*, *22*(3), 521-533.
- MacDougall, A. S., & Turkington, R. (2005). Are invasive species the drivers or passengers of change in degraded ecosystems?. *Ecology*, *86*(1), 42-55.

- Rodriguez, L. F. (2006). Can invasive species facilitate native species? Evidence of how, when, and why these impacts occur. *Biological Invasions*, *8*(4), 927-939.
- Didham, R. K., Tylianakis, J. M., Hutchison, M. A., Ewers, R. M., & Gemmell, N. J. (2005). Are invasive species the drivers of ecological change?. *Trends in ecology & evolution*, *20*(9), 470-474.
- Clarke Murray, C., Gartner, H., Gregr, E. J., Chan, K., Pakhomov, E., & Therriault, T. W. (2014). Spatial distribution of marine invasive species: environmental, demographic and vector drivers. *Diversity and Distributions*, *20*(7), 824-836.

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THE IMPACTS OF GREEN COVER CHANGES IN WILDLIFE DISTRIBUTION, THAIYUR RESERVE FOREST.

Submitted to

Department of Geography, University of Madras and ENVIS HUB, Government of Tamil Nadu.

Submitted by

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Chapter-I

Introduction

Green cover has several advantages for the environment as well as society. Green cover provides a rainwater buffer, purifies the air, reduces the ambient temperature, and encourages biodiversity in that area. Also, Green cover act as a climate-proof construction.

The benefits of the green cover one by one.

- **Provides a rainwater buffer: -**

The green cover areas absorb rainwater. This delays the discharge of rainwater to the sewage system, purifies the rainwater, and water also evaporates through the plants. So, this all helps to stabilize the groundwater level, reduces the peak load on the sewage system and reduces the risk of flooding.

- **Reduces the ambient temperature: -**

Plants in the green cover absorb sunlight, 50% is absorbed and 30% reflected; so, this helps to create a cooler and more pleasant climate through a 3°C temperature reduction in the city.

- **Purifies the air: -**

Plants filter particulate matter from the air and convert CO2 into oxygen. The major help from the green cover is contributing to air purification.

- **Increases biodiversity: -**

The green cover provides a habitat for birds, butterflies and insects, and Wild Life Habitats.

- **Offers healing environment:-**

Greenery encourages faster recovery for patients, resulting in a shorter hospital stay. Greenery offers relaxation and reduces stress.

- **Erosion protection**

o On embankments, pre-cultivated plant mats and vegetation blankets ensure that the soil does not get washed away by the rain. It offers a solid, anti-erosion layer.

- **Reduction of green cover means higher urban temperatures: -**

Modelling studies for urban temperatures over the next 70 years project that in urban areas where the green cover is reduced by 10 %, urban temperatures could increase by 8.2 °C above current levels.

- **Trees help tackle climate change**: -

Over one year a mature tree will take up about 22 kilograms of carbon dioxide from the atmosphere, and in exchange release oxygen. Each year, 1.3 million trees are estimated to remove more than 2500 tonnes of pollutants from the air.

In the present days lot of green cover is removed for the human needs, this is the one of the reasons for the temperature increasing and no perfect seasonal rainfall and food chain imbalance.

o For example, one of the biggest forests in the world AMEZON (lungs of USA) vast untamed wilderness is under increasing threat from huge-scale farming and ranching, infrastructure and urban development, unsustainable logging, mining and climate change.

Components of Wildlife Habitat

1. Food.
2. Cover.
3. Water.
4. Space.

1. **Food**:-

All living organisms require food for nutrients to live, grow, and reproduce. A key component of food is energy. The series of transfers of food energy from one organism to another is a biotic pyramid. The internal process by which an organism receives energy from food is metabolism.

2. **Cover**: -

Cover is needed for most wildlife species and is sometimes referred to as "shelter." Cover is providing safety in a habitat. Animals use cover for nesting, the vegetation or other material that resting, and protecting the pack, herd, etc. from predators and adverse weather.

3. **Water**: -

Water is the basic need of life. Water's chemical structure is H2O. With terrestrial habitats, water determines what species of plants will grow. The plants impact which animals live in the habitat. In aquatic habitats, there can be damaging pollutants (e.g., siltation, sewage, and other pollutants). Some wildlife animal species receive most of their water through the food they consume, but many need a watering area for drinking once or twice a day.

4. **Space**: -

Space provides air, food, and cover for wildlife species; it is the area around an organism. Space requirements vary with season, animal, and habitat quality. The space an animal normally uses for living is home range. It is where the animal obtains food, water, and cover. Within a home range, an animal may establish a territory—an area smaller than the home range. For example, squirrels may only travel a few feet around their den in a tree to acquire food.

Habitat management influences the diversity of species attracted to the area. Most habitats are managed for a featured species or for species richness.

Featured Species

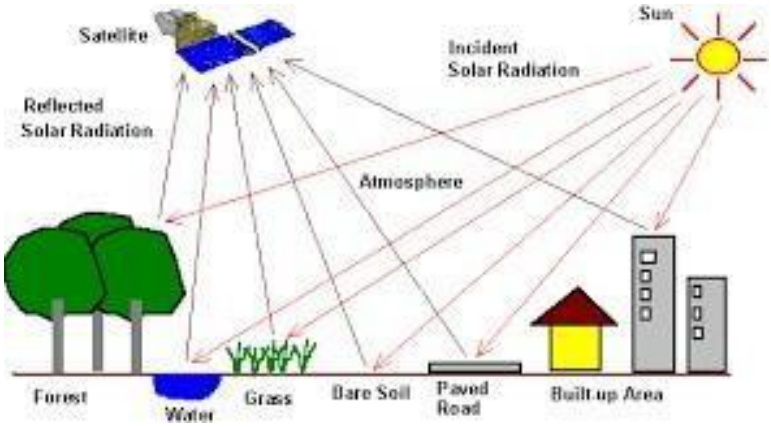
The first basic goal of wildlife habitat management is to provide a habitat for a specific wildlife species. A featured species is an animal type that will be promoted through an improved habitat. For instance, the needs in shortest supply (e.g., water, food, or cover) are provided. In selecting habitat management practices, the effects of practices on species other than the featured species must be studied.

Species Richness

The second basic goal of wildlife habitat management is to provide habitats for different wildlife species. Species richness is the number of different species found within an area. The following are part of the wildlife management plan to promote species richness: a mixture of successional stages is present; unbroken block sizes are of 10 to 40 acres; the edges have high contrast; and a wide variety of vegetation layers is present within each area containing only one successional stage. Providing some habitat for as many species as possible promotes species richness.

Remote Sensing and GIS :-

Remote sensing is the science and art of obtaining information about an object, area (or) phenomenon through an analysis of the data acquired by a device which is not in contact with the object, area or phenomenon under investigator. In Remote Sensing of earth's environment comprise measuring and recording of electromagnetic energy reflected from (or) emitted by the planet's surface & atmosphere from a vantage point above the surface.



Source: Google Images.

- Remote sensing and Geographic Information System play a pivotal role in environmental mapping, mineral exploration, agriculture, forestry, geology, water, ocean, infrastructure planning and management, disaster mitigation and management etc.
- Remote Sensing and GIS has grown as a major tool for collecting information on almost every aspect on the earth for last few decades. In the recent years, very high spatial and spectral resolution satellite data are available and the applications have multiplied with respect to various purpose.
- Remote sensing and GIS have contributed significantly towards developmental activities for the four decades in India. Remote Sensing and GIS has grown as a major tool for collecting information on almost every aspect on the earth for last few decades.
- In the recent years, very high spatial and spectral resolution satellite data are available and the applications have multiplied with respect to various purpose.
- In green cover mapping this technology is used. The changes in the green cover very well identified by some indices like NDVI, NDWI, EVI, SAVI etc. These indices calculated for the years of 2017, 2022.

Chapter-II

Review Of Literature

Land use changes is a significant threat to biodiversity and can arise due to urbanization, agricultural intensification and expansion, migration to forest areas, infrastructure development, intensive harvesting of forest products and others (**Lambin and Meyfroidt, 2010**). Forest destruction went hand in hand with forest degradation and fragmentation (**Davidar et al., 2010**). **Singh (1989)** Described Land use/land cover change detection process of identifies the differences in the state of an object or phenomenon by observing it at different times. Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

Pearson, S.M. (2002) made a detailed study on ecosystem management for understanding the impact of landscape level changes on biological diversity. All over the world the landscape is undergoing change due to several direct impacts of human activity and it is influenced by several reasons. Land use alters the abundance of natural vegetation and introduces new land cover types to increase species richness. Invasive species are introduced and replace the native vegetation. The study witnessed that in the changing landscape, describing the pattern of species distribution and its abundance is a challenging task. The spatial pattern of the habitat are described in terms of patch, connected, fragmented, edge and edge effects. Habitat is the site with features required by the species in which habitat patch is the cluster of the contiguous region of the same cover or habitat type. The author explained that the distribution of the large number of dominated large patches in the landscape is termed as connected landscape. The landscape which consists of a large number of small patches was termed as fragmented landscape. Finally the study concluded that the response by the species for the habitat fragmentation differs from species to species.

WWF (2006), Human-wildlife conflict is a universal problem and it vary according to geography, land use patterns, human behavior, and the habitat and behavior of wildlife species or individual animals within the species. The nature of HWC in buffer zone area and corridors of the Terai Arc is both historical and recent. What seems inevitable is that human wildlife conflicts incidences will continue to occur in the present context of wildlife habitat instability and growing human population's activity in and around the park and reserves.

S. Senthil Kumar(2013), Remote sensing and Geographic Information System play a pivotal role in environmental mapping, mineral exploration, agriculture, forestry, geology, water, ocean, infrastructure planning and management, disaster mitigation and management etc. Remote Sensing and GIS has grown as a major tool for collecting information on almost every aspect on the earth for last few decades.

Chapter-III

AIM:-

To study and determine the Green cover changes on wildlife displacement in Thaiyur Reserve Forest**.**

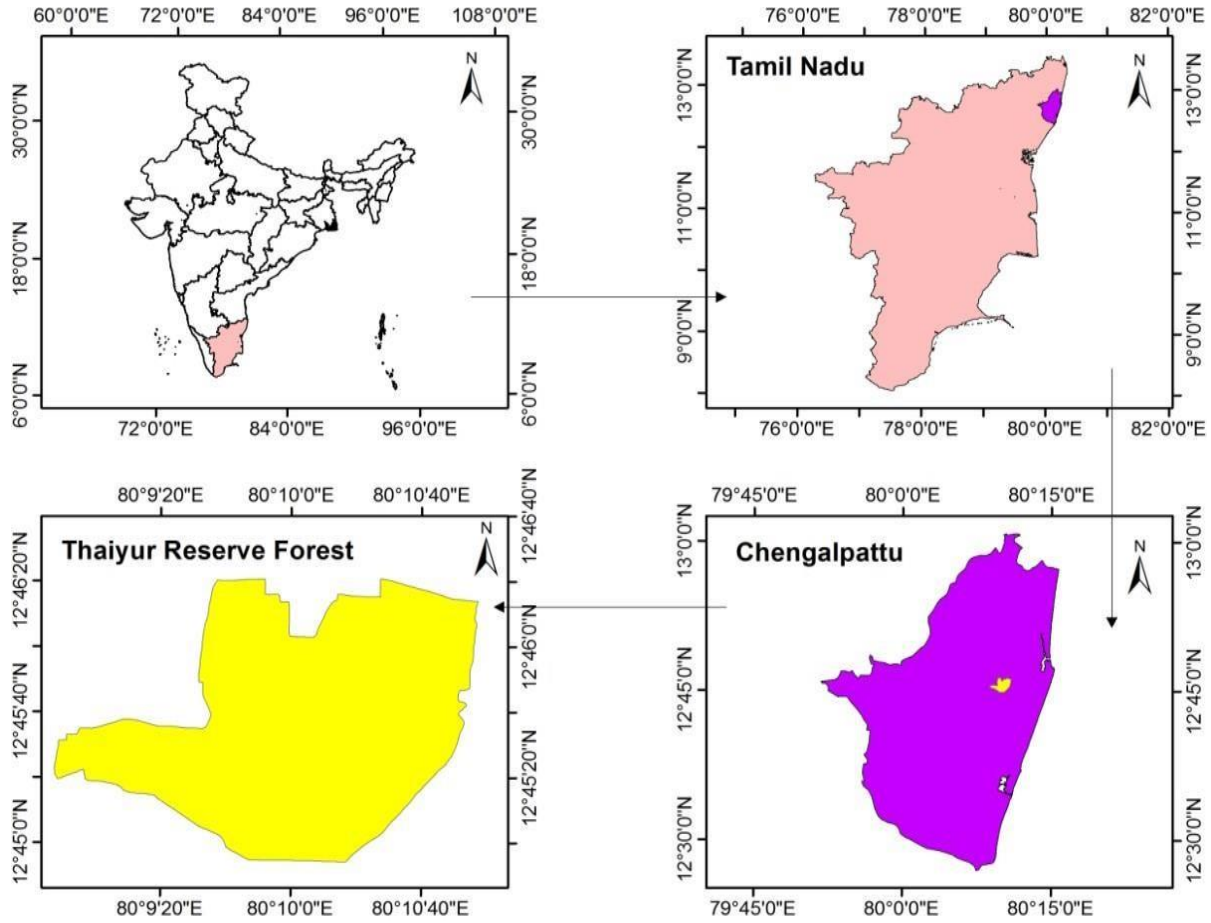
Objectives: -

1. By using sentenial-2 imageries of two different time period 2017 and 2022, study the variability of different indices like EVI, NDVI, NDWI, and SAVI time period between 2017 – 2022.
2. To find the reason for the change in the different indices.
3. Its impact on the wild life in the Thaiyur Reserve Forest.

