Thanal

CARBON NEUTRAL MEENANGADI

assessment & recommendations

March 2018

Carbon Neutral Meenangadi – Assessment and Recommendations

PUBLISHED BY :
Thanal
OD-3, Jawahar Nagar, Kawdiar P.O.
Thiruvananthapuram, Kerala, India 695 003,
Tel: +91 471 2727150,
Email: mail@thanal.co.in www.thanal.co.in

Year : 2018
Printed at : Akshara Offset, Thiruvananthapuram-35
Phone : 0471 2471174

Copies : 1000

ISBN :

Carbon Neutral Meenangadi – Assessment and Recommendations

March 2018

Thanal

Carbon Neutral Meenangadi – Assessment and Recommendations

March 2018

PROJECT TEAM

Mr. Jayakumar C.

Ms. S. Ushakumari

Mr. Shibu K. Nair

Mr. Sridhar R.

Mr. Raju S.

Mr. Dileep Kumar A.D.

Mr. V. Nikhilesh Paliath

Mr. Nidhin Davis K.

Ms. Shradha Sreejaya

Mr. Deepak R.

Mr. Ajith Tomy

Ms. Divya Sunilal K.S.

Technical Support/Advice

Dr. Sharadini Rath
Thanal

Dr. P. Indiradevi
Professor, Kerala Agricultural University

Dr. Prasadan P.K.
Dept of Zoology, Kannur University, Mananthavadi Campus

Dr. R. Ajayakumar Varma
Kerala Suchitwa Mission

Brig. Oommen John (Rtd.)
Thanal

Mr. Ajithkumar R.
Social Activist

Ms. Ganga Dileep C.
Recycle Bin- Thiruvananthapuram

Ms. Geetanjali M.R.
Recycle Bin- Thiruvananthapuram

Mr. Hari Krishnan C.U.
Recycle Bin- Thiruvananthapuram

Mr. B.V. Suresh Babu
Ottotractions- Thiruvananthapuram

Dr. Rajasekharan Pillai K.
Manipal University

Ms. Sneha Balakrishnan
University of Arizona

Mr. Shailendra Yashwant
Climate Action Network South Asia

Mr. Anoop Poonia,
Climate Action Network South Asia

Ms. Visakha K.A.
C.E.P.T- Ahmedabad

Mr. Rajesh T.C., Freelance Media Expert

Photo Credits

Mr. Raju S., Thanal

Mr. Nidhin Davis K., Thanal

Mr. Dileep Kumar A.D., Thanal

Foreword

Nearly two year work since 2016 June 5 chasing hope and dreams of youngsters who teamed in Thanal to explore the science of carbon neutral development is an inspirational story. Without any resources but with demands and deadline they worked, the students and youth in the Panchayat and locality led the team forward. Now it is dream come true where we can confidently advice and draw plans if required for offsetting carbon to reach a carbon neutral status which is based on the UNFCCC (United Nations Framework Convention on Climate Change) frame work with limitations clearly acknowledged. Finally with great pleasure we share this brief assessment and pathway to Carbon Neutral Panchayat dream in the context of Meenangadi Grama Panchayat with concrete data sets and details our team collected from Meenangadi.

We are indebted to Dr. T.M. Thomas Isaac , Hon'ble Minister for Finance, Govt. of Kerala for his vision of carbon free development to ensure jobs and increase in per capita earnings as milestone in rural Kerala as a driver of this idea. This report is a design for realizing that vision. We hope there will be villages or districts in Kerala to travel this road for transcending to a low carbon development paradigm. We are sure such efforts will be a big contribution to India's Nationally Determined Contributions (NDCs) under the Paris Commitment. There is not one but a diversity of options based on a common approach- the frame work of emissions and offsets.

We are sharing this in academic and planning domains and all spaces available to enrich the thoughts and rectify lapses if any . We realize that up to date maps ,details of buildings and roads, vehicles, crops and cropping patterns, soil carbon levels and transport data are not available at Panchayat level. We recommend generation of real time data sets at Panchayat level to help the decision makers. We also need robust primary data generation at community level to make the measurements accurate. We faced innumerable challenges and could progress inch by inch as our friends and supporters gave the intellectual backing to move forward. I am proud of the young team in THANAL.

I am also hopeful that we will be able to work with different actors, stakeholders and locations to support efforts in India to replicate the model based on the framework outlined in this work. Climate Resilient Communities are the need of the hour. Climate proofing , mitigating and adapting to changes in weather can be easily addressed when we follow a carbon neutral approach and reduce our emissions, offset the excess through creative ideas. Kerala has immense potential to invest in agro ecology as outlined by FAO (UN Food and Agriculture Organization) and make our soils richer in carbon and thereby move closer to become a low carbon economy.

Let me conclude quoting Author, Politician and Climate Activist Mr. Al Gore "*As human beings, we are vulnerable to confusing the unprecedented with the improbable. In our everyday experience, if something has never happened before, we are generally safe in assuming it is not going to happen in the future, but the exceptions can kill you and climate change is one of those exceptions*."

Jayakumar C.
Acting Executive Director
THANAL

Acknowledgements

This would not have been possible without the help of many wonderful people. We got right people at right time for each and every task. We would like to take this opportunity to express our sincere gratitude to various Government departments, Educational institutions, youth clubs and other volunteer groups for their whole hearted support at different phases of this project.

We thank *Kerala Forest Research Institute (KFRI)*, *Kerala Agricultural University (KAU)* and *Academy for Climate Change Education and Research (ACCER-KAU)* for their technical support during 'Carbon Sequestration Estimation' studies. We would like to express our gratitude towards the officials of *Department of Soil survey and Soil conservation- Govt. Of Kerala, Kerala State Electricity Board, Motor Vehicle Department and Road Transport Office of Sulthan Bathery, Kalpetta and Mananthavady* for their support during the secondary data collection. Land Use Board, Department of Statistics and Economics provided some vital information for preparing the spatial database for Meenangadi grama panchayat. We would like to thank officers of *Police Department*, Meenangadi Circle for their valuable assistance for carrying out some of the field studies related to transport sector. *Regional Agricultural Research Station, Ambalavayal (RARS)* provided the past weather data collected from their weather stations for the past three decades which was very useful for this study. We also acknowledge support and technical inputs of UNICEF to bring in the focus on women and children in climate change.

Apart from these Government departments and agencies, a number of educational institutions also collaborated with 'Thanal' during different phases of this project. We would like to express our gratitude to the students and research scholars from *Department of Applied Zoology, Kannur University Campus - Mananthavady, University of Calicut, University of Arizona and Manipal Academy of Higher Education* who were involved in different aspects of this research project. Student volunteers from the *National Service Scheme (NSS)*units of the following educational institutions have understood the uniqueness of this project and their whole-hearted contribution in primary data collection is impeccable. Volunteers from *Government Higher Secondary School-Meenangadi, National Institute of Technology - Calicut, Government Engineering College - Mananthavady, Govt. Poly-Technic-Meenangadi, Institute of Human Resource Development for Electronics College-Meenangadi and St. Mary's Higher Secondary School-Sulthan Bathery* along with the Student Police Cadets from *Government Higher Secondary School-Meenangadi* were part of the exercise. Mentors from Carbon Neutral Technical Cell and Green Army International have co-ordinated the training and orientation session for the students and volunteers ahead of their field exercise.

Participation of local youth volunteers in this campaign was very important because it is necessary to create a sense of ownership among the people. We would like to express our gratitude for the active participation of the members from youth clubs and libraries such as *Nethaji*

Smaraka Vayanashala, Aksharamithra Vaayanashala, Green Hills Vayanashala and Members of *Kudumbasree units in Meenangadi Grama Panchayat*, in various field surveys. We acknowledge the support and guidance of Mr. I.C. Balakrishnan M.L.A of Sultan Bathery Constituency, Mr. S. Suhas I.A.S, District Collector – Wayanad, Ms. T. Ushakumari, President of District Panchayat – Wayanad, Dr. S. Leenakumari, *Kerala Agricultural Univeristy*, Dr. George Chakkachery, Director – *Institute for Climate Change Studies Govt. Of Kerala (ICCS)*, Dr. Pratheesh C. Mammen, ICCS, Dr. K.T. Sreelatha Kumari, *State Nutrition Officer, State Nutrition Office – Govt. Of Kerala*, Mr. Santhoshkumar T. Asst. Research Scientist, *National Institute of Nutrition – Govt of India* and Mr. Atul Anand, data analyst, Thrissur and Mr. Bency Zachariah, Ottotraction. Most importantly the support from the *Meenangadi Grama Panchayat* leadership was very crucial for the successful completion of this project. We would like to express our heartfelt gratitude to Ms. Beena Vijayan, President – Meenangadi Grama Panchayat, Mr. C. Assainar, Vice President – Meenangadi Grama Panchayat, Mr. V. Suresh, Chairman – Standing Committee on Welfare, the Secretary and Staff of Meenangadi Grama Panchayat, Ward members, Chairpersons of Standing Committees for all the support and services they provided.

We would like to acknowledge and express our gratitude to two special persons, who initiated and took leadership of Carbon Neutral Meenangadi Project. Dr. T.M. Thomas Isaac, Hon'ble Minister for Finance and Coir who coined the idea of carbon neutral development and engaged Thanal Team for exploration. Mr. C.K. Saseendran M.L.A. of Kalpetta constituency of Wayanad, who facilitated the process of planning, research and campaign on Carbon Neutral Development in the District.

Thanal Team

Thanal

Contents

List of Tables

List of Figures

List of Graphs

List of Annexures

1. Executive Summary

Photo : Nidhin Davis K.

The purpose of this project is to propose sector-wise adaptation and mitigation strategies to develop Meenangadi Panchayat of Wayanad district in Kerala as a 'Carbon Neutral Panchayat' by carrying out a carbon emission and sequestration analysis in the sectors of Transportation, Energy, Waste, Livestock and AFOLU (Agriculture, Forests and Other Land Use). The concept of 'Carbon Neutral Community' puts forth the notions of zero carbon development and food-energy self-sufficiency at local government level.

Kerala State Action Plan on Climate Change identifies Wayanad as one of the climate change hotspots in the state. Wayanad is primarily an agrarian district with 50% of its geographical area under plantation and other agricultural land use. The district has 97% rural population and most of them are directly dependent on agriculture for their livelihood. A Green House Gas (GHG) emission profile was prepared for the Local self-government considering afore-mentioned sectors for the baseline year 2016-17. Forests, plantations, homestead trees and organic carbon in soil were considered for calculating amount of sequestered carbon in the district panchayat for the same time period. Broad methodology used for calculating GHG emissions as well as sequestration is based on the equation[1]

Total emissions = ∑ Activity Data X Emission Factor
Total sequestration = ∑ Sectoral Data X Sequestration Factor

Emission factors for various sectors were considered according to Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines with TIER 1 precision level*. Activity data pertaining to various sectors was collected through primary data collection with the help of student volunteers and secondary data from respective Government departments. The estimate shows that there was excess of carbon emissions (Surplus of total emissions over total sequestration in terms CO_2Eq) of **11,412.57** tonnes of CO_2Eq in 2016-17. A recommendation on action plan supported by an institutional mechanism at the local self-government level with short term and long term strategies for achieving carbon neutrality by 2020 has been proposed as a major outcome of this project.

* *In IPCC terminology, the lowest ranking or simplest method is "Tier 1", while more elaborate methods are "Tier 2" and "Tier 3." Tier 1 methods typically utilize IPCC default emission factors and require the most basic, and least disaggregated, activity data. Higher tiers usually utilize more elaborate methods and source-specific, technology-specific, region - specific and/or country-specific emission factors, which are often based on measurements, and normally require more highly disaggregated activity data.*

2. Introduction

Blue Capped Rock-Thrush

Photo : Raju S.

The state of Kerala *(Figure 1)* is blessed with rich biodiversity potential which also makes it highly vulnerable to climate change. According to State Action Plan on Climate Change[2] Kerala is severely vulnerable to climate change. Districts of Palakkad and Alappuzha are under Very High Vulnerable category where as Wayanad, Kannur, Idukki and Thiruvananthapuram are Highly Vulnerable to climate change (Figure 2) with a high degree of vulnerability to natural hazards like flood and drought; impact on biodiversity and human life. The degree of vulnerability of climate sensitive sectors like agriculture, fisheries and forests, tribal population and low ranking in the human development index were considered in identifying the hotspots. Wayanad is basically agrarian, with plantation economy playing a major role[3]. Agriculture sector is especially vulnerable to climate extremities and unpredictability. Deficit rainfall and increasing temperature will impact the productivity of thermo- sensitive crops like coffee, tea, pepper and cardamom, and therefore has serious implications for food security and local economy of Wayanad district. In Kerala, the emission rate of Carbon dioxide (CO_2) and other Green House Gases (GHGs) are comparatively low. Kerala has a fragile ecosystem which has critical eminence for carbon sequestration potential.

The concept of 'Carbon Neutral District' puts forth the notions of zero carbon development, nature conservation, food and energy self-sufficiency, economic well-being and development at local self-government level.

It was identified that the major cause of temperature rise is the uncontrolled emissions of greenhouse gases. CO_2 occupies major share in GHGs hence the assessment of emission levels make use of CO_2 as an equivalent indicator. Carbon neutrality refers to achieving net zero GHG emission by balancing the measured amount of carbon released into atmosphere due to human activities, with an equal amount sequestrated in carbon sinks. It is crucial to restrict atmospheric concentrations of GHGs released from various socio-economic, developmental and life style activities using biological or natural processes. It is recognized that addressing climate change is not as simple as switching to renewable energy or offsetting GHG emissions. Rather, providing an opportunity for innovation in new developmental activities for viable and effective approach to address the problem.

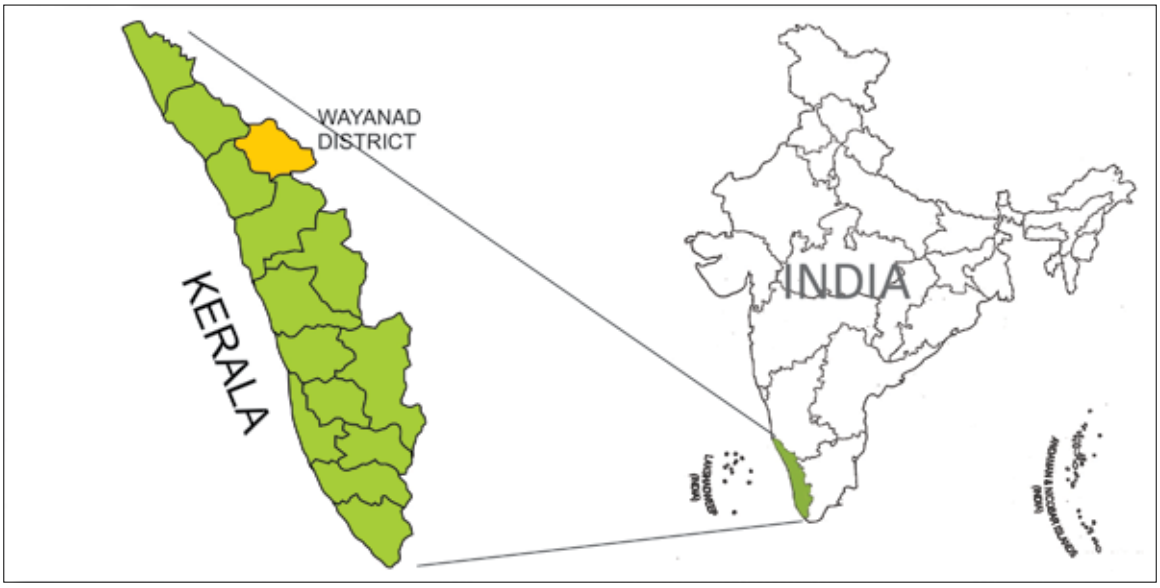


Figure 1
Location Map of Kerala

2.1 Genesis

The Paris Climate Change Agreement's (2015) central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below two degree Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degree Celsius. To do so effectively requires a carbon neutral world by the second half of this century. Earth's climate is undergoing continuous natural changes for centuries. However the variations in the last couple of centuries cannot be explained by natural climatic variations alone. Inter-governmental Panel on Climate Change (IPCC) had observed that this is due to global warming. The increase in global average temperature is due to the observed increase in anthropogenic greenhouse gas concentrations. Anthropogenic climate change has a significant role on physical and biological systems all over the globe. The overarching concern of climate change is that it will result in disintegration of the Earth's capacity to provide for, and support, human life. In 2009, Ministry of Environment and Forest, Government of India launched a report on National GHG Emission for the year 2007 [4]. The report highlighted the GHG emissions from various sources situated within the geographical boundary of the country. In India, the meteorological records indicate rise in the mean annual surface air temperature by 0.4°C with not much variations in rainfall. However, the rates of change in temperatures and precipitation have been found to be varying across the region. The intensity and frequency of heavy precipitation events have increased in the last 50 years. The tide gauge observations in the last four decades across the coast of India also indicate a rise in sea level at the rate of 1.06-1.25 mm/year. Further, some preliminary assessments point towards a warmer climate in the future over India, with temperatures projected to rise by 2 to 4°C by 2050. No change in total quantity of rainfall is expected, however, spatial pattern of the rainfall are likely to change, with rise in number and intensity of extreme rainfall events. The sea level is also projected to rise with cyclonic activities set to increase significantly with warmer oceans. The continuous warming and the changing rainfall pattern over the Indian region may jeopardize India's development by adversely impacting the natural resources such as water, forests, coastal zones, and mountains on which more than 70% of the rural population is dependent.

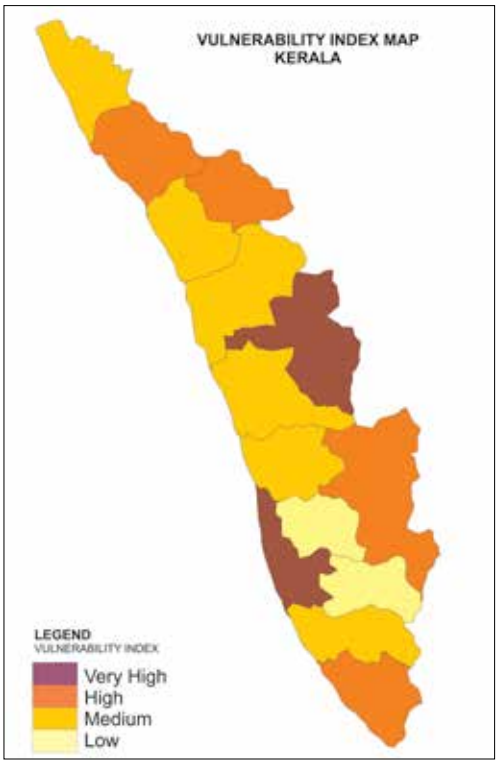


Figure 2
Climate Vulnerability Map of Kerala [2]

The accumulation of GHG in the atmosphere has led to global warming. If the world is indeed serious about making climate-friendly investments, it must consider the opportunity provided by a country like India where economic growth could be achieved with minimum level of emission by employing new technologies. Having said that, to achieve India's ambitious Intended Nationally Determined Contributions (INDCs) as per the Paris Agreement 2015, it is crucial that our future development activities follow a "Carbon-Neutral" trajectory. Carbon neutrality stands for "net zero emission" of GHGs from anticipated anthropogenic activities.

Post-Paris climate* commitments, Dr. T.M. Thomas Isaac, Finance Minister of Kerala and a well-known economist, wanted to set an example in the state for the rest of the country to follow. Wayanad district—nestled in the Western Ghats on the extension of Deccan Plateau and home

to crops that are thermo-sensitive and vulnerable to climate change such as coffee, paddy and pepper—was selected for a community-based climate change adaptation initiative called "Carbon Neutral Wayanad". A pilot project was then launched at a local self government (LSG) level on June 5, 2016. Meenangadi Grama Panchayat leadership came forward to take up the responsibility to be a model Panchayat for Wayanad district and the rest of the country. The non-profit organization Thanal was entrusted by the Kerala government to provide technical assistance to this flagship project.

When the project kick started in the field, it was a collective effort from the elected representatives, various youth clubs, students from different educational institutions, Kudumbasree (women self help groups) members, various experts under the supervision of Thanal team along with the local self-government with the support of District Administration and Government of Kerala. This kind of collectiveness created a sense of ownership of the project among the local people and it will reflect on the smooth implementation of various strategies and projects. Thus, this community level pilot scale project is of utmost importance to showcase as a model for other local governments in the district to follow and which in turn will make way for the concept of a 'Carbon Neutral District'. In general, Meenangadi Panchayat will serve as a laboratory for developing a 'Sustainable Development Framework' scientifically reinforced and catering to all needs of the people by mainstreaming Climate Change Adaptation as a core element in the development plans.

Dr. Thomas Isaac, Finance Minister for Kerala at Launching of Carbon Neutral Meenangadi Project on 5th June 2016

Photo : Dileepkumar A.D

2.2 Relevance

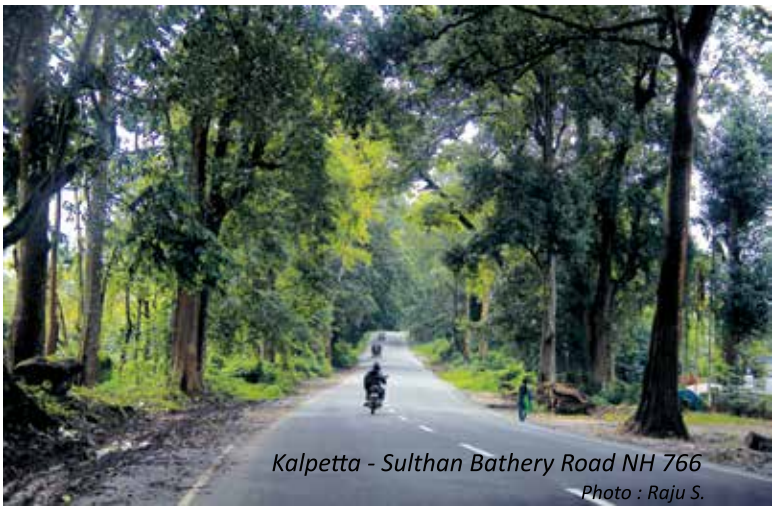
Low carbon development aspect took the central stage in global climate change adaptation development discussions after Paris Agreement at Conference Of Parties-21 (COP21). India has committed to reduce the GHG emission intensity by 33-35% by 2030 from 2005 levels. Rather, providing better livelihood opportunities and building socio-economic resilience through adaptation strategies are effective approach for addressing the problem. This philosophy is the backbone of this project and makes it unique.

State of Kerala always has been a model for other states to follow it's footsteps in various sectors such as Health, Education and Environmental conservation. Carbon Neutral Meenangadi is such an innovative project with a community based climate change adaptation approach which is a model that can be replicated for the rest of the country.

* *COP21, United Nations Climate Change Conference 2015, Paris*

2.3 Profile of Meenangadi Grama Panchayat

Wayanad district lies in the Western Ghats and at a distance of 76 Km from the seashore of Kozhikode at a height of 700-2100 meters above sea level on the north eastern part of the state of Kerala. The name Wayanad derived from the expression 'vayal nadu' the land of paddy fields which comprise an area of 2131 sq.kms and it is bounded on the east by the Nilgiris (Tamil Nadu) and Mysore (Karnataka) and in the north by Kodagu (Karnataka) districts. As the district is located completely at the highland region it's climate and land use pattern shows significant difference from all other districts of Kerala. The major portion of total land area of the district is coming under three major categories which include forest land (39.62%), plantation land (39.02%) and agriculture land (10.94%)[3].



Kalpetta - Sulthan Bathery Road NH 766
Photo : Raju S.

Meenangadi is one of the 25 Grama Panchayats (Local self government) in the Wayanad district. The Panchayat is situated *(Figure 3)* in the central part in between major urban centres, Kalpetta and Sulthan Bathery. National highway-766 which connects Calicut to Mysore passes through Meenangadi and major commercial establishments are situated along this highway. Meenangadi covers a geographical area of 53.52 Sq. Km with rocky hilly area, valley and plains. Some portions of Meenangadi falls under the rain-shadow region of Wayanad district since the district is situated on the eastern slope of the Western Ghats. Even though it receives an annual rainfall of about 2200 mm, some parts of Meenangadi experience water shortage during summer season. Recent unpredictable changes in rainfall pattern and untimely precipitation are impacting the productivity of highly thermo sensitive crops like coffee which is a major plantation crop in Meenangadi as well as in Wayanad. The region experiences a wide range of temperature ranging from around maximum temperature of 35°C during summer season (March-May) and maximum temperature of 29.8°C during winter season(December-

Student Volunteers who participated in Surveys at Meenangadi
Photo : Raju S.

February) where as minimum temperature in the ranges from 15°C to 12.5°C during respective seasons[6].

It is part of Sulthan Bathery Assembly constituency and Wayanad Parliament constituency. Meenangadi has a total population of 34,601 distributed across 8199 households as per Census-2011. The density of population in the Panchayat is 646 persons per Sq.Km. More than 70% of the total area is tableland and 20% is fertile plains. Nearly 2.7 % (145 ha) of the total area is covered by forest. Panchayat is divided into 19 wards and the Panchayat falls in two revenue villages namely, Krishnagiri and Purakkadi.

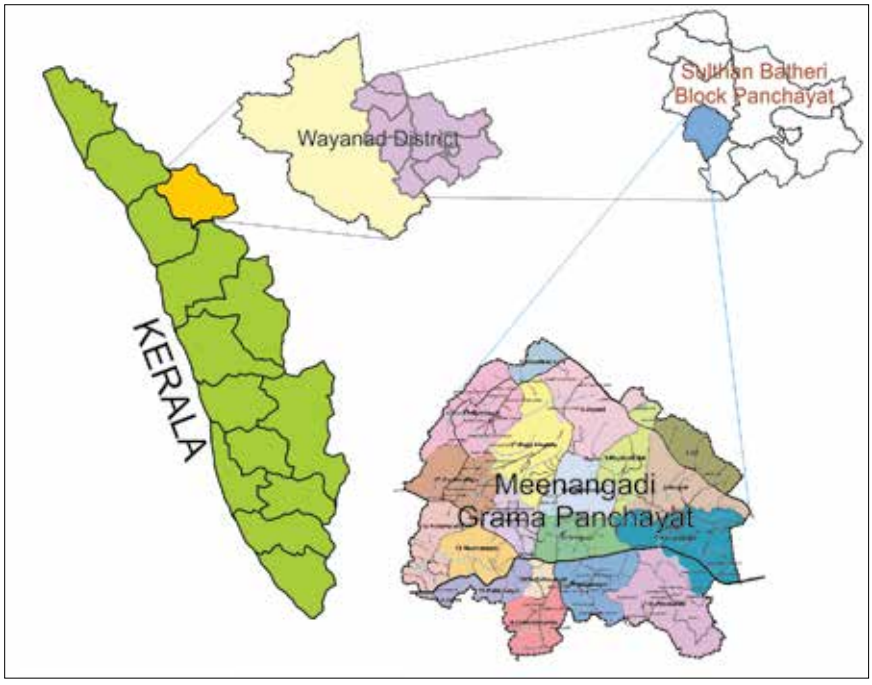
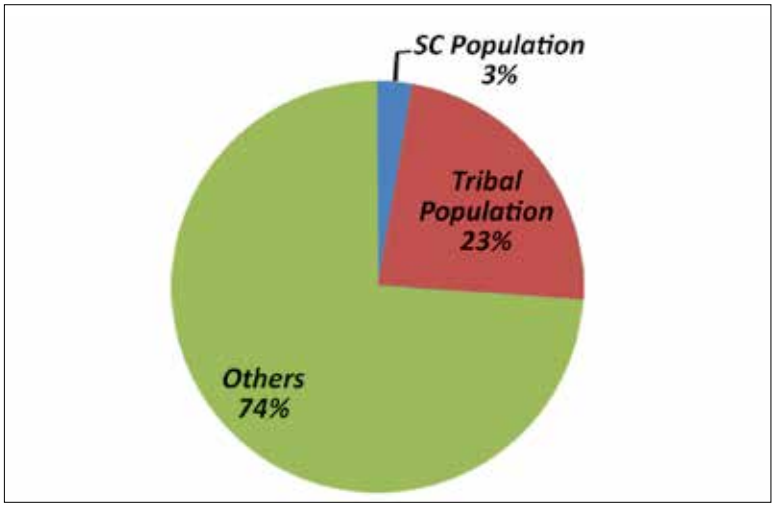


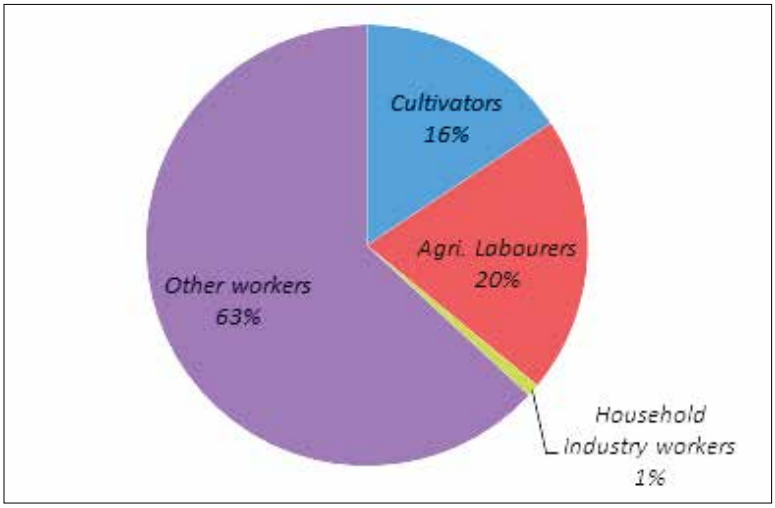
Figure 3
Location Map of Meenangadi Grama Panchayat

Tribal population account for about 23% of total population *(Graph 1)* of Meenangadi. *Kurumar/Mullakkurumar, Paniyar, Kaattunaykkar, Vettakkurumar(Urali)* and *Kurichyar* are the tribal communities of Meenangadi. These communities are dependent on non timber forest produce and agriculture. Some of them find jobs in coffee plantations in Kerala and Karnataka. The tribal communities are highly vulnerable to climate change, since their livelihood is dependent on climate sensitive crops and or resources from forest.



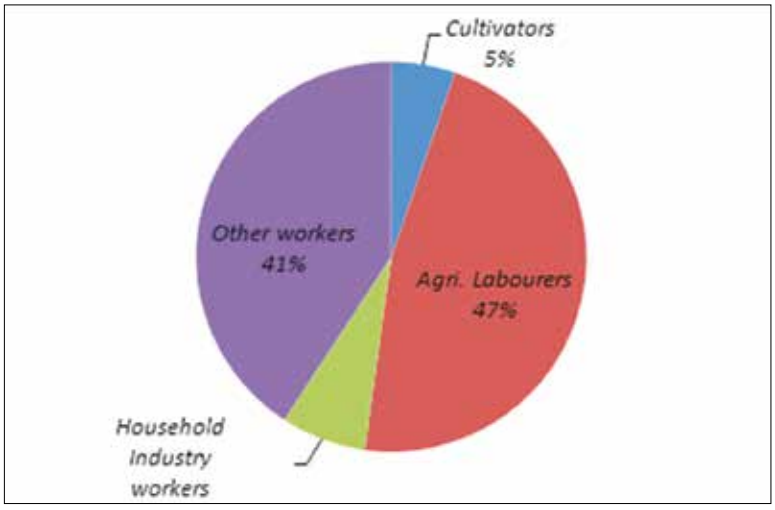
Graph 1
Composition of Population in Meenangadi Grama Panchayat

The literacy rate (as per 2011 census) of the Panchayt is 81%, which is well below the literacy rate of Kerala State (93.91%) and Wayanad District (89.2%). The literacy rate among tribal communities within the Panchayat is about 78.5%*. People are engaged in cultivation, agriculture labour, household level industrial work and other occupations.