Study Area: -

Thaiyur is a Village in Thiruporur Block in Kanchipuram District of Tamil Nadu State, India. It is located 61 KM towards East from District headquarters Kanchipuram. 2 KM from Thiruporur, 43 KM from State capital Chennai. Elevation / Altitude: 36 meters above sea level. It is near to bay of bengal. There is a chance of humidity in the weather. Elevation / Altitude: 36 meters above sea level. It is near to Bay of Bengal. There is a chance of humidity in the weather.

Location Map:



Climate of the Study Area

The climate of the Thaiyur Reserve Forest area is tropical monsoon type. The temperature during winter seldom goes below 18°C while in peak summer it rises to 43°C. This region receives rains from both the northeast and southwest monsoons. Maximum rainfall and occasional cyclones occur during the northeast monsoon.

Materials and Methodology: -

In this study Utilized softwares,

1. Arc GIS.

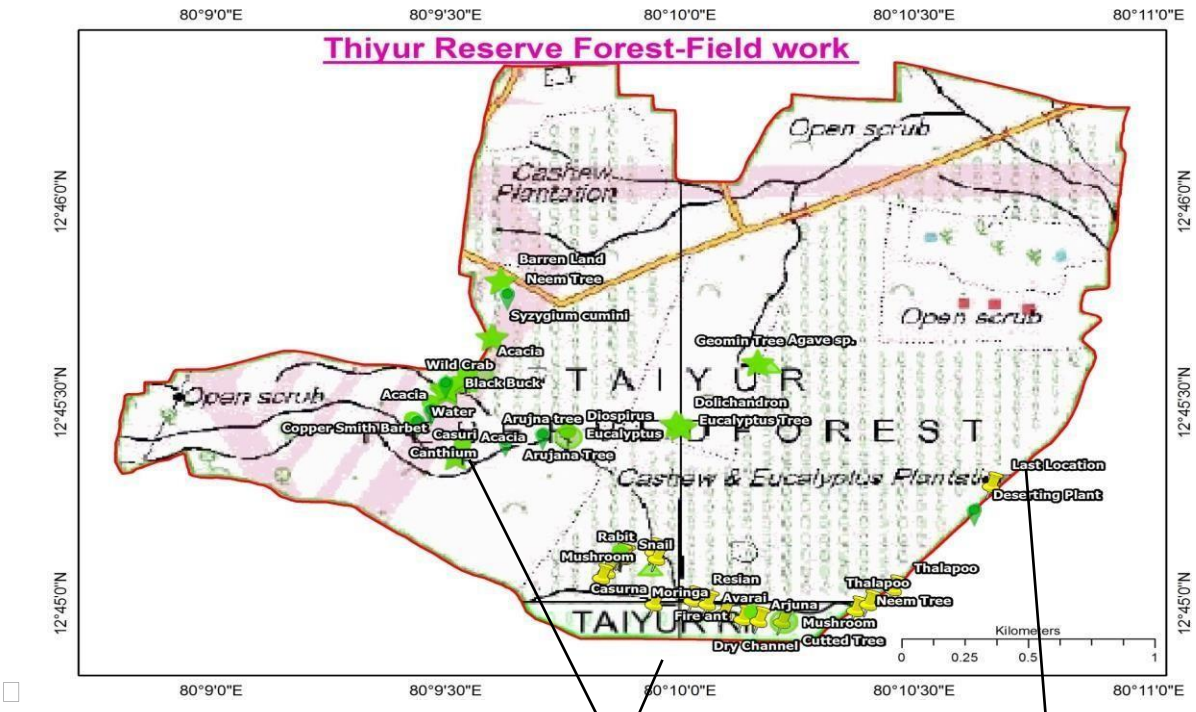
2. Q GIS.

3. ERADAS.

4. Google Earth Pro.

Data Collected from:

- SENTENIAL 2 IMAGERIES FROM USGS EARTH EXPLORER.
- TOPOSHEET FROM SURVEY OF INDIA.
- WAY POINTS COLLECTED FROM THE FIELD WORK.



Field Work Waypoints

SOI Toposheet clip study area

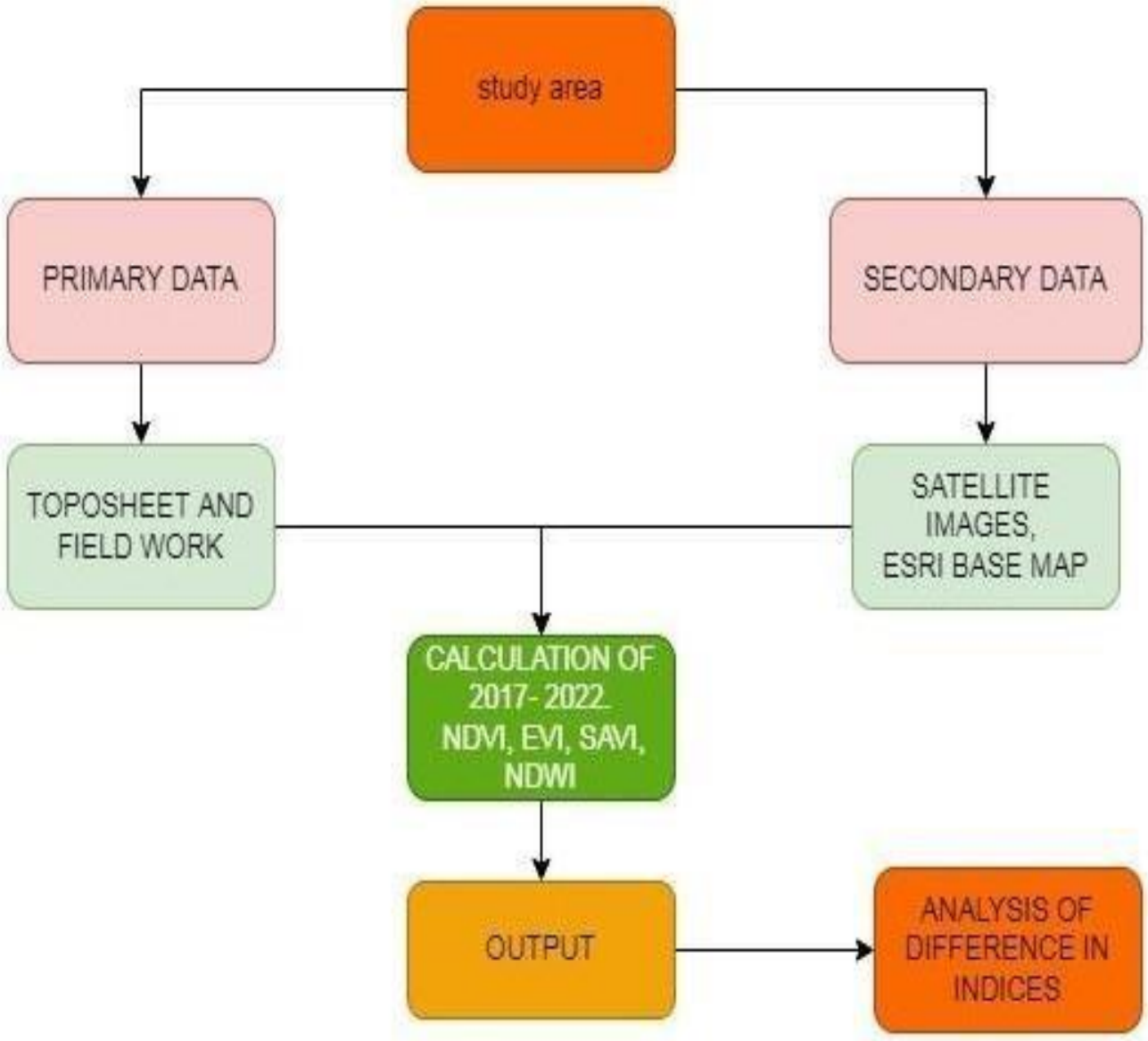
Field Work Collection of Way points

S.No	Type of Observation		Lattitude	Longitude
1	Barren Land	Uncovered Vegetation	N12 45.803'	E080 09.617'
2	Neam Tree	Palm Tree	N12 45.756'	E080 09.632'
3	Lyzygium	Cumini	N12 45.663'	E080 09.599'
4	Acicaia	Leocophoea	N12 45.572	E080 09.572'
5	Wild Crab	House	N12 45.558'	E080 09.550'
6	Civet	Cat	N12 45.558'	E080 09.542'
7	Phoenix	Pusila	N12 45.557'	E080 09.543'
8	Spotted Dear	Excrta	N12 45.531'	E080 09.521'
9	Phoenix	Pusila	N12 45.528'	E080 09.501'
10	Black Buck	Excrta	N12 45.537'	E080 09.501'
11	Cutted Tree		N12 45.535'	E080 09.500'
12	Copper Smith	Barbt	N12 45.484'	E080 09.467'
13	Acaccia	Terminifolia	N12 45.469'	E080 09.468'
14	Water	Fish	N12 45.442'	E080 09.429'
15	Canthium	Equisetifolia	N12 45.439'	E080 09.440'
16	Casurina	-	N12 45.637'	E080 09.521'
17	Accacia	Lololerico	N12 45.379'	E080 09.536'
18	Arjuna Tree	*Terminalia arjuna*	N12 45.392'	E080 09.628'
19	Arujuna Tree	-	N12 45.408	E080 09.707'
20	Eucalptus	-	N12 45.412'	E080 09.760'
21	Diospyrus Tree	-	N12 45.415'	E080 09.761'
22	dolichandrone	falcata	N12 45.447'	E080 09.991'
23	Eulaputus Tree	-	N12 45.440	E080 10.001'
24	Geomin Tree	-	N12 45.600'	E080 10.165'
25	Agave	-	N12 45.605'	E080 10.191'

Sentinal 2 Satellite image bands details: -

Sentinel-2 Bands	**Central Wavelength (µm)**	**Resolution** (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Methodology Flow Chart.



Chapter-IV

Results and Discussions

Normalized difference vegetation index

- The well known and widely used NDVI is a simple, but effective index for quantifying green vegetation. It normalizes green leaf scattering in Near Infra-red wavelengths with chlorophyll absorption in red wavelengths.

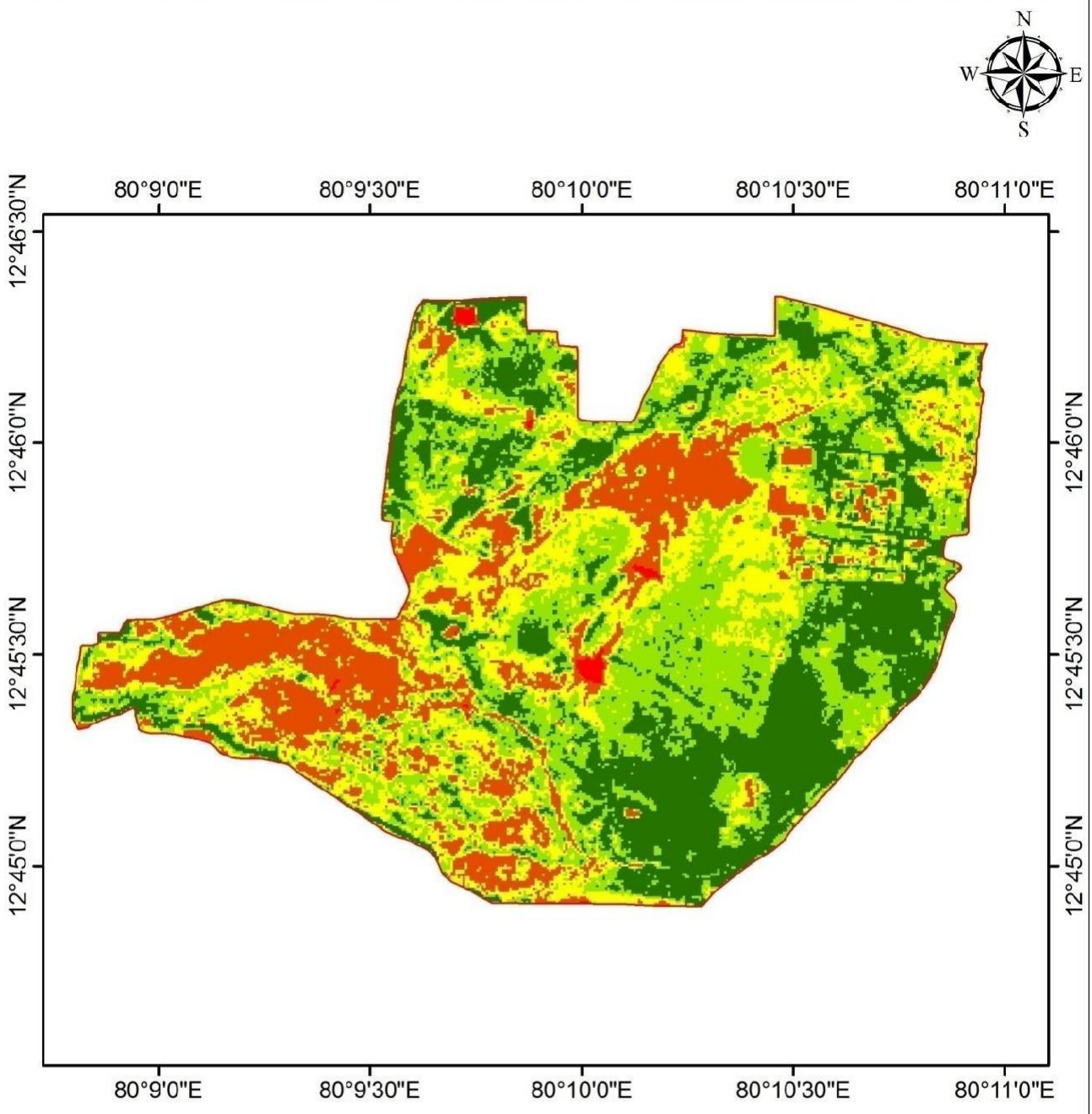
- The value range of the NDVI is -1 to 1. Negative values of NDVI (values approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1). It is a good proxy for live green vegetation;

- NDVI = (B8 – B4) / (B8+B4).

- In this area the NDVI values of 2017 vary in between -0.28 to 0.69, shows that very low vegetation to medium High vegetation.

- In this area the NDVI values of 2022 vary in between -0.11 to 0.58, shows that very low vegetation to medium High vegetation.

Normalised Difference Water Index Map- 2017 Thaiyur Reseve Forest



Legend

Thaiyur_RF

NDVI_2017_F

<VALUE>

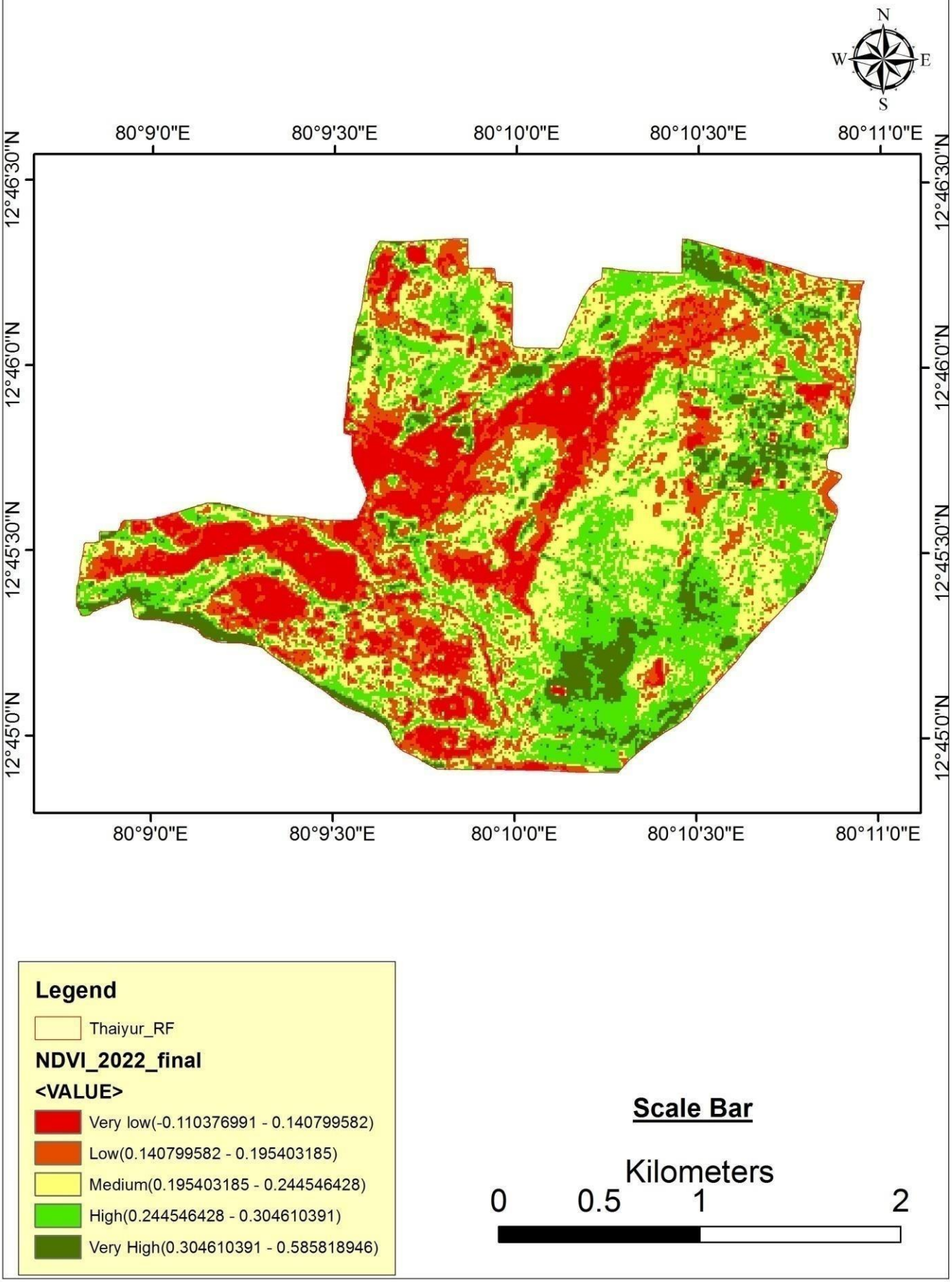
- Very low(-0.286649883 - 0.009490748)
- Low(0.009490748 - 0.228711735)
- Medium(0.228711735 - 0.344091202)
- High(0.344091202 - 0.451778704)
- Very High(0.451778704 - 0.690229602)

Scale Bar

Kilometers

0 0.5 1 2

NDVI Map - 2022 Thaiyur Reserve Forest



Enhanced Vegetation Index (EVI):-

- EVI is similar to Normalized Difference Vegetation Index (NDVI) and can be used to quantify vegetation greenness. However, EVI corrects for some atmospheric conditions and canopy background noise and is more sensitive in areas with dense vegetation. It incorporates an "L" value to adjust for canopy background, "C" values as coefficients for atmospheric resistance, and values from the blue band (B).

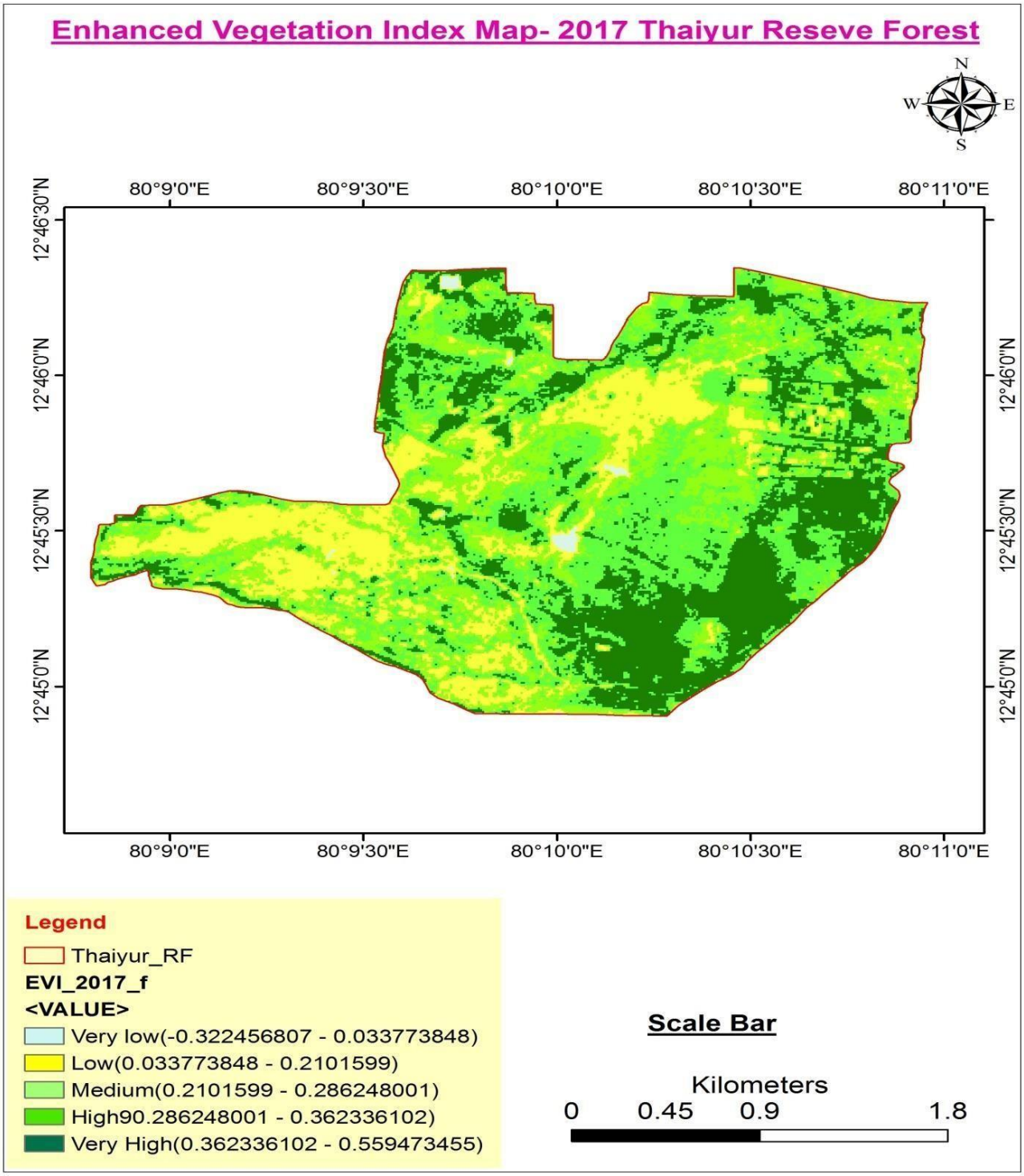
- These enhancements allow for index calculation as a ratio between the R and NIR values, while reducing the background noise, atmospheric noise, and saturation in most cases (USGS, 2019).