Graph 2
Composition of Major Occupations

On analyzing the contribution of each sector in providing main income *(Graph 2)* for the people, Non agriculture work is providing more jobs than agriculture sector. It supports about 63%** of workers for their main livelihood. Whereas agriculture provides about 36% only.



Graph 3
Composition of Marginal Occupations

The agriculture sector dominates as the source for marginal income in the Panchayat *(Graph 3)* with a contribution of 52%. It shows that people prefer agriculture labour in coffee plantations or paddy cultivation since the income is definite in terms of wages. Taking up farming is still a risky business due to market as well as climate fluctuations.

* *Meenangadi Grama Panchayat: Sub plan for Scheduled Tribes 2015-16, KILA*

** *Basic statistics for local level development, Govt. of Kerala 2015-16*

2.4 Land use

The satellite image of the Meenangadi Panchayat gives a general understanding about the prevailing physiography of the region, and a similar satelite image based map was used for community mapping. As evident from the aerial imageries most parts of the Panchayat have hill-valley patterns *(Figure 4)* with plantation crops on the high slopes and paddy cultivation on the valleys. Paddy fields are getting converted into banana and other cash crops which is adversely impacting the ground water levels. Meenangadi Panchayat has four major streams and 23 rivulets, it is also connected with an aquaduct from Karappuzha dam. Rural style of living dominates in majority of the wards and commercial spine is concentrated along the National highway.

*Figure 4 Major Physiography of Meenangadi Grama Panchayat**

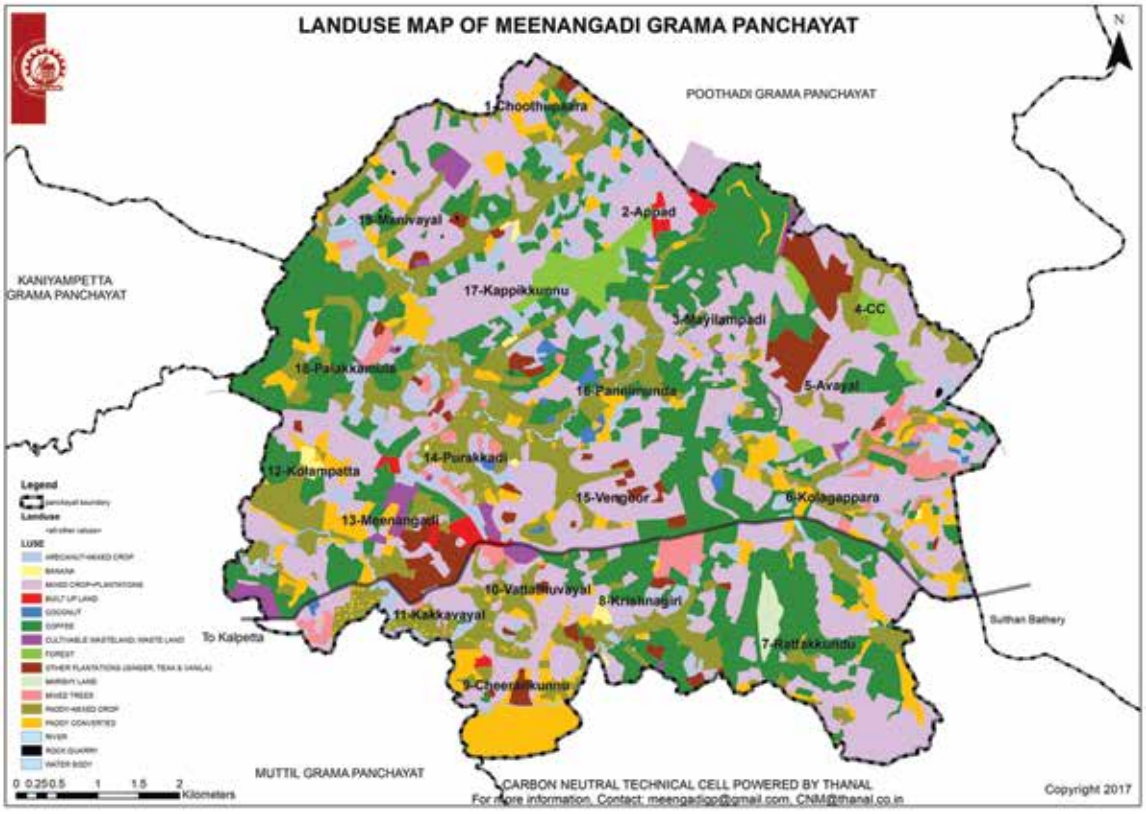
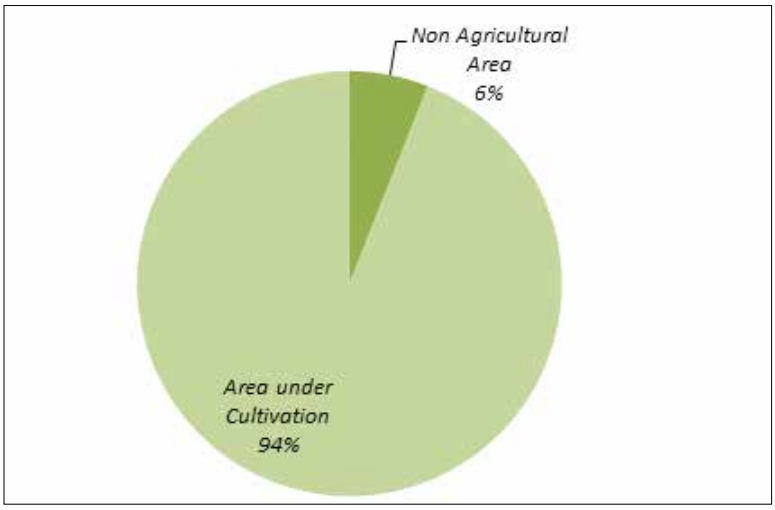


Figure 5 Land Use Map of Meenangadi Grama Panchayat

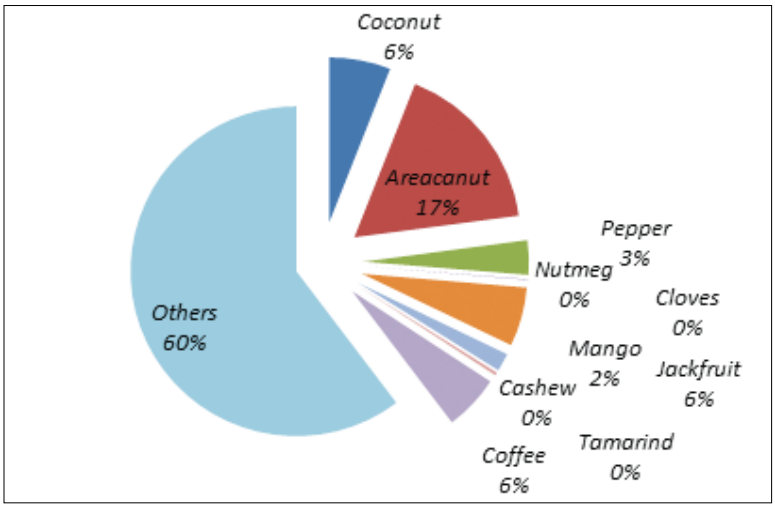
* *Ms. Ganga Dileep C, Recycle Bin*

About 70% of the total area of Meenangadi Grama Panchayat is table land and 20% is fertile plains. Nearly 3 % (1.45 Sq.Km) of the total area is covered by forest *(Figure5)*. 94% of the land available *(Graph 4)* except forest is being utilized for agriculture purpose and a meagre less than 1 % land is fallow and about 6%* is non agriculture land.

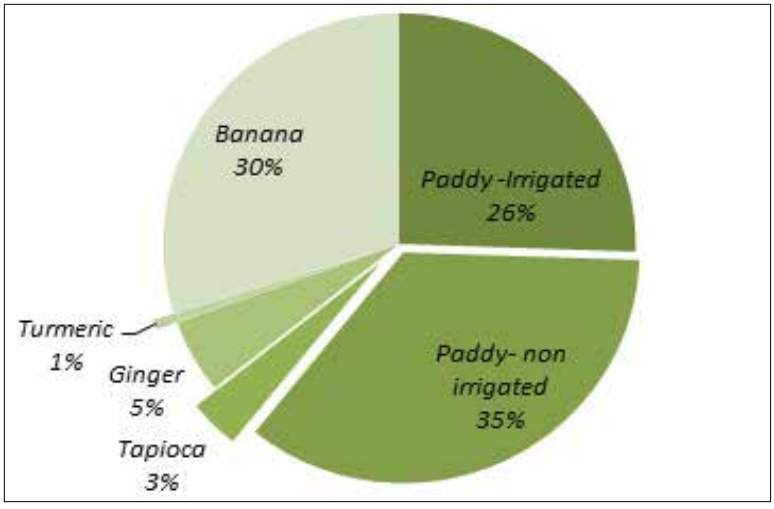
About 4674** ha. is utilized for cultivation of perennial crops. Coffee in homesteads and other mixed crops constitute 60%. Large coffee plantations occupy 6% of perennial crops *(Graph 5)*. About 1005 ha. is under seasonal crops, mainly paddy and banana. Both are sensitive to climate. Ginger is another major climate sensitive crop which occupies about 5% of land use *(Graph 6)*. There is a trend in change in land use. Cultivation of perennial crops is slowly and steadily expanding from homesteads to the paddy and wetlands for economic as well as climate reasons.



Graph 4 Area under cultivation in Meenangadi Grama Panchayat



Graph 5 Perennial Crops undercultivation in Meenangadi Grama Panchayat



Graph 6 Seasonal Crops under Cultivation in Meenangadi Grama Panchayat

* *Basic Statistics for Local Level Development, Govt of Kerala 2015-16*
** *Ibid.*

Agricultural Land Use in Meenangadi

Photo : Nidhin Davis K.

2.5 Infrastructure

The road network forms major infrastructure for the Panchayat. There is about 218 km* road available, of which 12 km maintained by National and State Highway authorities and 42 km road belong to State Public Works Department (PWD). Sulthan Bathery Block Panchayat is maintaining 24 km of roads and the rest of 140 km village roads are maintained by the Meenangadi Grama Panchayat.

There is a canal network for irrigation which covers 106.8 hectare of agriculture land. 48 ponds in the private properties also support irrigation for agriculture. There are 264 drinking water schemes in the Panchayat of which 12 are not functioning and two projects yet to complete.

Meenangadi Town

Photo : Nidhin Davis K.

There are three Lower Primary Schools, three Upper Primary Schools, two High schools and one Higher secondary school in Meenangadi. There are four village level reading room and library, seven sports and arts clubs for the youth and two mini stadiums which acts as cultural and sports activity centres. A community health Centre with 16 bed capacity, a Homoeo and an Ayurveda Clinic operates in the Panchayat to provide free or subsidized health services for public. There are two markets and a bus station cum commercial centre in panchayat which acts as a central hub of commercial activities.

See *annexure 1* for the spatial data of Meenangadi Grama Panchayat.

* *Basic Statistics for Local Level Development, Govt. of Kerala 2015-16*

2.6 Biodiversity


Signature Spider
Photo : Raju S.

Meenangadi Grama Panchayat published a Biodiversity Register in 2013 January. As per the biodiversity register, the major ecosystem habitats prevalent in Meenangadi Grama Panchayat are; Wetlands, Forests, Planta tions and Homesteads.

Wetlands include Biodiversity in and around cultivated and non cultivated agricultural fields and other wetlands like ponds, streams etc. 41 species of plants and trees were identified out of which seven species were weeds and 17 species were cattle feed plants. 21 species of insects, 36 types of vegetables and 69 varieties of rice were documented from the wetlands in The Panchayat. Out of the 69 cultivars of rice, 45 were traditional and 24 were hybrid. The crop varieties from upland include 14 varieties of pepper, five varieties of coffee and 13 varieties of tubers.

Forests and Plantations are rich in floral as well as faunal diversity though forest area is prevalent only to two wards of the Panchayat namely C.C* and Avayal. A total of 240 species of plants and trees have been identified from the forests and plantations of the Panchayat out of which 140 species were herbs, 55 species were trees. 12 species of wild plants, 14 species of water plants, 5 species of wild relatives of crops and 14 species of wild ornamental plants were also identified. The faunal diversity include 88 species of birds, 20 species of mammals, 16 species of fishes, 15 species of reptiles, 12 species aquatic animals and five species of frogs. 40 species of butterflies, five species of dragonflies and damselflies and 38 other species of insects were also documented in the Biodiversity register.


Indian Pond Heron-Nesting
Photo : Raju S.

Homesteads were also rich in flaural diversity. 28 species of fruit trees, 41 species of herbs, 57 species of ornamental plants 13 species of trees of timber value were identified from the homesteads of the Panchayat. 11 species of pets/domestic animals and seven species of pet fishes were also identified.

* *C.C is a name of a ward in the Panchayath which evolved from the name of a plantation.*

2.7 Meenangadi Bird Monitoring

Thanal team has planned a long term continuous bird monitoring programme to record and establish behaviour of birds and climate change. The baseline survey with a pre defined survey methodology recorded a total of 185 species of birds representing 80 families *(annexure 2)*. The survey came across three threatened species namely Wooly-necked Stork, Oriental Darter and Black-headed Ibis which come under International Union for Conservation of Nature (IUCN) Red list category. The survey also came across nine Western Ghats Endemic birds with fairly good density. 13 species of birds come under Schedule 1 category of Wildlife Protection Act 1972 (WPA).

Bird Monitoring
Photo : Nidhin Davis K.

Breeding of 49 species of birds were recorded. Out of these 24 species were seen breeding in the wet season of which eight were water birds. 16 species of perching birds were found breeding during the wet season. Breeding season for these species is considered to be between September and March indicating a shift in their breeding season. The survey also identified 124 species of butterflies belonging to 5 families and 32 species of dragonflies and damselflies belonging to 9 families.

3. Research Methodology

Photo : Nidhin Davis K.

This chapter explains the scientific methodology used to estimate the total GHG emissions in terms of tonnes of CO_2Equivalent (CO_2Eq) and similarly the carbon sequestration occurring at various levels in Meenangadi panchayat. This estimation framework can be used to carry out similar estimations in other local self-governments in Wayanad district with some site specific alterations. Developing such a detailed estimation framework for a local self-government scale was a challenging task and the study collated information and references from a large number of International journals and global protocols.

The Kyoto Protocol (1997) refers to the following gases: Carbon dioxide (CO_2), Nitrous Oxide (N_2O), Methane (CH_4), Sulphur hexafluoride (SF_6), hydro fluorocarbons (HFCs) and perfluorocarbons (PFCs) as Green House Gases. Uncontrolled emissions of these gases as a result of anthropogenic activities accelerated the climate change phenomenon. Thus quantification of theses GHGs in a political boundary signifies the contribution of that particular region to this global challenge. Carbon dioxide (CO_2), Nitrous Oxide (N_2O) and Methane (CH_4) were considered for this particular inventory since the emissions of other GHGs are negligible. CO_2 being the most abundant Green House Gas contributing almost 75-80% of total GHG emissions, quantities of N_2O and CH_4 are converted in terms of CO_2Eq by multiplying it with corresponding Global Warming Potential (GWP) values *(Table 1)*.

Table 1 GHGs and their GWP Values

Industrial Designation or Common Name	Chemical Formula	Lifetime (Years)	Radiative Efficiency ($Wm^{-2}ppb^{-1}$)	Global Warming Potential for Given Time Horizon (100 Yr)
Carbon dioxide	CO_2	Upto 100 yrs	1.4×10^{-5}	1
Methane	CH_4	12	3.7×10^{-4}	21
Nitrous oxide	N_2O	114	3.03×10^{-3}	310

Estimation of emission of these gases is carried out in different sectors on an annual basis. The Intergovernmental Panel on Climate Change (IPCC)[10] refers to four major sectors to be included in national inventories; Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), Waste and Transportation with each sector further subdivided into several categories. India is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and Government of India has to submit a National Inventory on GHG emissions in its National Communication submission to UNFCCC. There are several studies and research papers on sectoral and State wise GHG emissions but there is a lack of research on regional scale or district level emission inventory. Thus there is no established methodology for assessing 'Carbon Status' at regional or sub-national scale. Therefore developing a 'tailor made' research methodology for estimating GHG emissions at a local self-government level by strictly adhering to IPCC guidelines for each contributing sector was the most challenging part of this research. Planning for climate action begins with developing a GHG inventory. An inventory enables local governments to understand the emissions contribution of different activities in the community. Scoping of emission inventory was carried out according to Green House Gas Protocol for Communities. UNEP's low carbon mobility tool kit was used to estimate emissions from transportation sector within the political boundary of the region. Activities taking place within a region can generate GHG emissions that occur inside the region boundary as well

as outside the region boundary. To distinguish among them, the GPC classified emissions into three categories based on where they occur: scope 1, scope 2 or scope 3 *(Figure 6)* emissions and this particular emission inventory covers scope 1 and 2 emissions. As per IPCC Guidelines, three hierarchical tiers are used to categorize the methodological complexity of emissions factors and activity data. Tier 1 uses default data and simple equations, while Tiers 2 and 3 are each more demanding in terms of complexity and data requirements. Tier 2 methodologies typically use country-specific emission factors. Methodology used for calculating GHG emissions is based on a linear equation

Total emissions = ∑ Activity Data X Emission Factor
Total sequestration = ∑ Sectoral Data X Sequestration Factor

Activity data is a quantitative measure of a level activity that results in GHG emissions taking place during a given period of time. For this research, activity data was generated by carrying out an extensive primary data collection at house hold level for various sectors. An emission factor is measure of the mass of GHG emissions relative to a unit of activity. In this project the total carbon emission was estimated for transportation, energy, waste and AFOLU (Agriculture, Forestry and Other Land Use). Carbon emission for transportation, energy and waste was calculated using emission factors from internationally approved toolkits relevant for India. Secondary data was used for assessing the emissions from AFOLU sector. The emission from the transportation sector was estimated based on both primary and secondary data on vehicles from motor vehicles department and sample surveys. The emission from energy sector was measured based on primary data obtained from sample energy audit done at households as well as the consumption data obtained from Kerala state electricity board and liquid petroleum gas dealers. Estimating CO_2 emission from the use of electricity involves multiplying data on kilo watt/hours (kWh) of electricity used by the emission factor (kg CO_2/kWh) for electricity which will depend on the technology and type of fuel used to generate electricity. The information on waste was collected through primary sample surveys and observations.

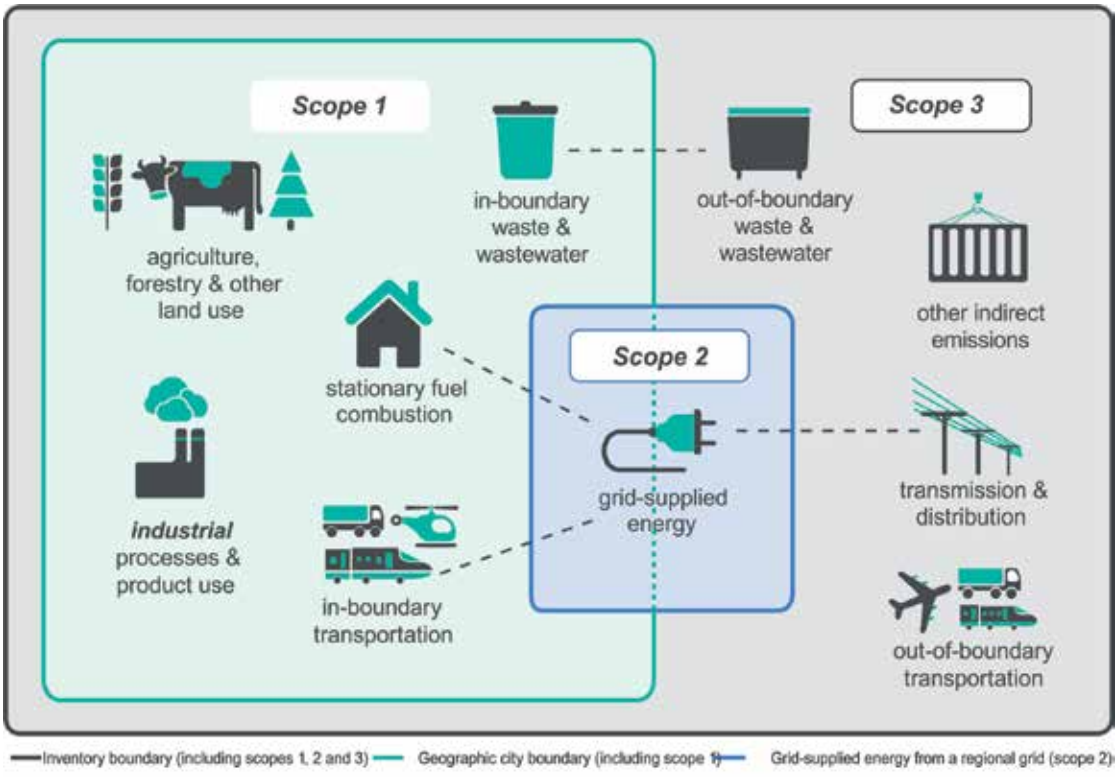


Figure 6 Classification of Scoping of Inventory
(Source : Green House Gas Protocol for Communities)

Total carbon was estimated for soil, trees in the homestead, forests and coffee plantations. The estimation of organic carbon in the soil was based on the study report of department of soil survey and conservation. A primary survey in the household level was conducted to collect information on trees such as number of trees, species, volume and age. About 50% of the households were covered under this survey. The tree species were identified and its Average girth (Ag) and Average height (Ah) is measured in metres. The volume of tree trunk is calculated and Above Ground Biomass (AGB) is calculated by multiplying the volume with form factor to accommodate un even radius of the tree from bottom to top. Similarly the Below Ground Biomass (BGB) of the root system is calculated by multiplying the AGB with a constant factor. Wood density of each tree species were used to derive the carbon stock from total volume of biomass. This study used secondary data for assessing carbon sequestration in forests and coffee plantations.

4. Limitations of Study

Photo : Raju S.

This project is a unique initiative by a local self-government supported by a visionary state government to set up a replicable model of a community based climate change adaptation project for the rest of the country. It was first of a kind attempt and there are many limitations for this campaign cum research project which includes the following aspects:

Emission inventory was limited to three major Green House Gases such as Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (NO_2). Inventory was limited to scope 1 and scope 2 precision level for all the sectors.

Similarly carbon sequestration estimation was limited to soil carbon, above and below ground biomass of homestead trees and carbon stored in forests and plantations.

Primary data collection was a major challenging part; and various sampling strategies were used to get a representative data of the Panchayat. Most of the secondary data was available at district level and extrapolation based on the population and number of households was carried out to assimilate the data at Panchayat level.

Emission inventory in the transportation sector is a complicated process and it was scoped down to emissions from internal traffic from the vehicles of residence of Meenangadi.

It is very important to understand the future trends based on the present and historical emission trends. The study used simple average based projections by extrapolating district level historical emission data to Panchayat level. Even though there are more accurate and reliable GHG emission models which were out of the scope of this study.

Given all the limitations of financial and technical constraints, the team have made a sincere effort to carry out an inclusive and comprehensive emission inventory and sequestration studies.

The technical skill and experience of the Thanal team was limited and made all efforts to overcome this limitation by consulting experts in the field from various sectors.

5. Baseline Assessment

Photo : Raju S.

A baseline assessment study was carried out during 2016-17 in the Meenangadi Grama Panchayat to assess GHG emission and sequestration profile.

5.1 GHG emission

Transportation, Energy, Waste, and AFOLU (Agriculture, Forestry and Other Land Use) sectors were assessed for GHG emission profile of Meenangadi Grama Panchayat

5.1.1 Transportation

Highly rated tourist destinations and important state and National highways attract vehicular traffic into this region. Although Meenangadi's vehicle ownership levels and mobility demands are still relatively low, both are rising. It is imperative that the transport sector experiences a 'course correction' early in this growth phase, before technologies and transport choices become locked into emission intensive patterns. Various options exist for enabling growth in mobility while tackling emissions, though it seems relatively little detailed evaluation of their probable costs and GHG emission consequences in an Indian context *(Table 2)* are available.

Even though interventions in Transport sector at a local self-government level for reducing the emissions is beyond the scope, on a pilot scale by introducing e-rickshaws and strengthening of public transport facilities and infrastructure facilities will make a positive impact on mitigation efforts of the overall emissions. It needs national and state level policy interventions on a large scale. Government of India as well as Government of Kerala have taken this issue very seriously and started setting up some ambitious targets for achieving low carbon mobility by 2030 [7].

Table 2 Emission Factors and AACD Considered for various types of vehicles

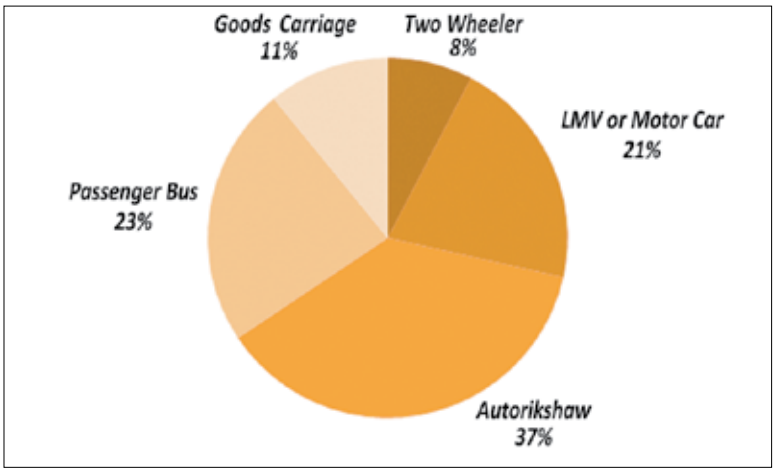
Vehicle Type	AACD* (in KM)	Emission Factor	
		CO2 (Kg/km)	N2O (g/km)
Two Wheeler	6300	0.0324	0.19
LMV or Motor Car	12600	0.149	0.2
Auto rickshaw	33500	0.1322	1.28
Passenger Bus	100000	0.328	1.2
Goods Carriage	63000	0.5375	1.3

Table 3 Total Emission of Carbon from Transportation

Vehicle Type	Total No.	AACD (in Km)	CO2(Kg/km)	N2O (g/km)	N2O in Tonnes of C02 Eq.	CO2 in tonnes of CO2 Eq	In Tonnes CO2
Two Wheeler	1990	6300	0.0324	0.19	738.4293	406.1988	1144.63
LMV or Motor Car	1160	12600	0.149	0.2	906.192	2177.784	3083.98
Autorickshaw	315	33500	0.1322	1.28	4187.232	1395.0405	5582.27
Passenger Bus	50	100000	0.328	1.2	1860	1640	3500
Goods Carriage	27	63000	0.5375	1.3	685.503	914.2875	1599.79
	Total Emission in Tonnes of CO_2 Eq.						14910.7

* *Annually Average Covered Distance. Source: India specific emission factors by India GHG Program toolkit by WRI India*

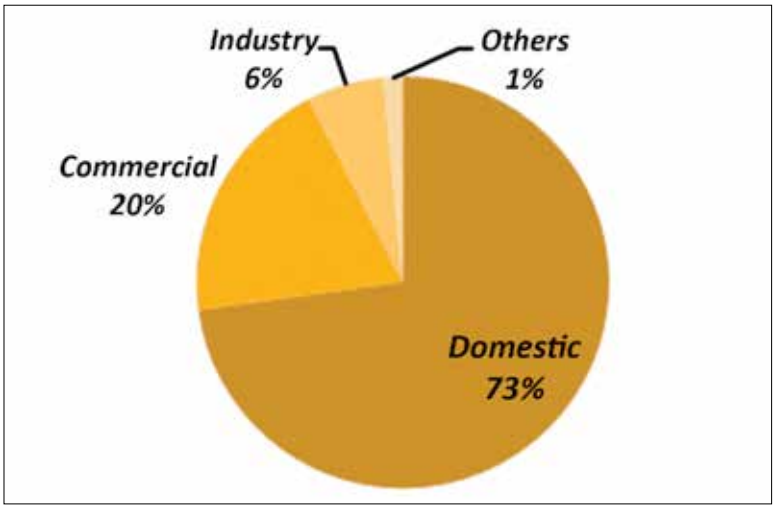
Estimate shows that transportation sector contributes about 45% *(Graph 13)* of total GHG emissions in Meenangadi. And major share of emissions are from diesel powered auto rickshaws followed by passenger buses and motor cars. The public transportation facilities are not adequate except for the state and national highways. Therefore people depend largely on auto rickshaws for their daily commute. Being a high range region Lite Motor Vehicles (LMVs) are dominated by diesel fuelled four wheelers like Jeeps. These two categories contribute majority *(Graph 7)* of the GHG emission from the sector.



Graph 7 GHG Emission Profile - Transportation Sector

5.1.2 Energy

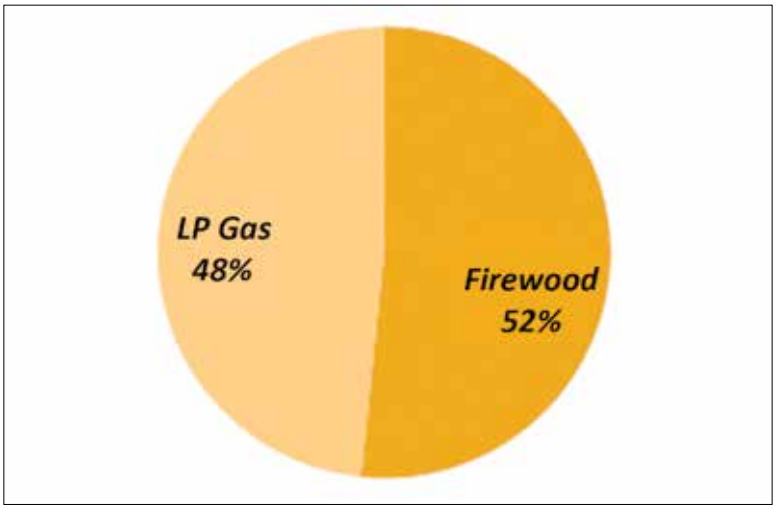
Energy sector account for the emissions from Electricity consumption and emissions from the other types of fuel used for meeting domestic energy needs. This sector contributes about 39% *(Graph 13)* of total GHG emission from Meenangadi. Most of the families in Meenangadi use firewood as a major fuel for the domestic cooking needs. Even though most households have LPG connections, they use firewood as a supplementary source for cooking and other related needs. Emissions from firewood burning are the direct emission where as those from electricity consumption is the indirect emissions. Data of consumption of electricity of commercial and small scale industrial establishments were obtained from Kerala State Electricity Board *(Table 4)*. Electricity consumption at household level contributes 73% of total emission from Electricity Segment *(Graph 8)*. This may increase as the non electrified houses get electrified. Similarly total firewood consumption in households is projected *(Graph 9)* from the sample household energy audit conducted in the Panchayat. Firewood consumption for cooking is common in the region. Access to firewood in the region is easy and cheap. This have created a market for firewood to be used in commercial establishments like restaurants, community halls etc. Share of Electricity consumption is the highest (81%) in terms of contribution *(Graph 10)* to GHG from Energy Sector.