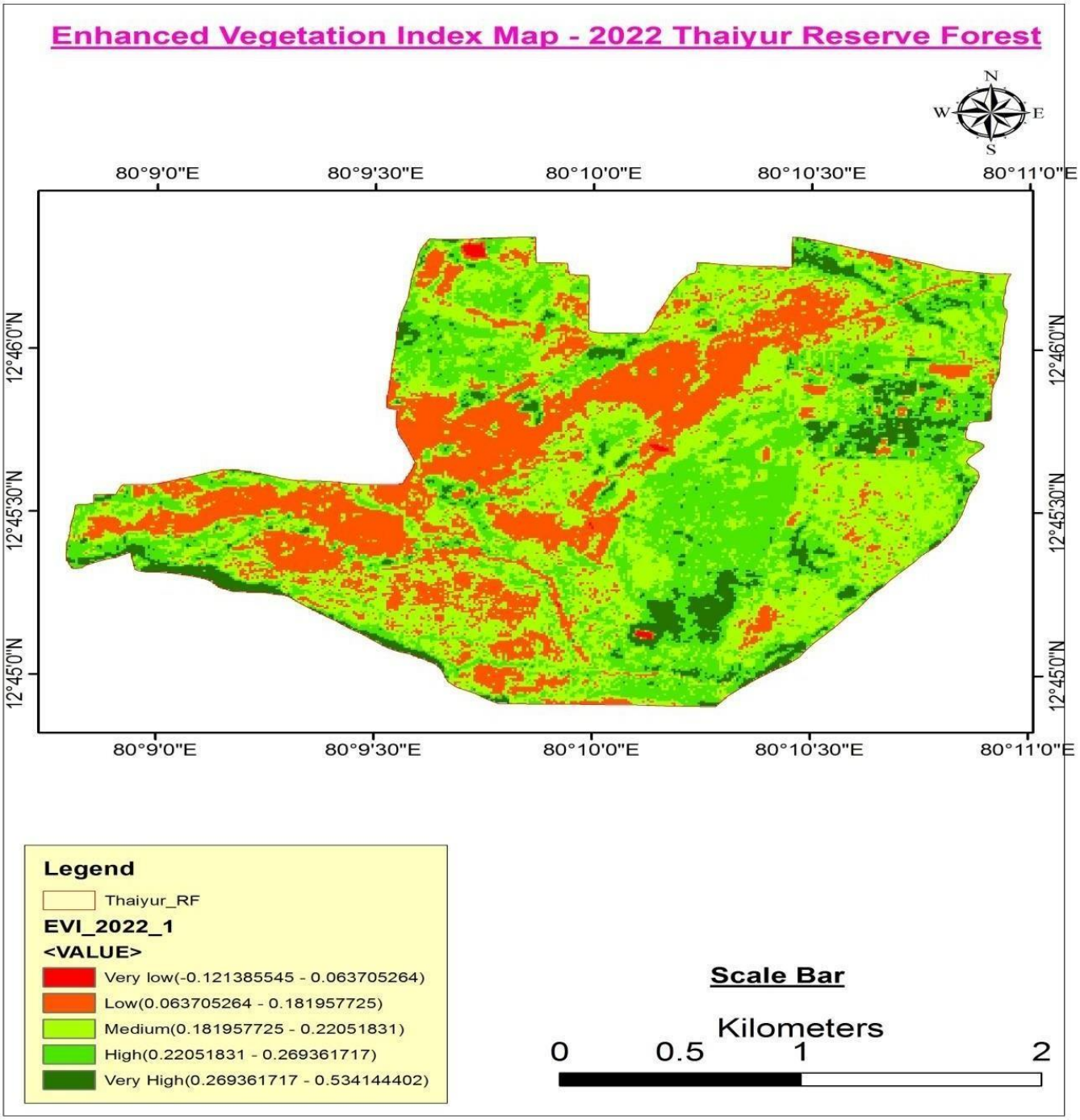
- EVI (Sentinel 2) = (B8 – B3) / (B8 + B3).

- In this area the EVI values of 2017 vary in between -0.32 to 0.55, shows that very low vegetation to medium High vegetation.

- In this area the EVI values of 2022 vary in between -0.12 to 0.53, shows that very low vegetation to medium High vegetation.

Enhanced Vegetation Index Map- 2017 Thaiyur Reseve Forest

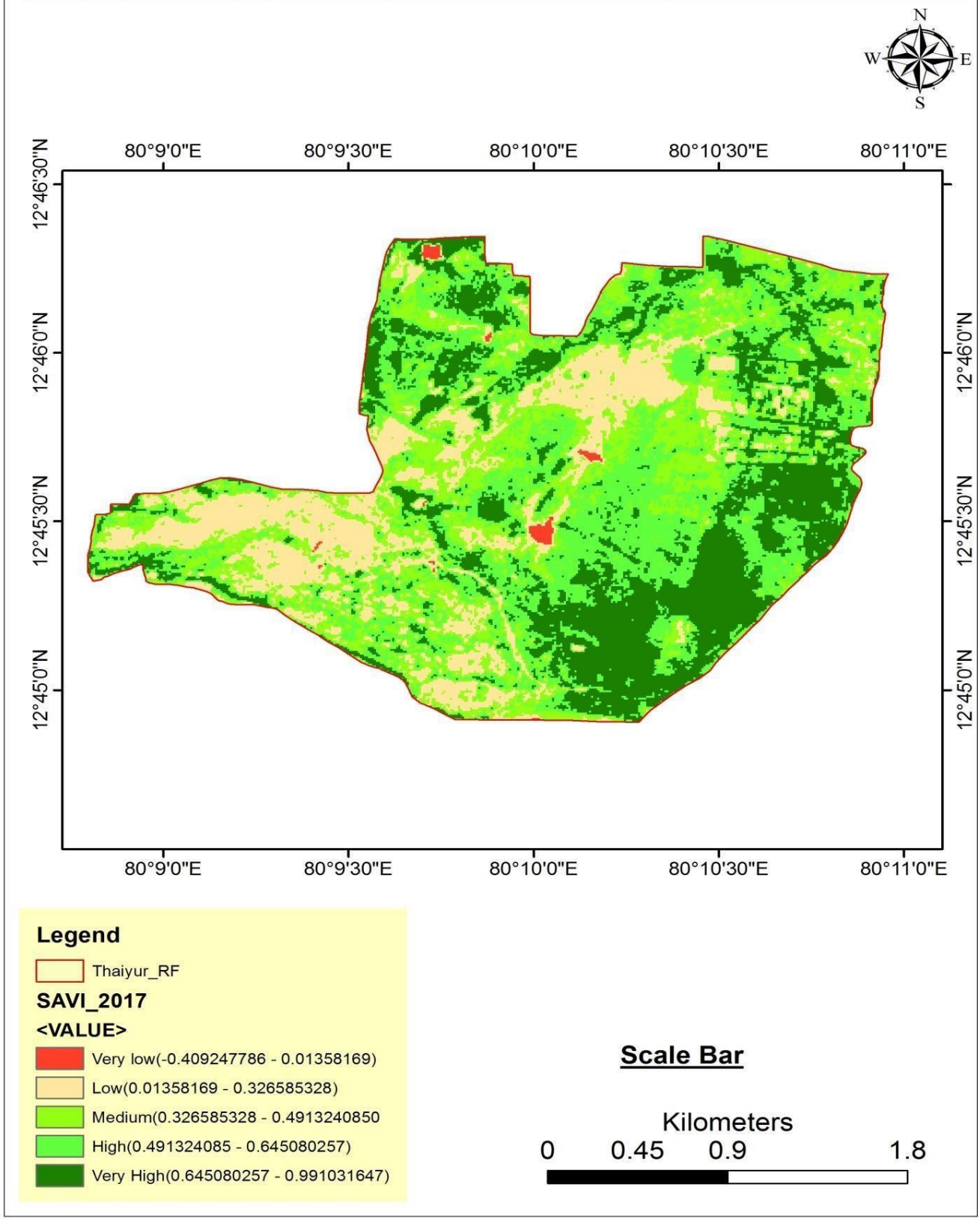



Enhanced Vegetation Index Map - 2022 Thaiyur Reserve Forest
N
W
E
S
80°9'0"E
80°9'30"E
80°10'0"E
80°10'30"E
80°11'0"E
12°46'0"N
12°45'30"N
12°45'0"N
Legend
Thaiyur_RF
EVI_2022_1
<VALUE>
Very low(-0.121385545 - 0.063705264)
Low(0.063705264 - 0.181957725)
Medium(0.181957725 - 0.22051831)
High(0.22051831 - 0.269361717)
Very High(0.269361717 - 0.534144402)
Scale Bar
Kilometers
0
0.5
1
2

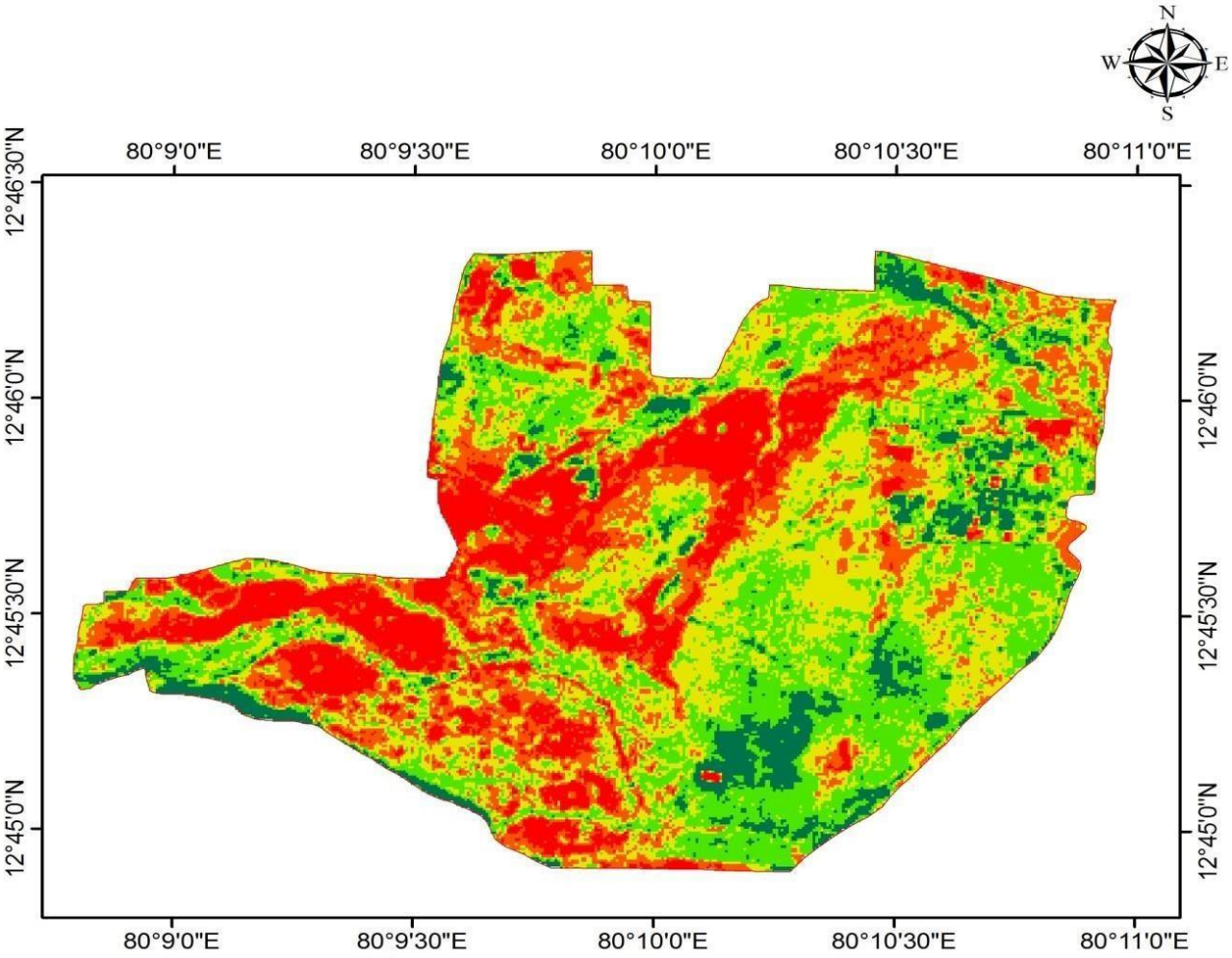
Soil Adjusted Vegetation Index (SAVI):

- SAVI is used to correct Normalized Difference Vegetation Index (NDVI) for the influence of soil brightness in areas where vegetative cover is low.
- Surface Reflectance-derived SAVI is calculated as a ratio between the R and NIR values with a soil brightness correction factor (L) defined as 0.5 to accommodate most land cover types.
- SAVI (Sentinel 2) = (B08 – B04) / (B08 + B04 + 0.428) * (1.428).
- In this area the SAVI values of 2017 values in between -0.40 to 0.99 shows that very low vegetation to medium High vegetation.
- In this area the SAVI values of 2022 values in between -0.15 to 0.83 shows that very low vegetation to medium High vegetation.