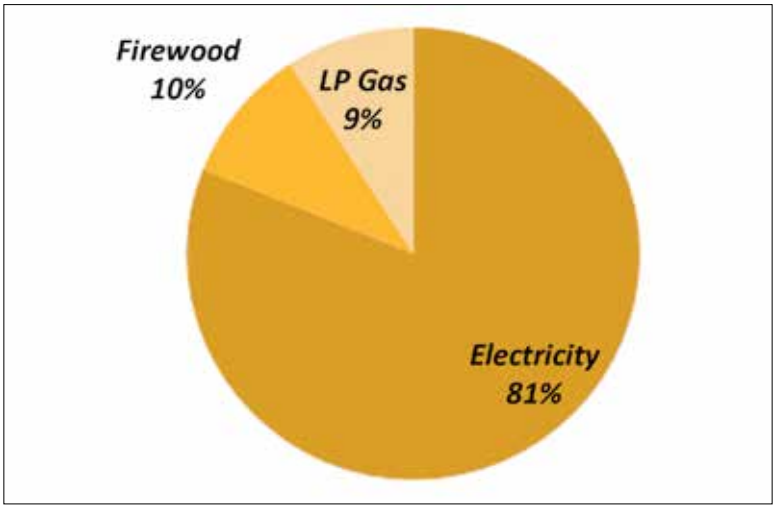
Graph 8 GHG emission Profile of Electricity consumption

Table 4 GHG emission from Energy Sector

Source	Sector	EF (Tonne/MWh)	Consumption (MWh)	CO2 Eq Emissions (in Metric Tonnes/Yr)
Electricity	Domestic	0.81	9534.2703	7722.76
	Commercial	0.81	2569.6797	2,081.44
	Industry	0.81	789.4557	639.46
	Others	0.81	198.8027	161.03
Firewood	Domestic	0.81	3366.76	1279.36
LP Gas	Domestic	0.81	413.28	1198.51
Total				13082.56



Graph 9 GHG emission from consumption of other energy sources



Graph 10 GHG emission Profile from Energy Sector

5.1.3 Waste

'Zero Waste and Zero Emissions' is one of the important pillars of 'Carbon Neutral Meenangadi' project. Even though contribution of Waste sector to the total emissions is the least with 3% of total emissions in Meenangadi *(Graph 13)* but there is a scope of close to 100% emission reduction potential in this sector.

Table 5 GHG emission from Bio degradable discards from commercial sector

	Tonnes	* EF for CH_4 in Kg/Kg	EF for CO_2 in Kg/Kg	TOTAL CH_4 EMISSION in CO_2Eq (in tonnes)	TOTAL CO_2 EMISSION (in tonnes)	TOTAL EMISSION (In Tonnes of CO_2Eq)
Commercial Mixed waste	365	0.013	0.165	99.645	60.225	159.87
		Total				159.87

Table 5 features the GHG emission from mixed biodegradable discards generated in the public places and commercial centres. On an average a tonne of waste is being collected for disposal from public places and markets in the Panchayat. Currently they are being dumped in a common facility.

Table 6 GHG emission from Bio degradable discards from house hold sector

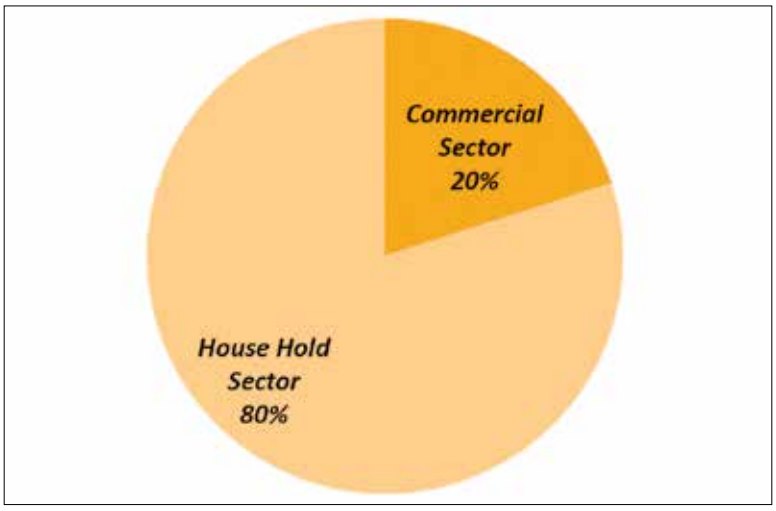
	In Tonnes	EF for Open dumping tonnes of CO_2 Eq /ton of waste (As per IGES tool &IPCC gudelines)	Total Emissions in CO_2Eq tonnes
Bio degradable waste generated in households	1457	0.541	788.24

Being a rural area, households enjoy the luxury of having space to dispose waste; often it ends up as waste dumping rather than waste disposal. *Table 6* summarizes the GHG emission from bio degradable waste from households based on sample surveys done in the Panchayat. Absence of proper system for managing waste at households make it largest contributer *(Graph 11)* of GHG emission in waste sector.

Table 7 Total GHG emission from Waste

Sector	Amount of Waste in Tonnes	Total Emissions in CO_2Eq tonnes
Commercial	365	159.87
Household	1457	788.24
Total		948.11

** Emission Factor*



Graph 11 GHG emission profile of Waste

5.1.4 Agriculture, Forestry and Other Land Use (AFOLU)

Emissions from AFOLU sector were quantified based on IPCC 2006 guidelines for National GHG inventory. It considers agricultural residue burning, livestock and rice cultivation as the major three activities which contribute in GHG emission which includes CO_2 and non CO_2 emissions from fire on all managed lands; N_2O emissions from all managed soils; CO_2 emissions associated with liming and urea application to managed soils; CH_4 emissions from rice cultivation; CO_2 and N_2O emissions from cultivated organic soils; CH_4 emission from livestock (enteric fermentation); and CH_4 and N_2O emissions from manure management systems. This study considered emissions from livestock and rice cultivation (Irrigated paddy cultivation) out of the three major contributing activities and it contributes about 13% of total emissions *(Graph 13)* of carbon in Meenangadi.

Livestock sector in general, supplements the agriculture sector. Ever since climate change started impacting the productivity of thermo-sensitive plantation crops like Coffee, livestock has been a steady source of income for the local people of Meenangadi. The population of cattle and buffalo comes around 5000 plus. Among livestock buffaloes got more emission factor than cows and goats *(Table 8)*. Livestock is one of the major or marginal sources of income for the farmers. Though there is a general concern over emissions from the sector AFOLU, it forms about 13% of total emissions and irrigated paddy contribute a meagre 1.69% of total emissions (Graph- 13)

Table 8 GHG emission from Livestock of Meenangadi Grama Panchayat

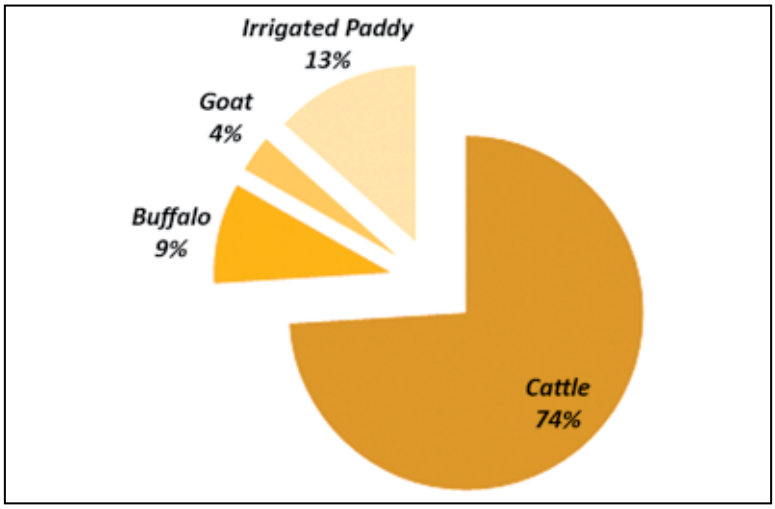
Livestock Type	TOTAL NO	EF (for enteric fermentation) (Kg/ Head/yr.)	EF (for Manure Management, State Specific) (Kg/Head/yr.)	TOTAL CH_4 EMISSIONS (In Kg)	CO_2Eq (Tonnes)
Cattle	3763	38.83	2.7	156277.39	3281.825
Buffalo	280	66.15	3.3	19446	408.366
Goat	1376	4.99	0.22	7168.96	150.548
			TOTAL		**3840.739**

Table 9 GHG emission from Irrigated Paddy in Meenangadi

	In Hectare	In Sq. metre	EF (Mean CH4 flux, g/sq.m)	CH_4 emissions (In g)	CH_4 In tonnes	In CO_2Eq (Tonnes)
Area Under Irrigated Paddy	256.57	2565709.24	11	28222801.64	28.22	593

Table 10 Total GHG emission from AFOLU

AFOLU	In CO_2Eq (Tonnes)
Livestock	3840.739
Irrigated Paddy	593.000
Total	4433.739



Graph 12 GHG emission Profile of AFOLU Sector

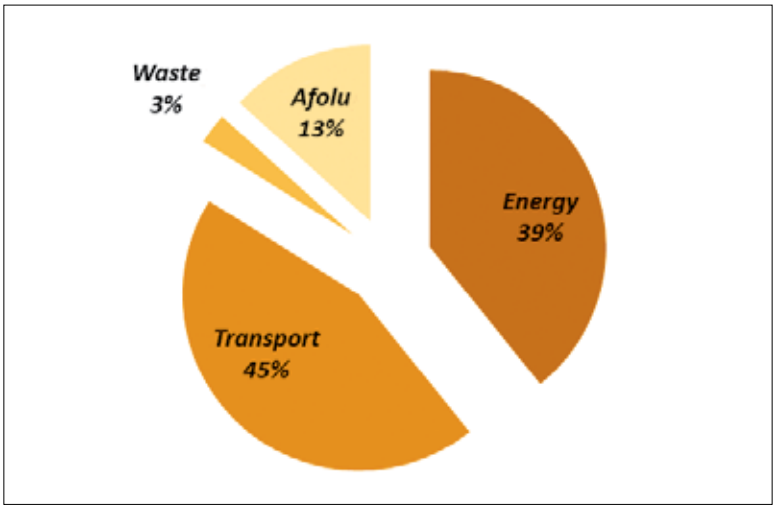
The apprehension about paddy cultivation, livestock and its role in climate change was expressed by many farmers during the consultative process. The concern was mostly on whether the support for paddy and livestock get withdrawn by the Panchayat as part of Carbon Neutral Project. The figures reveal that the share of Irrigated paddy to the total emission of carbon is just 1.69%, and the livestock contributes only 11.31% of total GHG emissions.

5.1.5 Total Carbon Emission

It was estimated that the total Emissions of GHGs in Meenangadi for the year 2016-17 was **33,375 tonnes CO_2Eq** *(Table 11)*.

Table 11 Total GHG emission from Meenangadi Grama Panchayat

Sector	Emissions in CO_2Eq tonnes
Transportation	14,910.700
Energy	13,082.560
Waste	948.100
AFOLU	4433.739
Total	**33,375.099**



Graph 13 Total GHG emission Profile of Meenangadi

The estimate shows that transportation and energy sectors are the largest contributor to GHG emissions in Meenangadi. *(Graph 13)*. The contributions from both of them are almost equal and the scope of intervention on both sectors for Meenangadi Grama Panchayat is also limited.

5.2 Carbon Sequestration

In order to quantify the amount of sequestrated carbon in Meenangadi Panchayat, The study considered Forest, Plantations and Homestead Trees (Carbon stored in the biomass) along with the organic carbon sequestration in Soil. There are no global guidelines for accounting carbon sequestration, since parties to UNFCCC are not obliged to report their sequestration levels, and that was indeed a great challenge in this exercise. Approach of the study was a combination of primary and secondary data with large number of samples.

5.2.1 Soil profile and organic carbon in Soil

The data of soil series, profile, organic carbon content and area was accessed from an un published study report on soil profile of Meenangadi Grama Panchayat by Department of Soil Survey and Conservation(DSSC), Government of Kerala[5]. The whole Panchayat was traversed by DSSC at close intervals. During this exercise by DSSC, the soils were subject to keen observation, examination and their differentiating characteristics were studied with respect to their capacity to support plant growth. Profiles up to a depth of two meter or up to the parent material were dug and the profiles were examined in detail for horizon wise characteristics such as texture, structure, colour consistency, concretions, mottling, soil reactions, pores, root distribution, permeability etc. The soil samples pertaining to each horizon were collected from profiles and sent to the laboratory for analysis.

On the basis of these observations and the supplementary laboratory analysis the soils of the area were classified into different soil series* . Four soil series were identified and mapped in the uplands of the panchayat. Most of the upland soils are strongly to slightly acidic in nature. Kambalakkad (683.698 ha) and Nayikolly (191.988 ha) are the soil series identified in the valleys. Paddy is the main crop of these soils. Occurrence and extent of soils are listed in *Table 12 and Figure 7*.

Table 12 Soil Series of Meenangadi and Organic Carbon Stock in Soil [5]

Soil Series	Parent material	Extent(ha)	Avg Organic Carbon Content (%)	Avg Organic Carbon Content (Kg/ha)**	Carbon Stock (tons)
Ambalavayal	Gneiss	249.563	1.03	96.17	24.001
Meenangadi	Gneiss	1498.362	2.39	223.11	334.298
Muttil	Gneiss	427.74	1.73	161.58	69.115
Purakkadi	Gneiss	1354.915	1.07	99.99	135.482
Kambalakkad	Alluvio-colluium	683.698	1.42	133.04	90.961
Nayikolli	Alluvio-colluium	191.988	1.28	119.44	22.930
Miscellaneous soil	Alluvio-colluium	484.051	1.54	143.76	69.588
TOTAL		**4890.317**			**746.375**

* *Soil series is the most homogenous category in Soil taxonomy. A Soil series is a group of soils or polypedons that have horizons similar in arrangement and in differentiating characteristics*

** *Average organic carbon content in kg/ha is obtained by multiplying unit conversion rate (93.4) with average organic carbon content percentage.*

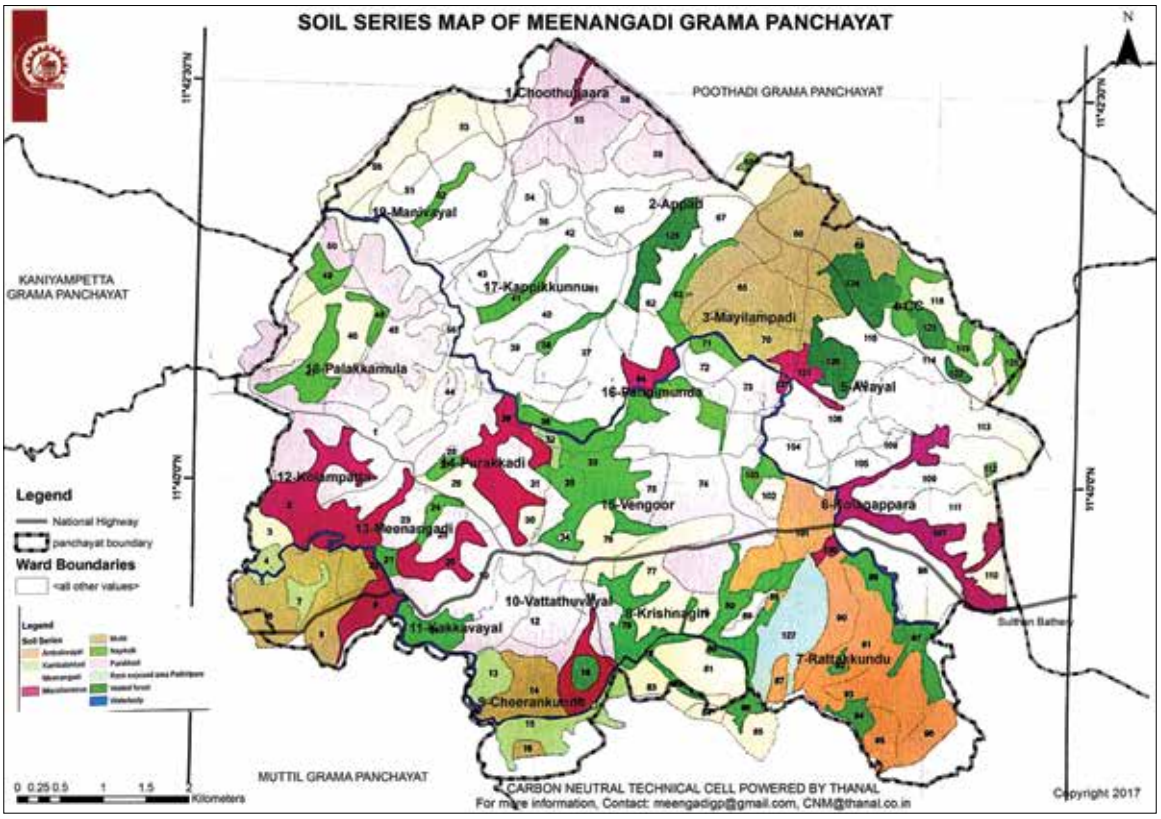


Figure 7. Soil Series Map of Meenangadi Grama Panchayat

Organic carbon was analysed using laboratorial methods and then based on their spatial distribution total carbon sequestration was calculated by multiplying the area under each soil series with the respective sample results. Each sample was taken along with its respective geographic co-ordinates and therefore it is possible to assess the carbon status on a later stage after implementing soil carbon enhancement strategies.