Soil Adjusted Vegetation Index Map- 2017 Thaiyur Reseve Forest



Soil Adjusted Vegetation Index Map - 2022 Thaiyur Reserve Forest



Legend

Thaiyur_RF

SAVI_2022

<VALUE>

- Very low(-0.157605231 - 0.201053285)
- Low(0.201053285 - 0.279022527)
- Medium(0.279022527 - 0.349194846)
- High(0.349194846 - 0.434961013)
- Very High(0.434961013 - 0.836502612)

Scale Bar

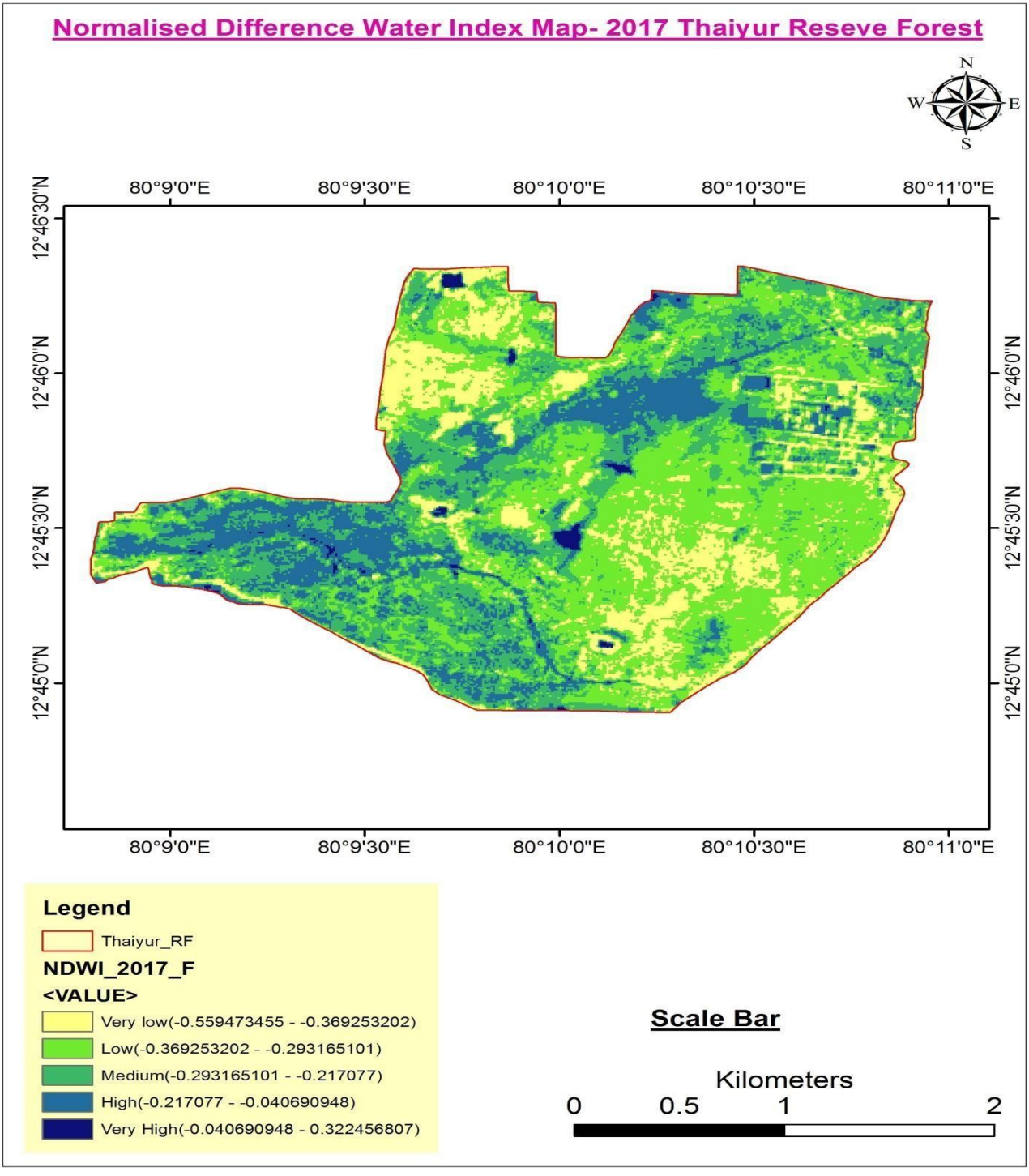
Kilometers

0 0.5 1 2

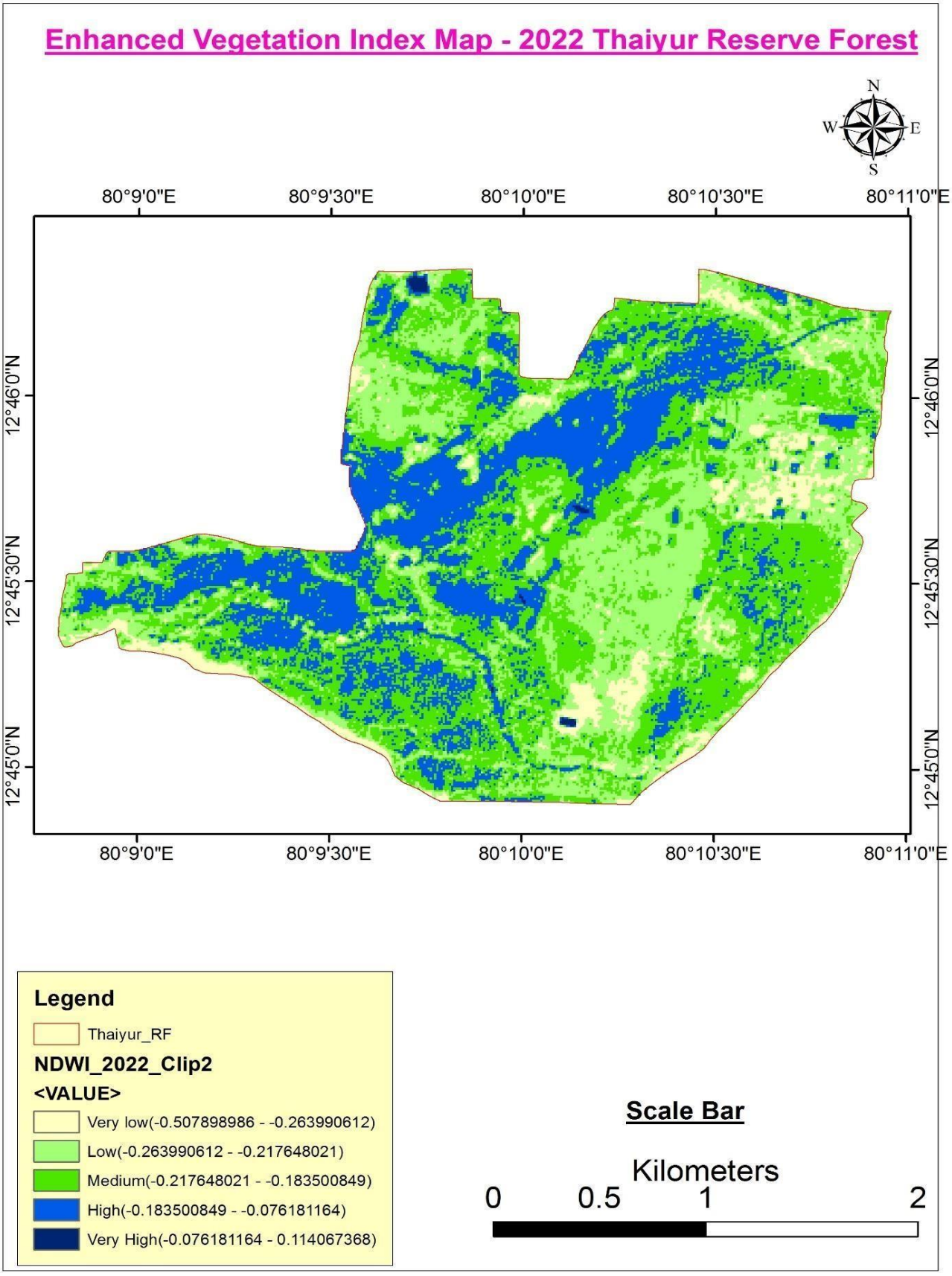
Normalized Difference Water Index (NDWI):

- Normalize Difference Water Index (NDWI) is use for the water bodies analysis.
- The index uses Green and near infra-red bands of remote sensing images.
- The NDWI can enhance water information efficiently in most cases. It is sensitive to build-up land and result in over-estimated water bodies.
- The NDWI products can be used in conjunction with NDVI change products to assess context of apparent change areas.
- NDWI (Sentinel 2) = (B3 – B8) / (B3 + B8).
- In this area the NDWI values of 2017 values in between -0.55 to 0.32 shows that very low water content of water bodies to medium number of waterbodies.
- In this area the NDWI values of 2022 values in between -0.50 to 0.11 shows that very low water content of water bodies to medium number of waterbodies.
- NDWI values decreases from the 2017 to 2022 due to soil condition and arresting of the Palar river sub streams.

Normalised Difference Water Index Map- 2017 Thaiyur Reseve Forest



Enhanced Vegetation Index Map - 2022 Thaiyur Reserve Forest



Statistics of the different Indices: -

- 2017 Statistics of the Thaiyur Reserve Forest,

NDVI-2017 Thaiyur Reserve Forest				
VALUE	**COUNT**	**Area**	**Area_hect**	**Type**
1	244	24400	2.44	Very Low
2	11278	1127800	112.78	Low
3	15600	1560000	156.00	Medium
4	19169	1916900	191.69	High
5	16083	1608300	160.83	Very High

NDWI-2017 Thaiyur Reserve Forest				
VALUE	**COUNT**	**AREA**	**Area_hect**	**Type**
1	10199	1019900	101.99	Very Low
2	23826	2382600	238.26	Low
3	18187	1818700	181.87	Medium
4	9748	974800	97.48	High
5	415	41500	4.15	Very High

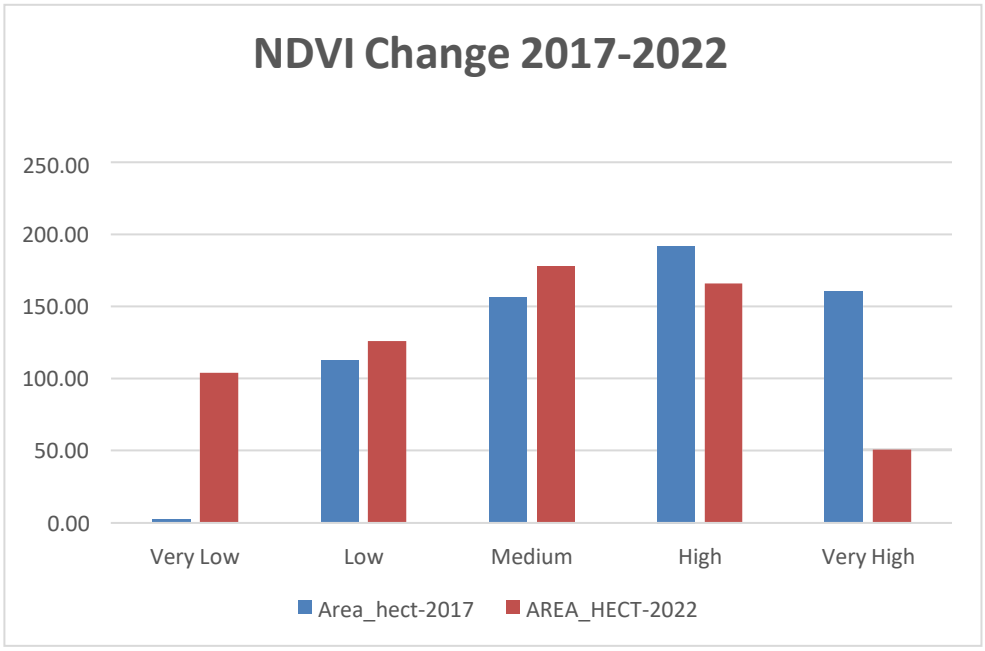
EVI-2017 Thaiyur Reserve Forest				
VALUE	**COUNT**	**AREA_sq.mt**	**AREA_Hect**	**Type**
1	391	39100	3.91	Very Low
2	8299	829900	82.99	Low
3	17755	1775500	177.55	Medium
4	23717	2371700	237.17	High
5	12213	1221300	122.13	Very High