5.2. 2 Trees in the Homestead

Biomass in the trees, plants and all the living system consists of carbon. Plants and trees for that matter takes up carbon dioxide from the atmosphere through the process of photosynthesis. They are the only source of natural removal process of carbon from atmosphere. Forests are the lungs of our nature which maintains the balance of life.

Trees in homesteads were considered for estimating total carbon sequestration in the Panchayat. An extensive household level 'Tree Survey' was conducted to quantify the total number of existing trees including their size, age and species. A data base of trees is formulated for each ward by taking average girth and height of each species of trees from the primary survey and wood densities of each species from the secondary sources. Above ground biomass of each species of trees have been calculated using the equations explained in the methodology section. Simultaneously carbon sequestration levels are estimated for each species under different age category with the support of secondary data. Average carbon sequestration potential per homestead was calculated based on data collected from 3746 samples. It was extrapolated to total number of households to find total carbon sequestrated in homestead trees *(Table 13)* in the Meenangadi Grama Panchayat. It accounts for about 34% of total carbon stock *(Graph 14)* of Meenangadi Grama Panchayat. Even if more trees are planted, it will take at least three years for the tree to start the carbon sequestration process. Therefore conservation of existing homestead trees is very important to attain 'Carbon Neutrality'.

Table 13 Carbon sequestrated in Homestead Trees

Total number of species registered during survey	65
Total number of sample homesteads/households surveyed	3746
Total number of Households / homestead	8199
Sequestration/Household	905.62 kg/Year
Total Sequestration (in tonnes of CO_2Eq)	7425.22

See *annexure 3* for the checklist of trees in the homestead

5.2.3 Forests and Plantations

Meenangadi Panchayat has large coffee plantations and forest areas. Carbon sequestration will occur at the above ground biomass, litter and below ground biomass. Around 13,790 tonnes of CO_2Eq is the total carbon sequestration which happens *(Table 14)* in these plantations and forests. Forests and Coffee in homestead accounts for 61% of total Carbon sequestrated *(Graph 14)* in Meenangadi Grama Panchayat. It plays a very vital role in reducing Green House Gases, and their conservation is important on the Carbon Neutral trajectory of development

Table 14 Carbon Sequestrated in Forests and Plantations of Meenangadi

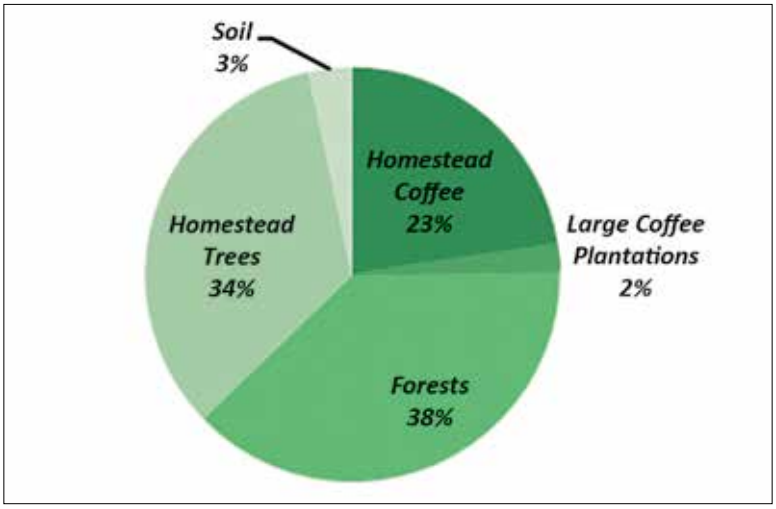
Category	Area in Ha	Sequestration factor in tons/ha/yr		Carbon sequestration (in tonnes/yr)
		Soil	Biomass	
Homestead Coffee	**2704.11**	**NA**	**1.84**	**4975.57**
Large coffee Plantation	**242.00**	**NA**	**1.84**	**445.28**
Forests	**178.47**	**0.3**	**46.9**	**8370.08**
	Total			**13790.93**

5.2.4 Total Carbon Sequestration

The assessment shows that the total carbon sequestrated in Meenangadi Grama Panchayat is above **21962.53 tonnes of CO_2 Eq.** *(Table 15)*

Table 15 Total Carbon Sequestrated in Meenangadi Grama Panchayat

Sector	CO_2Eq (Tonnes)
Homestead Coffee	**4975.57**
Large Coffee Plantations	**445.28**
Forests	**8370.08**
Homestead Trees	**7425.22**
Soil	**746.38**
Total	**21962.53**



Graph 14 Profile of Carbon Stock in Meenangadi Grama Panchayat

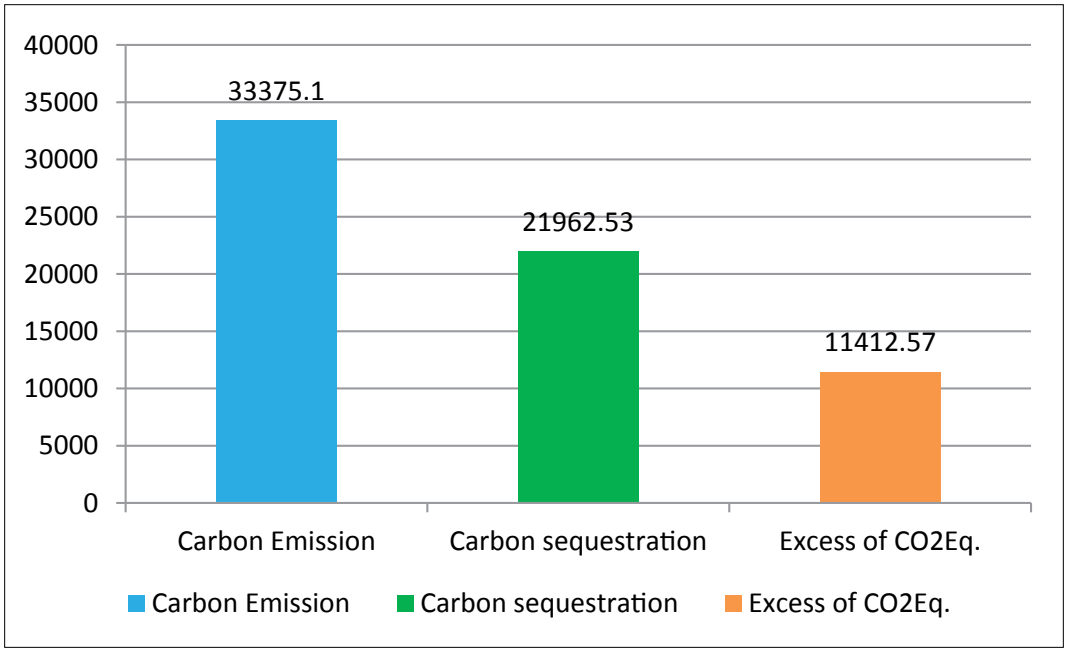
Forests, homestead trees and Homestead Coffee forms largest carbon sinks in the Meenangadi Grama Panchayat. Forests and Homestead trees cover 72% of carbon reservoirs *(Graph 14)*.

5.3 Carbon Balance

Based on the baseline assessment of total emissions and sequestration for the base year 2016-17 *(Table 16)*, it is estimated that **11,412.57** tonnes of CO_2 eq. is the difference between total emissions and sequestration, and it can be called as the 'Carbon Balance' for Meenangadi panchayat for the base year 2016-17. This surplus of GHG emission over the carbon stock has to be brought down to zero in order to achieve net zero emission or carbon neutral status. For achieving net zero emissions, it is very important to understand how the emission rates are going to be in the future. A target has to be set to reduce the projected carbon excess to zero.

Table 16 Sectorwise GHG Emission and Carbon Sequestration in Meenangadi Grama Panchayat

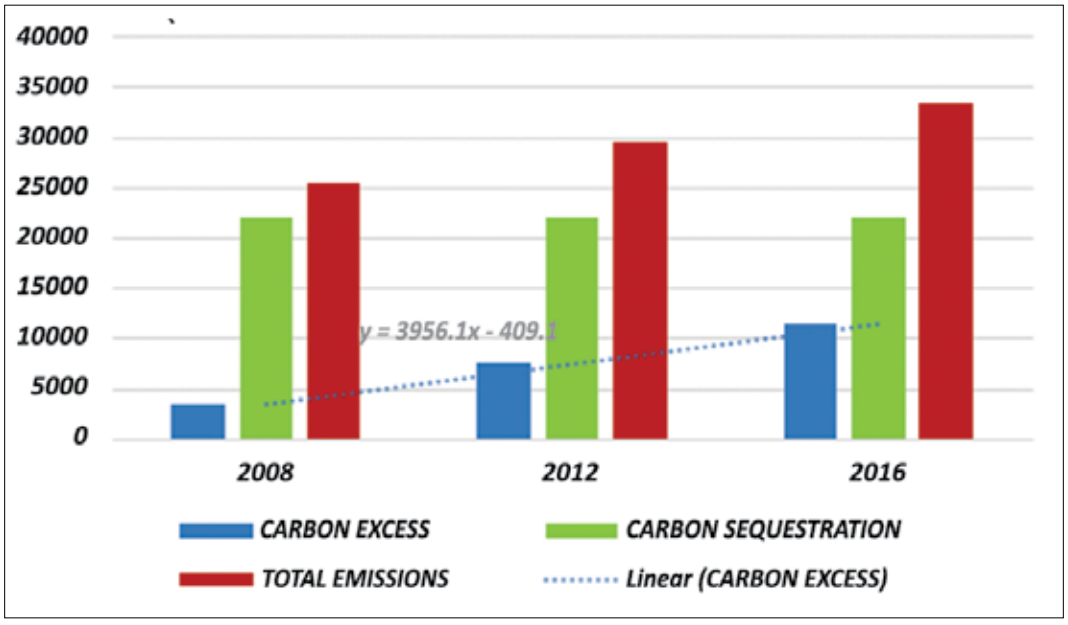
Sector	Emissions in CO_2 Eq. tonnes	Sector	Sequestration in CO_2 Eq. tonnes
Transportation	14910.70	Homestead Coffee	4975.57
Energy	13,082.56	Large Coffee Plantations	445.28
Waste	948.10	Forests	8370.08
AFOLU	4433.74	Homestead Trees	7425.22
		Organic carbon in Soil	746.38
Total	**33,375.10**		**21,962.53**
		Excess of CO_2 Eq.	**11,412.57**



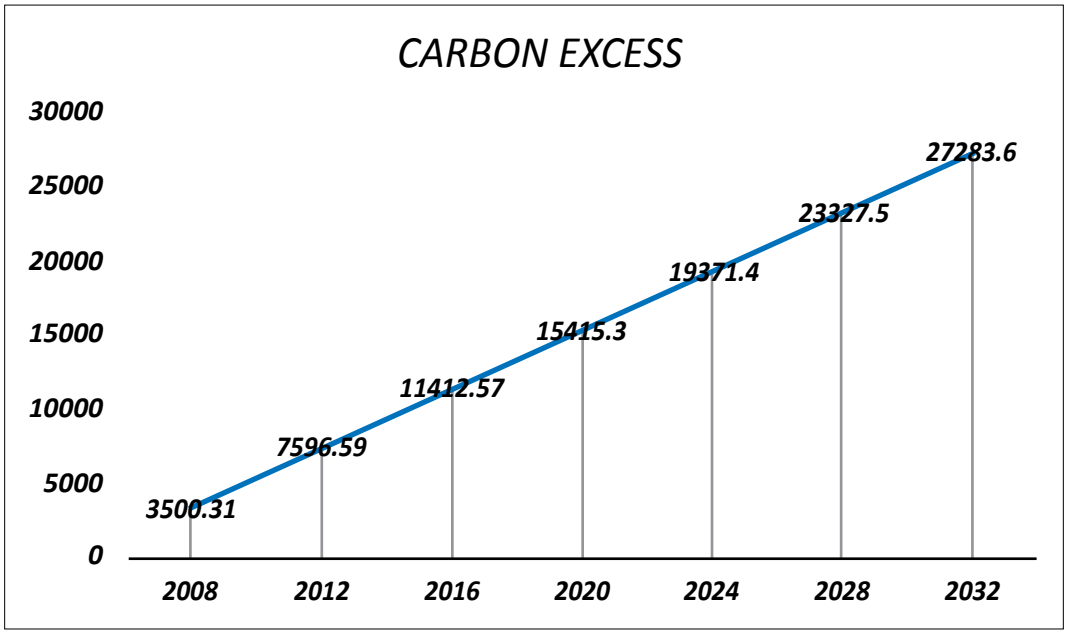
Graph 15 Comparison of GHG Emission Stock and the gap
(Values in CO_2 Eq. Tonnes / Year)

It is very crucial to understand the historical emissions for projecting it to the future. Since it was very difficult to calculate the historical emissions at a Panchayat level, it was carried out at district level and extrapolated to the Panchayat scenario. The study considered 2 past time frames, 2008 and 2012 to build a trend line to ascertain future emissions. From the secondary data, at district level GHG emissions were calculated for Wayanad district and extrapolated it to Meenangadi Grama Panchayat for 2008 and 2012. There is no historical data available for carbon sequestration, and the present quantity of sequestrated carbon is assumed to be the sequestration value for year 2008 and 2012 since there was no significant loss in forest cover in Meenangadi Grama Panchayat during this time period. A trend line was prepared *(Graph 16)* for carbon excess under *Business As Usual* scenario and projected the carbon excess for 2020 and 2032 based on the linear equation.

GHG emission modelling methods are used globally for getting more accurate prediction. Modelling analysis was beyond the scope of this project, the study used simple average based projections. Based on the projections given in *Graph 17*, Meenangadi has to offset about **15000 tons of CO_2 Eq. by 2020** in order to achieve 'carbon neutrality'



Graph 16 Trend line Projection of CO2 Excess in Meenangadi Grama Panchayat
(Values in CO_2 Eq. Tonnes / Year)



Graph 17 Carbon Excess Projections for Meenangadi Grama Panchayat
(Values in CO_2 Eq. Tonnes / Year)

5.4 Strategy for achieving Carbon Neutrality

The recommended strategies for achieving and maintaining carbon neutrality are reduction in emissions, improving stock of carbon and creating carbon credits / reserves. The scope for emission reduction is given in ***Table 17***. It is evident that a minimum of 30% reduction is possible in current total emissions through systematic intervention. The scope for improving the existing stock is less than three percent *(Table 18)* except for carbon stock in trees. The excess gap of CO_2 Eq. over and above this need to be managed by planting trees. Assuming a fully grown

tree would sequestrate about 25 kg of Carbon per year[39], to meet the gap of 15000 tons the Panchayat may require about 6,00,000 trees to be planted. The number of trees to be planted can be reduced as the Panchayat sets its targets of intervention in terms of reduction of emission. If the Panchayat targets 30% reduction in emission, that would bring down the gap of carbon excess to less than 5000 tonnes of CO_2 Eq. This can be achieved in a time frame of 3-4 years and this gap may continue to stay for a long time. Hence the Panchayat may require to plant about 2,00,000 trees to cover the gap. The list of trees ideal for efficient carbon sequestration is given in Annexure 4. The Panchayat can also think of creating additional reserves of carbon through developing medium scale solar power plants, practicing agro ecology, conservation and improvement of forests etc. The scope of developing intervention projects are discussed in the recommendation part of this report.

Table 17 Scope of CO_2 Eq. Emission Reduction Targets in Meenangadi Grama Panchayat

Sectors / Activity	Current Emission at targeted sources	% of Emission to the Total Emissions	Reduction / Replacement Potential %	Net Saving CO_2 Eq. in Tons	Net Saving in %
Interventions to plug wastage of Electricity in Domestic level	7722.76	23.14	10	772.276	2.31
Introduction of LED bulbs	3861.38	11.57	70	675.7415	2.02
Installing Solar Electric system	2316.83	6.94	30	2316.828	6.94
Solar Lanterns	1544.55	4.63	20	1544.552	4.63
Installing Energy efficient equipments	1930.69	5.78	60	1158.414	3.47
Interventions to plug wastage of Electricity in Commercial institutions and Industries	2720.90	8.15	10	272.09	0.82
Introduction of LED bulbs at Commercial institutions and industries	1360.45	4.08	70	238.07875	0.71
Installing Solar electric system in Commercial Institutions and Industries	816.27	2.45	30	408.135	1.22
Improving efficiency of Firewood consumption	1279.36	3.83	1.53	511.744	1.53
Improving efficiency of cooking and heating / storage-thermobox	2477.87	7.42	10	247.787	0.74
Domestic Waste Management-Pit composting	788.24	2.36	50	394.12	1.18
Pot Composting	788.24	2.36	25	197.06	0.59
Biogas- Installation	788.24	2.36	5	39.412	0.12
Common Facility for Commercial Waste	159.87	0.48	80	127.90	0.38
Livestock-Cattle / Buffalo / Goat-Manure Management	239.1	0.72	80	191.28	0.57
Introduction of Electric Autorickshaw	5582.27	16.73	30	1674.68	5.02
			Total	**10770.10**	**32.27**

Table 18 Scope for improving Organic Carbon stock in the soil of Meenangadi

Soil Series	Parent material	Extent (ha)	Avg Organic Carbon Content (%)	Avg Organic Carbon Content (Kg/ha)	Carbon Stock (tons)	Projected Average Organic Carbon Content (%)	Projected Average Organic Carbon Content (Kg/ha)	Projected Carbon Stock (tons)
Ambalavayal	Gneiss	249.563	1.03	96.17	24.001	4	373.6	93.2
Meenangadi	Gneiss	1498.36	2.39	223.11	334.298	4	373.6	559.8
Muttil	Gneiss	427.74	1.73	161.58	69.115	4	373.6	159.8
Purakkadi	Gneiss	1354.92	1.07	99.99	135.482	4	373.6	506.2
Kambalakkad	Alluvio-colluium	683.698	1.42	133.04	90.961	4	373.6	255.4
Nayikolli	Alluvio-colluium	191.988	1.28	119.44	22.930	4	373.6	71.7
Miscellaneous soil	Alluvio-colluium	484.051	1.54	143.76	69.588	4	373.6	180.8
TOTAL		4890.317			**746.375**			**1827.0**
Projected Stock of Organic Carbon in Soils (tons)					**1827.022**			
Projected Increase in Carbon Stock (tons)					**1080.65**			
Percentage of Net Increase in Total Carbon Stock					**4.9%**			

The current average organic carbon content in the soil of Meenangadi is below 3% and at some places it is as low as 1%. This has to be increased to improve the agriculture productivity in the region. If organic carbon content in soils can be increased to 4% that would bring a net increase of 4.9% in total sequestrated carbon.

6. Recommendations

Achieving carbon neutral status needs concerted and focussed intervention in all development activities of Meenangadi Grama Panchayat. Targets have to be set in each sector with a timeline to ensure a progress in action. Based on the studies it is recommended to focuss on sector wise interventions to improve the sequestration capacity and to reduce emissions to meet the goal of carbon neutrality. The recommendations given below will help in planning development projects and programmes.

6.1 Studies / Monitoring

Carbon Neutral Meenangadi is first of its kind and it is important to track the impacts of the project and share the experience with other local self governments and communities. The following studies need to be undertaken to establish baseline status.

- ***Socio Economic Survey –*** A sample study has to be conducted to establish the socio economic status of the community within Meenangadi Grama Panchayat. This should include all the beneficiaries of the Panchayat. This is to provide a baseline to evaluate the impact of project.
- ***Agriculture practices, diversity and productivity assessment*** – Agriculture practices, diversity and productivity need to be analyzed for current period as well as historical data need to be analyzed to identify trends and impact of climate change on agriculture. The baseline data will help to evaluate the interventions of the Panchayat to build climate resilient agriculture systems.
- ***Water resources and watershed status*** – A stock taking of current status of water resources and watershed is important for future project planning as well as monitoring
- ***Updation of Bio diversity Register*** – The Panchayat Bio diversity Register need updation and field studies need to be taken up. Bird and Butterfly Monitoring by Thanal Team came up with checklists which are given in Annexure 2 and Annexure 3

6.2 Institutional Mechanism

Carbon Neutral Meenangadi Project require lot of efforts in terms of local research, planning, organizing, integration, execution and campaigns. The Panchayat may set up the following institutional mechanisms to support the project implementation process.

- ***Carbon Neutral Meenangadi Technical Cell –*** A technical cell may be formed with experts, volunteers, officials and representatives of Panchayat council to plan and provide technical support to formulate and implement projects to achieve Carbon Neutral Status. The Cell has to be based in the Meenangadi Grama Panchayat Office and should be anchored by President of the Panchayat.
- ***Haritha Karma Sena*** – A technical professional team may be formed in line with Haritha Keralam Mission directives. Young professionals may be identified to form Haritha Karma Sena. This will help to ensure technical services like organic farming, energy audit and management, waste management etc in the Panchayat. The Haritha Karma Sena need to be trained and oriented to take up green jobs in the Panchayat which will catalyze the Carbon Neutral Project.
- ***Carbon Neutral Meenangadi Campaign Team*** – A campaign team has to be formed involving youth volunteers, teachers, students and other interested people to access all segments of the community to reach out the message of Carbon Neutral Project. The objective of the campaign team is to create a conducive environment for the project and to build a sense of ownership among the stakeholders.

6.3 Projects/ Programme Ideas

Achieving Carbon Neutral status require a lot of interventions in sectors like agriculture, energy, transportation, waste, water, social security, education, health, development, etc. It also requires intelligent Integration of existing projects, programmes and or smart implementation of existing projects. Based on the results of this study the *Thanal Team* is proposing the following project ideas. This need to be further refined and researched to build proper fundable detailed project report. The project team suggests basic thread and a bare minimum template for further exploration and development.

6.4 Energy Conservation

Consumption of energy in the form of electricity, fuel wood and Liquid Petroleum Gas contributes to 39% of total GHG emissions in Meenangadi Grama Panchayat. Adopting energy efficient equipments/ methods to save energy and switching to renewable energy sources and best practices will help to bring down the emissions from energy consumption. Targeting a total of 22% net saving (See Table 17) of GHG emission in energy consumption will save about 7350 tonnes of CO_2 Eq. / year.

6.4.1 Energy Efficiency Measures

Surveys found that there is a potential for saving electricity by switching to energy efficient equipments. A minimum of 10% of electricity consumption can be reduced through a proper energy audit and interventions at household level and commercial level to improve energy efficiency. This will bring a net saving of 3% of GHG emissions from energy sector and that would amount to about 1000 tonnes of CO_2 Eq. The Panchayat has to engage Haritha Karma Sena to provide household level and commercial establishment level energy audits at a subsidized cost. Making energy audit report from Haritha Karma Sena mandatory to avail support / incentives as part of Carbon Neutral Project will speed up the process.

6.4.1.1 LED bulbs

Incandescent bulbs and Compact Fluorescent Lamp (CFLs) in 8199 households of the Panchayat is consuming lot of energy. Consumption of electricity contributes about 81% of emissions from the energy sector and 73% of electricity is consumed at domestic sector. Assuming that 50% of electricity is consumed for lighting in domestic sector, replacing a minimum of 50% of lighting needs (assuming that the existing lights are 12W CFL and is replaced with 9W LED bulbs) with energy efficient lights like LED bulbs would address about 11% of total emissions and will result in a net saving of 2.3% in GHG emission from Energy Sector.

Sector: Development / Energy		**Fund: Plan fund / ANERT***	
Beneficiary: XX households		**Estimated Cost:**	
Cost		**Source of Fund**	
XX LED bulbs		Beneficiary Contribution	
Distribution Cost		Support from ANERT	
		Plan Fund	
Total			
		Savings / Sequestration of CO_2 Eq.	675 Tonnes
Implementing Officer			

*Agency for Non-conventional Energy and Rural Technology

6.4.1.2 Financial support for shifting to star rated electric appliances and brushless DC fans.

It is recommended to create a rolling capital fund to provide soft loans for people to buy star rated electrical appliances as a move towards improving efficiency in consumption of electricity. The micro credit units of Kudumbashree can facilitate this loan and enterprising units can take up supply of efficient electrical appliances at a reduced price. This can be developed as a business model to support local enterprises. Targeting 25% households to make a net saving of 3.4% of total emissions through switching energy efficient equipments. A detailed project report has to be developed to implement this project

6.4.1.3 Solar Mobile phone chargers

Mobile phones are no more a luxury but necessity. Draining batteries are a headache for every user and during outdoors it is hard to find an energy source to recharge the battery. Airports, Railway stations etc. are installing mobile device charging stations as part of branding. But they use conventional energy sources for powering the charging station and they disseminate commercial information in the charging hubs.

Meenangadi Grama Panchayat can initiate a process to install mobile charging hubs which runs on Solar power at places like Panchayat Office, Bus Stand, Agriculture Office, Village Office and other places of public utility. These hubs can disseminate information on carbon neutral Panchayat schemes.

Sector : **Development / Energy**	Fund: **Plan fund /**
Beneficiary: **General Public**	**Estimated Cost:**
Cost	**Source of Fund**
X units of solar powered mobile charging hubs	Corporate Social Responsibility fund support
Information boards/ displays	Support from ANERT
	Plan Fund
Total	
	Savings / Sequestration of CO_2 Eq.
Implementing Officer	

6.4.1.4 Renewable Energy Projects

There is a potential and scope for switching to alternate energy sources in the Meenangadi Grama Panchayat. Targeting to shift a minimum of 30% of total domestic electricity consumption to off grid through solar electricity systems would bring about 7% net savings of GHG emissions and will save about 2300 Tonnes of CO_2Eq. Targeting to shift a minimum of 30% consumption of electricity in commercial sector to renewable energy sources and improving the energy efficiency by 10% in the commercial sector can bring in a net saving of 3% GHG which will amount to about 680 Tonnes of CO_2 Eq.

6.4.1.5 Solar lighting

The lighting purpose consumes about 50% of total electricity consumption. Only seven houses adopted off grid solar for lighting so far. And less than 100 solar lanterns have been distributed. Encouraging people to shift to solar powered lighting will be an option to attain this goal. To initiate an interest towards solar lighting it is recommended to subsidize a minimum solar lighting unit to every household which can be expanded at beneficiary's own interest. Targetting 20% of population, this project may help to make a net saving of 1500 tonnes of CO_2Eq which is about 4.6% in total GHG emissions.

Sector: **Development / Energy**	Fund: **Plan fund**	
Beneficiary: households	**Estimated Cost:**	
Cost	**Source of Fund**	
X units of 250 Watt Solar panel, charge controller and battery for beneficiaries	Beneficiary Contribution (Can avail bank / micro finance loan)	
Cost of Installation	Support from ANERT	
	Plan Fund	
Total		
	Savings / Sequestration of CO_2 Eq.	1500 Tonnes
Implementing Officer		

6.4.1.6 Solar street lighting

Powering street lights with solar panels backed by battery is not feasible in long run. A project may be implemented to install solar panels on every roof of public building owned by the Panchayat to harvest solar power under the '*Saura*' Scheme of Kerala State Electricity Borad (KSEB). This may bring in a net saving of 1% electricity consumption which will amount to 330 Tonnes of CO_2Eq.

Sector: **Development / Energy**	Fund: **Plan fund /**	
Beneficiary: Public	**Estimated Cost:**	
Cost	**Source of Fund**	
X units of Solar panels, power control equipments, LED Street light bulbs etc.	Plan Fund	
Cost of installation	Support from ANERT	
Total		
	Savings / Sequestration of CO_2 Eq	330 Tonnes
Implementing Officer		

6.4.1.7 Energy efficient stoves

The study found that about 89% of households are dependent on fire wood for their energy needs. Fire wood consumption constitutes about 10% of GHG emission from the Energy sector. The conventional stoves are utilizing less than 10% of the fuel efficiency of the feed. This can be improved up to 40% which will result in reduction of fuel wood intake and carbon pollution. This project of energy efficient stoves will make a net saving of 1.5% in GHG emission and that would result in about 500 tonnes of CO_2 Eq.

Sector: **Development / Energy**	Fund: **Plan fund / ANERT**	
Beneficiary:	**Estimated Cost:**	
Cost	**Source of Fund**	
X units of Energy efficient Stoves	Beneficiary Contribution	
Distribution Cost	Support from ANERT	
	Plan Fund	
Total		
	Savings / Sequestration of CO_2 Eq	500 ton.
Implementing Officer		

6.4.1.8 Thermo boxes

In most of the households the fuel is wasted for reheating cooked food or for slow cooking of rice and cereals. Thermo boxes can come handy in saving energy in cooking. It is very useful especially in rural area. A thermo box can save a minimum of 10% of energy in cooking. The heating / cooking needs are mainly met from fire wood or LPG. That constitutes about 7.5% of total GHG emissions. 10% improvement in cooking process is targeted by distributing thermo boxes that would bring in about 0.7% net reduction in GHG emission from energy sector.

Sector: **Development / Energy**		Fund: **Plan fund / ANERT**	
Beneficiary: **X units of households**		**Estimated Cost:**	
Cost		**Source of Fund**	
X units of Thermo Box		Beneficiary Contribution	
Distribution Cost		Support from ANERT	
		Plan Fund	
Total			
		Savings / Sequestration of CO_2 Eq.	250 Tonnes
Implementing Officer			

6.4.1.9 Solar dryers

One of the popular and simple forms of preserving food is sun drying. Vegetables, fruits, tubers, fish, meat, spices and cooked/semi cooked food used to store sundried. Surplus yield / food used to get preserved in this method will prevent wasting of food materials. Energy efficient low cost solar dryers are available today which can save time as well as ensure quality of food that are stored. These devices will help to build consistency in quality of preserved food items that also gives scope for marketing thus adding livelihood opportunities. These devices can be handy for marginal farmers and small families who have coffee, ginger, turmeric, chillies, jackfruit, mango, etc.

Sector: Development / Energy		**Fund: Plan fund /**	
Beneficiary:		**Estimated Cost:**	
Cost		**Source of Fund**	
1000 units of Solar Dryers		Beneficiary Contribution	
Distribution Cost		Support from ANERT	
		Plan Fund	
Total			
		Savings / Sequestration of CO_2	
Implementing Officer	This is a new activity hence historical data is not available for calculating the reduction in consumption		

6.4.1.10 Biogas plants

The study found that there are about 5000 plus cattles in the region. The domestic waste, cow dung and cow urine can be used as feed for biogas plant to generate cooking gas and enriched liquid manure. This will also help to regulate GHG emissions from manure management of livestock which constitutes about 0.7% of total GHG emissions.

Sector: **Development / Energy**		Fund: **Plan fund /**	
Beneficiary: **1000 households**		**Estimated Cost:**	
Cost		**Source of Fund**	
1000 units of 2 cuM biogas plant		Beneficiary Contribution (Can avail loan / micro finance support)	
Cost of installation		Support from Kerala Suchitwa Mission	
		Plan Fund	
Total			
		Savings / Sequestration of CO_2 Eq.	190 tonnes
Implementing Officer	This is linked to solid waste at domestic sector and this is a saving from emissions from waste sector and it is about 10% of GHG Emissions from Waste.		

6.4.1.11 Energy Park

Energy Park is a centre where electricity is produced from renewable energy sources and is fed to the power grid. The roofing area of the Panchayat office building and bus stand will be utilized to harvest light and will be converted into electricity. That will offset the grid based electricity consumed by the institutions, offices and commercial establishments working in the Panchayat office building of Meenangadi Grama Panchayat. The energy park will be an icon of Carbon Neutral Meenangadi to provide information and awareness to general public on energy conservation, energy saving equipments, concepts of carbon neutrality etc. Vertical garden, expo space for alternate technologies and equipments, space for community activities will be available in the Energy Park. The Energy Park is expected to bring about 2% net saving in GHG emissions.