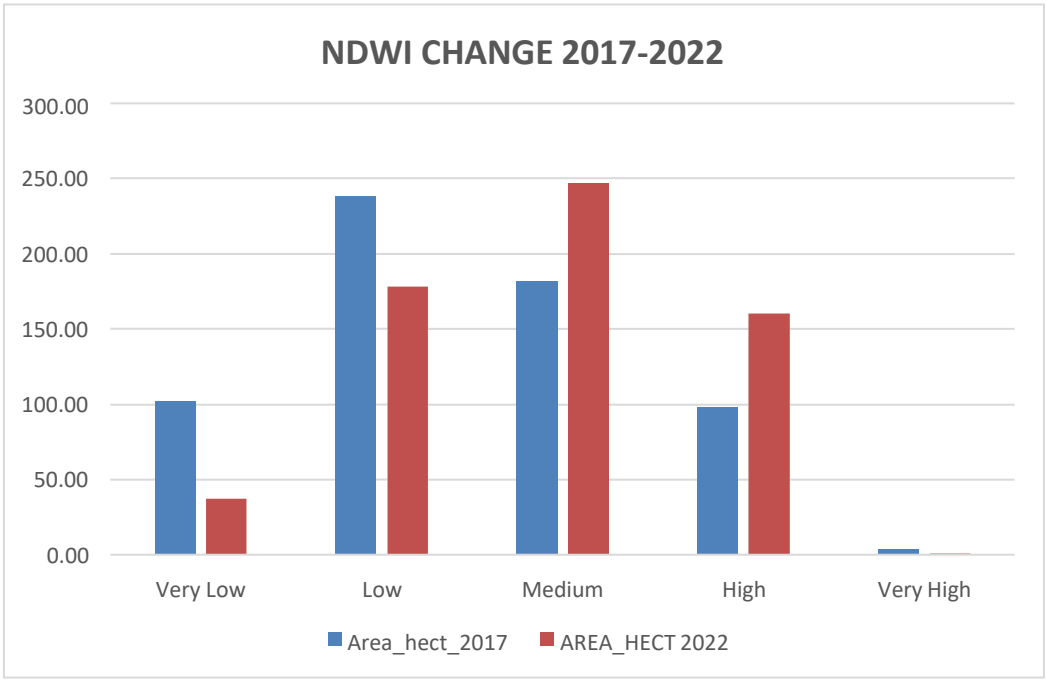
- 2022 Statistics of the Thaiyur Reserve Forest,

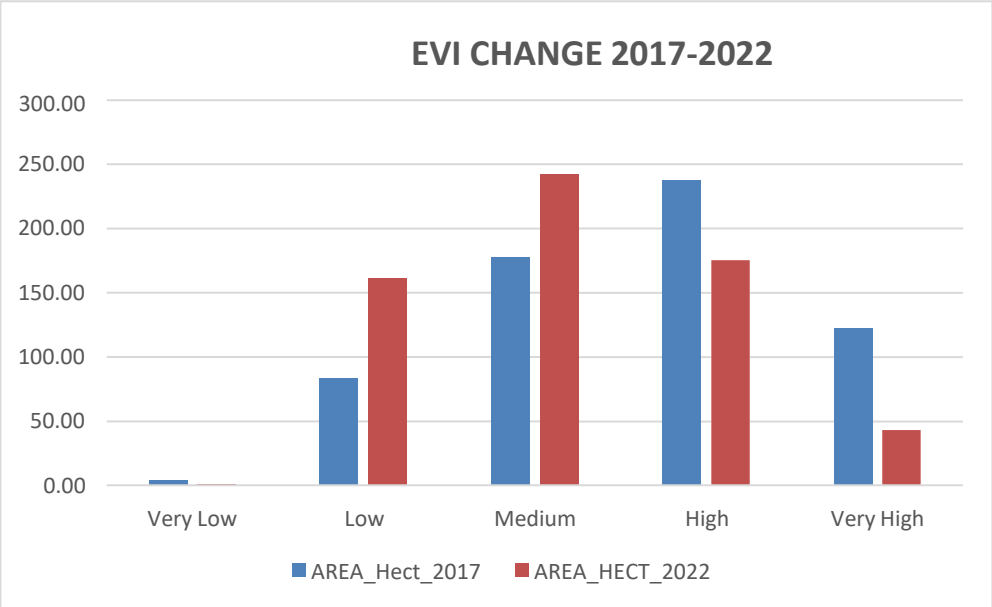
NDVI- 2022- Thaiyur Reserve Forest				
VALUE	**COUNT**	**AREA**	**AREA_HECT**	**TYPE**
1	10363	1036300	104	Very Low
2	12560	1256000	126	Low
3	17821	1782100	178	Medium
4	16550	1655000	166	High
5	5081	508100	51	Very High

NDWI-2022-Thaiyur Reserve Forest				
VALUE	**COUNT**	**AREA**	**AREA_HECT**	**TYPE**
1	3748	374800	37	Very Low
2	17805	1780500	178	Low
3	24651	2465100	247	Medium
4	16050	1605000	160	High
5	121	12100	1	Very High

EVI-2022- Thaiyur Reserve Forest				
VALUE	**COUNT**	**AREA**	**AREA_HECT**	**TYPE**
1	107	10700	1	Very Low
2	16103	1610300	161	Low
3	24318	2431800	243	Medium
4	17505	1750500	175	High
5	4342	434200	43	Very High


NDVI Change 2017-2022
250.00
200.00
150.00
100.00
50.00
0.00
Very Low
Low
Medium
High
Very High
Area_hect-2017
AREA_HECT-2022


NDWI CHANGE 2017-2022
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Very Low
Low
Medium
High
Very High
Area_hect_2017
AREA_HECT 2022



- The indices are changed from the 2017 to 2022, so the green cover decreased in the thaiyur reserve forest.
- In this forest area soils are rich in the Ca content so, this area not suitable for the construction of the check dams and storage tanks.
- The palar river basin sub streams are flowing across this forest area, these are the best source of the water for the wild life and birds in that area. Arresting of that sub streams may impact on the wild life habitats in that area.
- Previously this area having good amount of population of Black bugs (Times of India News Paper) but in our two field works we are not seen the Black bugs. May be its population decreases or displacement of that species into another place.

Suggestions: -

- ❖ Soils study very useful for understand which plants suitable for this area.
- ❖ Plantation of some fruit trees helpful for the birds and other species in this reserve forest.
- ❖ We know so much difficulty to stop human encroachment into the reserve forest at least try to stop the vehicle moment in the forest region, we observe some local people using bikes. Because the wildlife habitats are disturbed by that sounds of vehicle moments.

Field observations;

PLANTS;

1. Eucalyptus globules
2. Acacia holoserica
3. Pandanus sp.,
4. Casuarina sp.,
5. Arjuna tree
6. Jamun tree.
7. Dolichondron falcata
8. Cassia auriculata
9. Phoenix pusila
10. Accacia leucophorea
11. Syzygium cumini.

12. Neem tree.

13. Palm tree non flowering.

ANIMALS:

1. Black buck.
2. Porcupine.
3. Spotted deer.
4. Silver deer.
5. Wild rabbit.
6. Indian palm squirrel.

Insects:

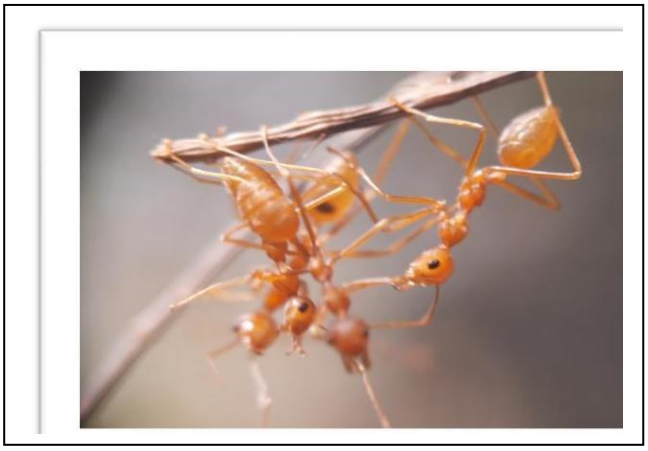
1. Praying mantis
2. Rosy footman
3. Spider
4. Weaver ant
5. Bug

Field Photos

Crimson - peckled Moth

Rosy Footman

Praying Mantis

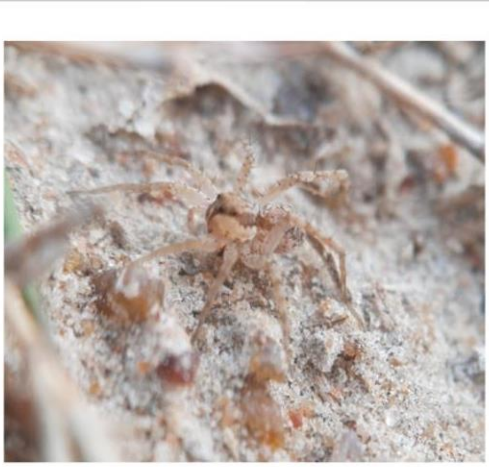


Weaver Ant

Hottentotta sp

Brachymeria

funnel web spider



Wolf Spider

Gephyrin Variegate

Colonus Spider

Rat Snake Skin

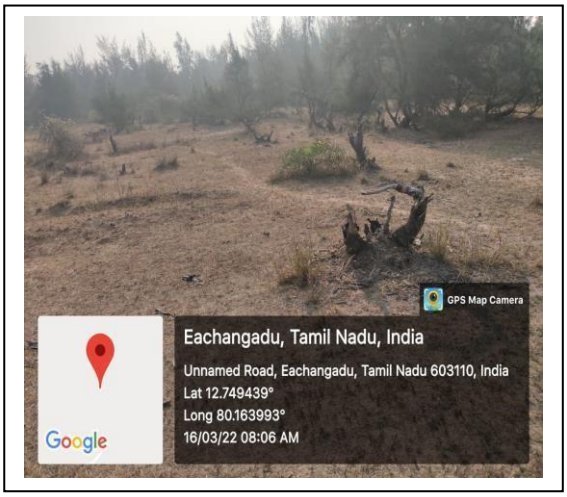
Cobra Skin

palm civet droppings

Blackbuck Dropping

Porcupine Dropping

Pentatomidae Eggs



Human activities cutting of the tress.


GPS Map Camera
Eachangadu, Tamil Nadu, India
Eachangadu, Tamil Nadu, India
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Long 80.16524°
16/03/22 08:28 AM
Google


GPS Map Camera
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GPS Map Camera
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Google


GPS Map Camera
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Nigeria
Eachangadu, Tamil Nadu, India
Eachangadu, Tamil Nadu, India
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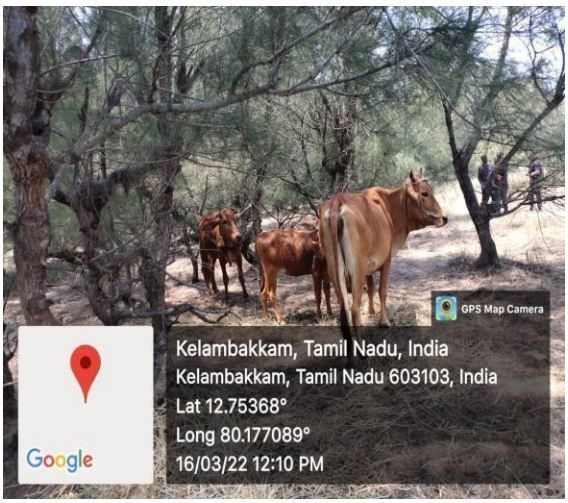
Google


Shot on vivo Z1Pro
Vivo AI camera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Kelambakkam, Tamil Nadu 603103, India
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16/03/22 12:10 PM
Google

References: -

1. Davidar, E. R. C., Davidar, P., Davidar, P., and Puyravaud, J. P. (2012). Elephant (Elephas maximus Linnaeus) (Proboscidea: Elephantidae) migration paths in the Nilgiri Hills, India in the late 1970s. Journal of ThreatenedTaxa, 4 (14): 3284-3293.

2. Lambin, E.F. and Meyfroidt, P. (2010). Land use transitions: Socio-ecological feedback versus socio-economicchange. Land Use Policy 27:108–118

3. Pearson, S. M. (2002), "Interpreting landscape patterns from organism-based perspectives", In Learning Landscape Ecology, Springer, New York, NY., 187-198.

4. S. Senthil Kumar, S. Arivazhagan, N. Rangarajan(2013), “Remote Sensing and GIS Applications in Environmental Sciences - A Review”, J. Environ. Nanotechnol. Volume 2, No.2 92-101 pp. ISSN (Print) : 2279-0748 ISSN (Online) : 2319-5541. doi-https://doi.org/10.13074/jent.2013.06.132025

5. Singh, A., (1989). Digital change detection techniques using remotely sensed data. International Journal of Remote Sensing. 6 (10), 989 – 1003.

6. https://timesofindia.indiatimes.com/city/chennai/proposal-to-declared-3-reserve-forests-as-blackbuck-sanctuaries/articleshow/61166913.cms.

ANNEXURE - II

LIST OF PARTICIPANTS

GSDP Certificate Course on Wildlife Management using Geospatial Techniques (2022)

S.NO	NAME, AGE & GENDER	COMMUNITY	PHONE	EMAIL ID	ADDRESS	QUALIFICATION	PHOTO
1.	**P. SENTHILKUMAR** AGE : 33 Male	MBC	9159892394	psenthilkumar761@gmail.com	28/5 AYYERAM KALL MANDAPAM BACK SIDE ARIYALUR-621 704.	M.Sc., Environmental Sciences	
2.	**SANJAY. S** AGE : 22 Male	OBC - NCL	8281426534	ssanjaysuresh19@gmail.com	KINARPALLAM, VELANTHAVALAM,PALAKKAD, KERALA – 678 557.	M.Sc., Zoology	
3.	**MATTE SIVA TEJA** AGE : 29 Male	GENERAL	9505353033	sivatejageo@gmail.com	ACHARYA NAGARJUNA UNIVERSITY, GEOLOGY DEPARTMENT, GUNTUR DISTRICT, ANDHRA PRADESH, PIN CODE:-522510	M.Sc., Geology	
4.	**SREERAG. K** AGE : 28 Male	SC	8089597727	sreeragkkhd@gmail.com	KRISHNENDH, PALLOT, AJANUR P.O, KASARAGOD, KERALA, PIN- 671531	M.Sc., Ecology & Environmental Sciences	
5.	**G. PAVITHRA** AGE : 24 Female	BC	7904385194 / 8144424205	pavithraganeshav@gmail.com	NO 44/64, AMMAI APPAN STREET, ROYAPETTAH, CHENNAI - 600 014.	M.Sc., Zoology	

6.	**NIRAJ SUDHAKAR NANDANE** AGE : 24 Male	OBC	9922188184	nirajnandane1997@gmail.com	FAIZPURI, JALGAON, MAHARASTRA – 425 001.	B.Sc., Zoology	
7.	**SHANMUGAM. A** AGE : 33 Male	MBC	9840621516	sweetkith12@gmail.com	No 425 LAKSHMIPURAM PAKKAM POST THIRUVALLUR - 602024	M.Sc., Medical Microbiology	
8.	**ARAVINDAN. B. K** AGE : 21 Male	BC	8680928769	bkaravindan2000@gmail.com	5/160, 1ST CROSS STREET, MAHARAJAN NAGAR, TEACHERS COLONY, VIRAGANUR, MADURAI - 625009	B.Sc., Zoology	
9.	**SATHISH. M** AGE : 29 Male	SC	9585319566	sathishmanibala@gmail.com	NO 4 PERUMBAKKAM (VILLAGE) MUTHUVADU POST) KANCIPURAM TAMILNADU	B.Sc., Zoology	
10.	**N. POONKATHIR** AGE : 31 Male	OBC	7871611403	kathirmadrasuniversity@gmail.com	PRUMBADI,AGRAVARAM POST,GUDIYATTAM TK,VELLORE DIST.PIN – 632 604.	M.Sc., Plant Biology &Plant Biotechnology	
11.	**P. R. KUMARESAN** AGE : 27 Male	BC	8610460975	kumaresanmoongis@gmail.com	PLOT NO 15, PUNNIYAKOTTI STREET (EXTN), SAINATHAPURAM, VELLORE- 632 001.	M.Tech., Geotechnology and Geoinformatics	

12.	**REVAN YOGESH CHAUDHARI** AGE : 22 Male	BC	8329020726	revanchaudhari2220@gmail.com	PLOT. NO 81, SAKHARWADI, TRAMBAK NAGAR, MAHABAL JALGAON- 425 001.	B.Sc., Botany	
13.	**GRACE SELVARANI. E** AGE : 29 Female	BC	9790913391	graceedward11@gmail.com	NO. 15, RAJESHWARI FLATS, B4, 8th Cross Street(2nd Street) SAMRAJ NAGAR, SEMBAKKAM, CHENNAI- 600 073.	M.Sc., Geography	
14.	**D. SHANBAGAPRIYA** AGE : 33 Female	BC	9840846326	priya.praisejesus@gmail.com	No.189 KAMARAJ STREET TIRUVUR VILLAGE & POST, THIRUVALLUR DISTRICT-602025	M.Sc., Geography	
15.	**A. RAVETHA MILKI** AGE : 23 Female	BC	9940030384	milkiravetha@gmail.com	No: 7/76, PENSIONER'S LANE, 3RD STREET, OLD WASHERMENPET, CHENNAI - 600021	M.Sc., Applied Geography	
16.	**B. AYISHA KHANAM** AGE : 24 Female	BC	6383063657	ayishukhanam@gmail.com	NO:46,PULIANTHOPE HIGH ROAD, CHENNAI-600012	M.Sc., Applied Geography	
17.	**VEENITA RANI** AGE : 31 Female	SC	8580564803 / 9410694278	raniveenita@gmail.com	H.NO. 217, I- BLOCK SHASTRI NAGAR, MEERUT, UTTAR PRADESH, PIN-250004.	M.Sc., Geography	

18.	**SADHU. C** AGE : 28 Male	SC	9043916625	sadhusunder777@gmail.com	DEPARTMENT OF GEOLOGY, UNIVERSITY OF MADRAS, GUINDY CAMPUS, CHENNAI - 600 025.	M.Sc., Geology	
19.	**KIRUBHANANDHINI. V** AGE : 34 Female	MBC	9488753659	kirubhanandhini@yahoo.in	F2, N0:15/16 STATE BANK STAFF COLONY, ALWARTHIRUNAGAR, VALASARAVAKKAM, CHENNAI - 600 087.	M.Sc., Zoology	
20.	**KEERTHIKA. C** AGE : 24 Female	BC	8667544473 / 8122912330	keerthidevasena@gmail.com	NO. 60/18B NORTH MADA STREET, KALADIPET, CHENNAI – 600 019.	M.Sc., Zoology	

LIST OF RESOURCE PERSON

Sl. no	*Resource Person*	*Designation and Address*
1.	Dr. Kannan Vaithiyanathan	Wildlife Biologist Mudumalai Tiger Reserve Masinagudi Division
2.	Dr. G. Bhaskaran	Professor Department of Geography University of Madras Chennai - 600 025
3.	Mr. A. Srinivasan	Project Associate (Wildlife & Ecology) Care Earth Trust Chennai - 600 061
4.	Mr. Dipjyoti Gogoi	Research Scholar Department of Geography University of Madras Chennai - 600 025
5.	Mr. Vinoth Balasubramanian	Senior Project Associate (Wildlife) Care Earth Trust Chennai - 600 061
6.	Prof. N. Sivagnanam	President (Indian Geographical Society) Former Professor and Head Department of Geography University of Madras Chennai - 600 025
7.	Mr. V. Shyam Sundar	Research Scholar Department of Geography University of Madras Chennai - 600 025
8.	Dr. S. Sanjeevi Prasad	Assistant Professor Department of Geography University of Madras Chennai - 600 025
9.	Mrs. N. Priyanka	Research Scholar Department of Geography University of Madras Chennai - 600 025
10.	Dr. R. Jaganathan	Professor and Head Department of Geography University of Madras Chennai - 600 025
11.	Mr. Ayuthavel Kalaimani	Project Associate (Wildlife) Care Earth Trust Chennai - 600 061
12.	Dr. K. Sivakumar	Professor Pandichery University Puduceri – 605014.

13.	Mr. S. Stephen Jayaseelan	Research Scholar Department of Geography University of Madras Chennai - 600 025
14.	Dr. S. Ganapathy	Professor Centre for Environmental Studies Anna University Chennai - 600 025
15.	Mr. V. N. Indiaselvan	Research Scholar Department of Geography University of Madras Chennai - 600 025
16.	Dr. D. Surendran	Faculty Department of Geography University of Madras Chennai - 600 025
17.	Mr. Gururaj	L&T Infrastructure Porur Chennai.
18.	Ms. A. Sona	Research Scholar Department of Geography University of Madras Chennai - 600 025
19.	Dr. S. Jayakumar	Professor Pandichery University Puduceri – 605014.
20.	Dr. S. R. Ganesh	Director Guindy Snake Park Chennai- 600005.
21.	Dr. M. Veeraselvam	Assistant Professor Department of Wildlife Science Madras Veterinary College

22.	Dr. N. Manikandan	Faculty Department of Geography University of Madras Chennai - 600 025
23.	Dr. R. Aravinth	Faculty Department of Geography University of Madras Chennai - 600 025
24.	Dr. S. Sivasankar	Faculty Department of Geography University of Madras Chennai - 600 025
25.	Mr. Dharshan Shylesh. D. S	Research Scholar Department of Geography University of Madras Chennai - 600 025
26.	Dr. Tamil Ilakiya	Faculty Department of Geography Bangalore University Bangalore - 560 056
27.	Dr. K. Narmadha	Post-Doctoral Fellow Department of Geography University of Madras Chennai - 600 025
28.	Ms. Shurmili. R. V.	Research Scholar Department of Geography University of Madras Chennai - 600 025
29.	Dr. Ranjit Daniels	Project Associate (Wildlife) Care Earth Trust Chennai - 600 061
30.	Mr. Muthukarthick	Project Associate (Wildlife) Care Earth Trust Chennai - 600 061

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 1 (07.02.2022 - 12.02.2022)*

07.02.2022 (Monday)		
Time	**Topic**	**Name of Resource Person**
11.00 - 01.00	**Inaugural Function**	
01.00 - 02.00	Lunch	
02.00 - 05.00	Introduction to Wildlife Management and its Importance	Dr. Kannan Vaithiyanathan
08.02.2022 (Tuesday)		
09.00 - 01.00	Humans and Wildlife in perspective	Mr. S. Stephen Jayaseelan
01.00 - 02.00	Lunch	
02.00 - 05.00	Managing Human Wildlife Confilcts	Mr. Vinoth Balasubramanian
09.02.2022 (Wednesday)		
09.00 - 01.00	Introduction to Wildlife Ecology and Habitat	Mr. S. Stephen Jayaseelan
01.00 - 02.00	Lunch	
02.00 - 06.00	Introdction to GIS	Dr. D. Surendran
10.02.2022 (Thursday)		
10.00 - 01.00	Population, Community and its Diversity	Mr. A. Srinivasan
01.00 - 02.00	Lunch	
02.00 - 05.00	Niche and its significance	Mr. Vinoth Balasubramanian
11.02.2022 (Friday)		
10.00 - 11.30	Introdution to Biosphere and its components	Mr. A. Kalaimani
11.30 - 01.00	Introduction to Ecosystems and its components	Mr. S. Stephen Jayaseelan
01.15 - 02.15	Lunch	
02.00 - 05.00	Modes in Wildlife Management	Mr. Vinoth Balasubramanian
12.02.2022 (Saturday)		
09.00 - 01.00	Camera Trapping Method and Techniques	Mr. S. Stephen Jayaseelan
01.15 - 02.15	Lunch	
02.00 - 03.30	Wildlife Censuses - General Method	Mr. Vinoth Balasubramanian
03.30 - 05.00	Wildlife Censuses - Quadrate Method	Mr. A. Srinivasan

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 2 (14.02.2022 - 19.02.2022)*

14.02.2022 (Monday)		
Time	**Topic**	**Name of the Resource Person**
09.00 - 01.00	Forest Fire Spread modelling	Mr. D. S. Dharshan Shylesh
01.00 - 02.00	Lunch	
02.00 - 03.30	Distance Sampling - Line transect	Mr. Vinoth Balasubramanian
03.30 - 05.00	Methods used in Wildlife counting	Mr. A. Kalaimani
15.02.2022 (Tuesday)		
09.00 - 01.00	LBS techniques and its applications in wildlife	Mr. D. S. Dharshan Shylesh
01.00 - 02.00	Lunch	
02.00 - 03.30	Forest Fragmentation	Mr. A. Kalaimani
03.30 - 06.00	Distance Sampling - Point transect	Mr. S. Stephen Jayaseelan
16.02.2022 (Wednesday)		
10.00 - 01.00	Landscape ecology and habitat	Dr. Ranjit Daniels
01.00 - 02.00	Lunch	
02.00 - 05.00	Human Wildlife Conflicts - Measures and Mitigation	Mr. Vinoth Balasubramanian
17.02.2022 (Thursday)		
10.00 - 11.30	Habitat Loss and conservation Implication	Mr. A. Kalaimani
11.30 - 01.00	Raster and Vector data models in GIS	Dr. S. Sivasankar
01.00 -02.00	Lunch	
02.00 - 04.00	GIS tools in Ecological modeling	Dr. S. Jayakumar
04.00 - 06.00	Wildlife Poaching and its mitigation steps	Dr. K. Sivakumar
18.02.2022 (Friday)		
09.00 - 01.00	Scope and Application of GIS in wildlife management	Dr. D. Surendran
01.15 - 02.15	Lunch	
02.00 - 05.00	Field Visit to Snake Park - Geographic Range and Habitats	Dr. S. R. Ganesh
19.02.2022 (Saturday)		
	Local Body Election - Holiday	

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 3 (21.02.2022 - 26.02.2022)*

21.02.2022 (Monday)		
Time	**Topic**	**Resource Person**
09.00 - 01.00	Wildlife and Forest Laws in India	Dr. S. Ganapathy
01.00 - 02.00	Lunch	
02.00 - 03.00	Basics of Computer	Mr. Dharshan Shylesh
03.00 - 06.00	Lab: Introduction to QGIS	Mr. Dharshan Shylesh
22.02.2022 (Tuesday)		
10.00 - 01.00	Basics of Remote Sensing - I	Dr. G. Bhaskaran
01.00 - 02.00	Lunch	
02.00 - 05.00	Mapping Sciences	Prof. N. Sivagnanam
23.02.2022 (Wednesday)		
10.00 - 01.00	Basics of Remote Sensing - II	Dr. G. Bhaskaran
01.00 - 02.00	Lunch	
02.00 - 05.00	Wildlife Forensics	Dr. Veeraselvam
24.02.2022 (Thursday)		
10.00 - 01.00	GNSS and its Applications in Wildlife	Dr. S. Sanjeevi Prasad
01.00 - 02.00	Lunch	
02.00 - 06.00	Spatial Database Management System & Applications of LBS in Wildlife Management (Presentation)	Dr. D. Surendran
25.02.2022 (Friday)		
07.00 - 07.00	Field Work - Vallam Reserve Forest (Wildlife Census)	Stephen and Team
26.02.2022 (Saturday)		
10.00 - 01.00	Lab: Getting started with Surveying	Mr. Shyam Sundar
01.00 - 02.00	Lunch	
02.00 - 03.00	Open source softwares and its importance	Mr. Dharshan Shylesh. D. S
03.00 - 06.00	Lab: Getting started with QGIS	Mr. Dharshan Shylesh. D. S

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 4 (28.02.2022 - 05.03.2022)*		
28.02.2022 (Monday)		
Time	**Topic**	**Resource Person**
09.00 - 11.00	Sources for Downloading Data	Mr. India Selvan
11.00 - 01.00	Recap & Assessment - Theory	Mr. S. Stephen Jayaseelan
01.00 - 02.00	Lunch	
02.00 - 03.00	Georeferencing and its Importance	R.V. Shurmili
03.00 - 06.00	Lab: Georeferencing using QGIS	R.V. Shurmili
01.03.2022 (Tuesday)		
09.00 - 10.00	Attribute data management	A. Sona
10.00 - 01.00	Lab: Working with Attribute table in QGIS	A. Sona
01.00 - 02.00	Lunch	
02.00 - 05.00	Lab: Digitisation using QGIS	Dr. S. Sivasankar
02.03.2022 (Wednesday)		
09.00 - 10.00	Spatial Editing in GIS	Dr. D. Surendran
10.00 - 01.00	Lab: Spatial and Non-spatial data editing and management	Dr. D. Surendran
01.00 - 02.00	Lunch	
02.00 - 03.00	Advanced Editing - I(Ring, Cut Polygon, Merge Features)	
03.00 - 06.00	Lab: Advanced editing tools in QGIS - I (Ring, Cut Polygon, Merge Features)	R. V. Shurmili
03.03.2022 (Thursday)		
09.00 - 10.00	Advanced Editing - II(Editing Vertices, Snapping & Tracing)	Dharshan Shylesh. D. S
10.00 - 01.00	Lab: Advanced editing tools in QGIS - II (Editing Vertices, Snapping & Tracing)	Dharshan Shylesh. D. S
01.00 - 02.00	Lunch	
02.00 - 06.00	Spatial Analysis - Buffer & Overlay	Dr. D. Surendran
04.03.2022 (Friday)		
09.00 - 01.00	Applications of GIS in Wildlife Management	Dr. Tamil Ilakiya
01.00 - 02.00	Lunch	
02.00 - 05.00	Lab: Web Based Mapping using Bhuvan & Google Earth	Dr. R.Aravinth
05.03.2022 (Saturday)		
09.00 - 10.00	Introduction to Spatial Analysis	A.Sona
10.00 - 01.00	Lab: Spatial Analysis (Clipping & Merging of Toposheets)	A.Sona
01.00 - 02.00	Lunch	
02.00 - 05.00	Lab: Elements of Mapping	R. V. Shurmili

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 5 (07.03.2022 - 12.03.2022)*

07.03.2022 (Monday)		
Time	**Topic**	**Resource Person**
09.00 -10.00	Proximity Analysis	A. Sona
10.00 - 01.00	Lab: Proximity Analysis in QGIS	A. Sona
01.00 - 02.00	Break	
02.00 - 05.00	Lab: Overlay Analysis in QGIS	Ms. R. V. Shurmili
08.03.2022 (Tuesday)		
09.00 - 10.00	Editing and Data Manipulation in ArcGIS	Dr. D. Surendran
10.00 - 01.00	Lab: Editing in ArcGIS	Dr. D. Surendran
01.00 - 02.00	Break	
02.00 - 05.00	Lab: Satellite data pre-processing (layer stacking, clipping and mosaicking)	Dr. N. Manikandan
09.03.2022 (Wednesday)		
10.00 - 01.00	Lab: An overview of ArcGIS, ArcGIS Pro and ArcGIS Enterprise DB	Dr. S. Sivasankar
01.00 - 02.00	Lunch	
02.00 - 06.00	Special Lecture on Geospatial Technology and its latest advancements	Mr. Gururaj L&T
10.03.2022 (Thursday)		
10.00 - 01.00	Lab: Supervised and Unsupervised Classification	Dr. N. Narmadha
01.00 - 02.00	Lunch	
02.00 - 05.00	Lab: Vegetation Indices (NDVI, VGI, NDWI, NDBI, SAVI)	Mrs. N. Priyanka
11.03.2022 (Friday)		
10.00 - 01.00	Lab: Change Detection Analysis	Dr. N. Manikandan
01.00 - 02.00		
02.00 - 05.00	Lab: Getting started with ArcGIS (Editing and Data manipulation)	Mr. Dipjyothi Gogoi
12.03.2022 (Saturday)		
05.00 - 05.00	Field Visit to Thaiyur	

6 WEEK GREEN SKILL DEVELOPMENT PROGRAMME (GSDP) CERTIFICATE COURSE ON WILDLIFE MANAGEMENT USING GEOSPATIAL TECHNIQUES *WEEK 6 (14.03.2022 - 19.03.2022)*		
14.03.2022 (Monday)		
Time	**Topic**	**Resource Person**
08.00 - 10.00	Introduction to GIS Project Management	Dr. S. Sivasankar
10.00 - 06.00	Lab: Mini Project Work	Dr. S. Sivasankar
15.03.2022 (Tuesday)		
08.00 - 06.00	Lab: Mini Project Work	Dr. D. Surendran
16.03.2022 (Wednesday)		
06.00 - 06.00	Field Work : Thaiyur Forest	S. Stephen Jayaseelan
17.03.2022 (Thursday)		
08.00 - 06.00	Lab: Mini Project Work	Dr. N. Manikandan
18.03.2022 (Friday)		
08.00 - 07.00	Evaluation (Theory & Practical) and Presentation	Dr. R. Jaganathan
19.03.2022 (Saturday)		
09.00 - 12.00	Virtual Reality Demo	Mr. Dharshan Shylesh.D.S
12.00 - 02.00	**Valedictory Function**	

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

1. **Name of the Participant:** Mrs. D. Shanbagapriya

Sl. No.	Particulars	Score
1.	Theme of the programme	8
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	10
4.	Relevance of the Resource persons for the programme	6
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	7
10.	Refreshments and Meals	8
11.	Overall training experience	8

2. **Name of the Participant:** Ms. C. Keerthika

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	10
7.	Boarding and Lodging facilities	9
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	8
10.	Refreshments and Meals	8
11.	Overall training experience	8

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

3. **Name of the Participant:** Mr. P. Senthilkumar

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	6
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	8
11.	Overall training experience	8

4. **Name of the Participant:** Mr. S. Sanjay

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	8
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	10
5.	Training kit and relevant study materials	6
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	5
10.	Refreshments and Meals	8
11.	Overall training experience	7

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

5. **Name of the Participant:** Mr. K. Sreerag

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	10
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	6
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	6
8.	Classrooms and Laboratories	7
9.	Field visit and Fieldwork	5
10.	Refreshments and Meals	8
11.	Overall training experience	7

6. **Name of the Participant:** Ms. G. Pavithra

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	7
5.	Training kit and relevant study materials	5
6.	Technical and Non – technical stall support	9
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	10
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	9
11.	Overall training experience	9

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

7. **Name of the Participant:** Mr. Matte Siva Teja

Sl. No.	Particulars	Score
1.	Theme of the programme	8
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	10
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	8
11.	Overall training experience	7

8. **Name of the Participant:** Mr. A. Shanmugam

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	7
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	8
11.	Overall training experience	7

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

9. Name of the Participant: Mr. Niraj Sudhakar Nandane

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	10
3.	Structure and Syllabus of the programme	10
4.	Relevance of the Resource persons for the programme	9
5.	Training kit and relevant study materials	5
6.	Technical and Non – technical stall support	9
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	8
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	9
11.	Overall training experience	8

10. Name of the Participant: Mr. B. K. Aravindan

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	9
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	9
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	7
10.	Refreshments and Meals	8
11.	Overall training experience	9

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

11. Name of the Participant: Mr. M. Sathish

Sl. No.	Particulars	Score
1.	Theme of the programme	8
2.	Efficiency of the organizers	9
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	9
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	6
7.	Boarding and Lodging facilities	10
8.	Classrooms and Laboratories	8
9.	Field visit and Fieldwork	5
10.	Refreshments and Meals	6
11.	Overall training experience	9

12. Name of the Participant: Mr. N. Poonkathir

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	8
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	9
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	8
10.	Refreshments and Meals	8
11.	Overall training experience	9

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

13. Name of the Participant: Mr. P. R. Kumaresan

Sl. No.	Particulars	Score
1.	Theme of the programme	8
2.	Efficiency of the organizers	8
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	9
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	10
7.	Boarding and Lodging facilities	7
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	10
10.	Refreshments and Meals	8
11.	Overall training experience	9

14. Name of the Participant: Mr. Revan Yogesh Chaudhari

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	10
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	6
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	7
9.	Field visit and Fieldwork	8
10.	Refreshments and Meals	9
11.	Overall training experience	9

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

15. Name of the Participant: Mrs. E. Grace Selvarani

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	10
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	6
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	9
7.	Boarding and Lodging facilities	9
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	7
10.	Refreshments and Meals	9
11.	Overall training experience	9

16. Name of the Participant: Ms. A. Ravetha Milki

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	9
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	9
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	6
10.	Refreshments and Meals	7
11.	Overall training experience	8

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

17. Name of the Participant: Ms. B. Ayisha Khanam

Sl. No.	Particulars	Score
1.	Theme of the programme	9
2.	Efficiency of the organizers	8
3.	Structure and Syllabus of the programme	6
4.	Relevance of the Resource persons for the programme	9
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	10
7.	Boarding and Lodging facilities	9
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	9
10.	Refreshments and Meals	9
11.	Overall training experience	9

18. Name of the Participant: Ms. Veenita Rani

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	10
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	8
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	8
7.	Boarding and Lodging facilities	8
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	8
10.	Refreshments and Meals	8
11.	Overall training experience	9

Feedback from the participants

(Scores are provided on a scale of 1 to 10)

19. Name of the Participant: Mr. C. Sadhu

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	7
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	7
5.	Training kit and relevant study materials	7
6.	Technical and Non – technical stall support	7
7.	Boarding and Lodging facilities	10
8.	Classrooms and Laboratories	9
9.	Field visit and Fieldwork	10
10.	Refreshments and Meals	9
11.	Overall training experience	8

20. Name of the Participant: Ms. V. Kirubhanandhini

Sl. No.	Particulars	Score
1.	Theme of the programme	10
2.	Efficiency of the organizers	8
3.	Structure and Syllabus of the programme	9
4.	Relevance of the Resource persons for the programme	10
5.	Training kit and relevant study materials	8
6.	Technical and Non – technical stall support	9
7.	Boarding and Lodging facilities	9
8.	Classrooms and Laboratories	8
9.	Field visit and Fieldwork	7
10.	Refreshments and Meals	9
11.	Overall training experience	9