The idea of Energy Park as an icon project of Carbon Neutral Meenangadi which is perceived and developed jointly by ***Recycle Bin*** – an architecture firm and ***Ottotractions*** – an energy management consulting firm from Thiruvananthapuram. The concept note and 3D CAD visualizations are ready for preparation of Detailed Project Report.

Figure 8 Upgraded Panchayat Office Cum Enegry Park - Front View

Figure 9 Upgraded Panchayat Office Cum Enegry Park - Rear View

Sector: **Development / Energy**		Fund: **Plan fund / CSR / ANERT / Bank**	
Beneficiary: Public		**Estimated Cost:**	
Cost		**Source of Fund**	
Design and DPR		CSR Fund	
Construction		Support from ANERT	
		Plan Fund	
		Bank Loan	
Total			
		Savings / Sequestration of CO_2 Eq.	650 Tons
Implementing Officer			

6.5 Transportation

Transportation accounts for 45% of GHG emission in the Panchayat. The connectivity of bus network is limited to major roads and for the rest, people depend on jeeps and auto rickshaws. At least 30% of auto rickshaws can be made independent of fossil fuel by introducing new modes of transportation and by promoting shared transportation.

6.5.1 Electric Auto Rickshaws

Diesel powered auto rickshaws dominate the region and 16% of total GHG emissions is from auto rickshaws. Auto rickshaws are mostly used for short distance travel. Electric powered auto rickshaws can reduce emission, pollution and noise. On an experimental basis, for short distances at level roads- connecting two junctions- electric auto rickshaws can be introduced in Meenangadi. This will result in a net saving of 5% in GHG emissions.

Sector: **Development / Kudumbasree**		Fund: **ANERT / CSR / Kudumbasree**	
Beneficiary: **Kudumbasree**		**Estimated Cost:**	
Cost		**Source of Fund**	
X units of Electric Auto rickshaw		Beneficiary Contribution	
Training, orientation		Support from ANERT	
		CSR support	
		Kudumbasree Mission	
Total		Local Bank	
		Savings / Sequestration of CO_2 Eq.	1700 ton.
Implementing Officer			

6.6 Zero Waste

Composting of organic waste and agricultural waste is the back bone of the process of enriching levels of soil carbon. Composting need to be promoted at household and community levels. People should be encouraged for large scale application of compost as soil amendments to improve soil health through increasing levels of soil carbon. Waste contributes 948 tonnes of carbon per year. It accounts for about 3% of total GHG emission in the Panchayat. 100% reduction is possible by adopting appropriate technologies and processes. Decentralized and source level composting / biogas plants can handle the organic waste and resource recovery facility can recover non-biodegradable discards through recycling.

6.6.1 Source level Aerobic Composting

Pit composting or Earthen Pot composting or both will be the efficient method for handling organic waste at household level. Both the methods are approved by Kerala Suchitwa Mission and is eligible for subsidy support. This can bring in a net saving of 590 tonnes of CO_2 Eq./ year

Sector: **D / NREGS**		Fund: **Plan fund / NREGA**	
Beneficiary: **XX households**		**Estimated Cost:**	
Cost		**Source of Fund**	
Construction Two pit compost		Beneficiary Contribution	
Lid for compost pit		NREGA (labour)	
Total			
		Savings / Sequestration of CO_2	390 ton.
Implementing Officer			

Sector: **Health and Sanitation**		Fund: **Plan fund**	
Beneficiary: **XX households**		**Estimated Cost:**	
Cost		**Source of Fund**	
XX units of earthen pots		Beneficiary Contribution	
Distribution Cost		Support from Kerala Suchitwa Mission	
Total			
		Savings / Sequestration of CO_2 Eq	200 Tons
Implementing Officer			

6.6.2 Community level / Cluster level Composting

The Meenangadi Grama Panchayat collects about one tonne of waste per day from its commercial area and markets. A facility has been created near the existing waste dumping ground. That facility is enough for managing the organic waste collected. The existing waste dump needs to be phased out in the long run. It needs to be bio mined* to save the organic waste in it. The rest need to be capped to prevent groundwater contamination.

6.6.3 Material Recovery and Recycling

A material recovery facility need to be set up in the existing dumping ground to recover the non-biodegradable discards from the waste collected.

Sector: **Health and Sanitation**		Fund: **Plan fund /**	
Beneficiary: **General Public**		**Estimated Cost:**	
Cost		**Source of Fund**	
Material Recovery Facility with sorting systems		Support from Kerala Suchitwa Mission	
Distribution Cost			
		Plan Fund	
Total			
		Savings / Sequestration of CO_2Eq.	130 ton.
Implementing Officer			

6.6.4 Green Protocol

Waste reduction is important when it comes to waste management. The Panchayat have to make it mandatory to all to follow basic measures to reduce the use of disposable products and plastics to save energy and resources. A draft Green Protocol have been attached as Annexure 4

6.6.5 Extended Producer Responsibility

Plastic Waste Management Rules 2016 provides for levying the brand owners who contribute majority of plastic waste in a LSG. The Panchayat have to develop the plastic waste management bylaw and need to finalize a tariff for charging the brand owners, shops and other commercial establishments who dispense disposable plastic product and products that are packed in plastics.

6.7 Afforestation

Meenangadi has to offset the target of 15000 tonnes of CO_2Eq by 2020. The efforts to reduce emission will not be enough. The gap has to be covered with planting trees. a total of 2,00,000 trees need to be planted in the Meenangadi Grama Panchayat assuming that an average fully grown tree sequestrates 25 kg CO_2 per year. Trees are important when it comes to sequestration of carbon. Hence a lot of trees need to be planted in the Panchayat to balance the present as well as future GHG emission. A list of trees suitable for Meenangadi Grama Panchayat has been given in *annexure 5.*

* *Bio mining is the process of recovering organics and recyclables in the historical waste dumps and disposal of residuals. This often requires injection of inoculums into the waste dumps for composting and sieving*

6.7.1 Tree Banking

Planting trees is like long term investments. People plant trees out of passion or as an investment for their next generation. For many people this is not attractive since they have to wait for a long time or may not be able to enjoy the economic benefit of planting trees. Tree banking is a scheme to get paid in advance for the future yield of a tree planted now. The tree Banking Scheme provides for ensuring cash benefits in terms of annuity as well as liquidity for financing. There are couple of models suitable for Wayanad.

6.7.1.1 Model – 1 Banking on Existing Trees

The State Planning Board* has come up with guidelines to provide liquidity to existing trees in private properties. Under this scheme a beneficiary can pledge the trees in his/her homestead or farm to the Cooperative Bank for short term loans and advances. This has to be done through the Panchayat.

Process

Panchayat have to set up Haritha Karma Sena- a group of green technicians who are trained to identify trees and do valuation for the Cooperative Bank. Based on the valuation report the Bank can sanction short term loans up to 2-3 years with a minimum interest. The trees should be at least 10 years old and having at least 50 cm girth and 5-8 meter height. The Panchayat has to approve a list of species of trees which are eligible for banking. A suggested list of trees for this purpose is given as *annexure 6.* The Panchayat has to guarantee for the loan through a recommendation by the council. If needed the cooperative bank can register a lien on the trees through a formal registration process to ensure the right over the trees during the loan period.

The loan can vary from Rs.10, 000 to 2, 00,000 with or without a subsidy on interest.

6.7.1.2 Model – 2 Annuity on newly planted saplings

This scheme is for planting trees and protecting them for 20 or more years. The Panchayat has to entrust the Haritha Karma Sena to do the evaluation and monitoring of tree planting and maintenance. On receiving an application from a beneficiary to join the scheme, the Haritha Karma sena does a site visit and submit a field report to the Panchayat. Based on the report the Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS) team supplies and plants the saplings in the land of the beneficiary. The planted saplings will be registered by the Panchayat through Haritha Karma Sena using GPS to locate every single sapling planted. The MNREGS team does three visits a year to the site to manage the saplings and to replace saplings which are lost or died.

After three years the Panchayat will hand over the records to the Cooperative Bank and will recommend for annuity. The annuity will be as follows;

Year 1- 3 Rs.100/ Sapling
Year 4-6 Rs. 200/ Sapling
Year 7-10 Rs. 500 / Sapling
Year 11 and above Rs. 1000/ Tree

* Panchayati Raj / Nagarpalika Institutions – Norms for subsidies Section. 8.1.22.G.O. (M.S.)No.80/2017/ LSGD dt.03.04.201

The ownership of the trees will be with the cooperative bank who pays the annuity as advance. After 20 years or at maturity, the trees will be cut and sold in the market to recover the advance along with the interest due to the bank. The rest of the money will be paid to the beneficiary. The Panchayat can create a Tree Fund by making it mandatory for beneficiaries to contribute a share of money recovered through selling of timber.

6.7.1.3 Avenue Tree Planting

Trees need to be planted in spaces available along the roads, in campuses of government institutions and other public places. Species of trees need to be defined prior to the tree planting. A balance has to be maintained between fruit trees and trees with timber value in the medium term and long term. The tree planting and maintenance can be done through MNREGS.

6.7.1.4 Agroforestry

Agroforestry is an agricultural system which integrates food crops, perennial tree crops and livestock in the same plot of land. The Panchayat may allot fallow land to the marginal farmers or farmer groups who are interested to share agroforestry units. Farmers can cultivate fodder grass for their cattle around trees or they can grow bamboo as a short term low maintenance crop among wild trees, or can utilize space between trees for cattle grazing. In short the farmers reap short term benefits while planting and protecting trees in the land to rebuild the ecosystem in the long run.

6.7.1.5 Shade Coffee

Wayanad is known for coffee plantations. Due to the external factors the price and yield of coffee is unstable. Farmers need motivation to stay in the coffee farming. Coffee in homestead and plantations constitute about 39% of Carbon stock in the Panchayat. It is important to protect existing coffee plants and improve its stock. Shade Coffee is an emerging brand of coffee which attains a premium price despite of regular coffee market prices. The premium comes with the label 'shade' which ensures conservation of local ecosystem. The farmers have to grow a minimum of five different species of trees that will provide space for birds, butterflies and will contribute to the local biodiversity. The coffee plantations who follows the mandatory processes will be labelled under Shade Coffee/Bird Friendly Coffee by a society facilitated by the Panchayat with the coffee growers. The plantations will be documented and monitored for the increase in biodiversity. This process will also ensure non-toxic farm management practices. The coffee will be branded and marketed in the niche market at a higher price.

6.8 Agroecology

"Agroecology is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system. By building synergies, agroecology can support food production and food security and nutrition while restoring the ecosystem services and biodiversity that are essential for sustainable agriculture. Agroecology can play an important role in building resilience and adapting to climate change" (FAO, 2018)

The elements of Agroecology are Diversity, Co-creation and sharing of knowledge, Synergies, Efficiency, Recycling, Resilience, Human and social values, Culture and food traditions, Responsible governance, Circular and solidarity economy.

The Panchayat can take up projects aiming at improving diversity of food and non food crops; improving organic carbon in soil through recycling of agriculture waste, municipal waste and mulching; identification and promotion of climate resilient varieties of existing crops or climate resilient crops to the changed climate; improving culture and food habits to ensure nutrition

to all; improving efficiency of agriculture practices through promotion of organic farming; integration of livestock and small enterprises to improve value addition etc.

This requires support from scientific community, technical service providers, farmers etc. The Panchayat may initiate a process to launch Agroecology as a mission to complement Carbon Neutral Meenangadi Project.

6.9 Climate Emergency Response Units (CERU)

CERUs are a kind of back up system for managing climate events like natural calamities, epidemic outbreaks etc. CERUs will be the facilitating centre for communities who are impacted by climate emergencies for a short term. These CERUs can act as an extension of disaster management team and district administration for rehabilitation and rescue support.

People need to be sensitized about the climate vulnerabilities and trained to face climate eventualities and equipped to build climate resilience. This cannot be a one time process. It need to be a continuous and active visible process to get it internalized in the community.

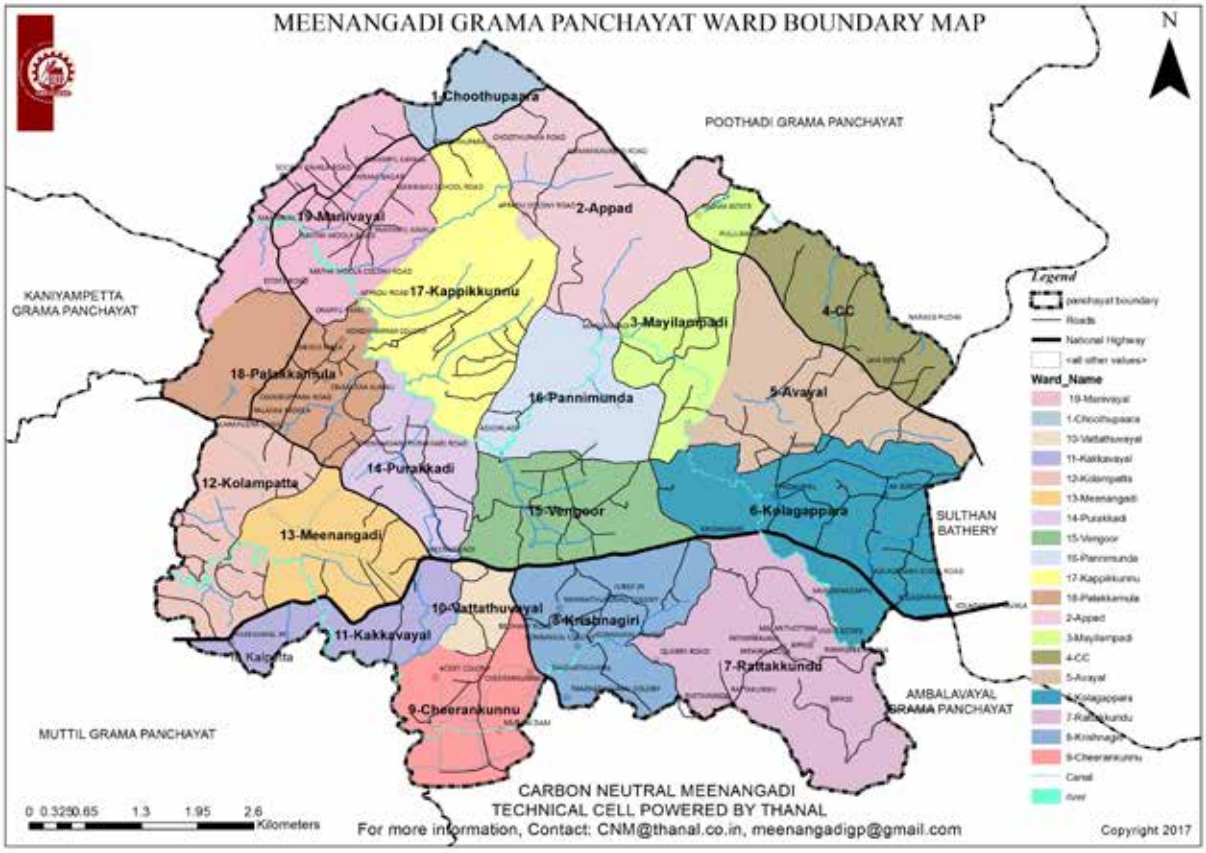
The Panchayat may set up CERUs in communities who are more vulnerable to climate emergencies. The functions of a CERU are to facilitate coordination of communications, warnings, precautions and rescue operations at the time of climate emergencies. Besides this the CERUs can take up activities or functions to build capacities among women and children to be climate resilient. This may include life skill training, career guidance, counselling, nutrition awareness, health care support for pregnant women, infants and elderly women, distribution of nutrition supplements, special food, medicine, provide information and support for citizens to avail benefits of Government schemes and projects etc.

CERUs can be formed along with existing Anganwadis or by upgrading existing Anganwadis. The operation and maintenance can be integrated with existing projects / programmes of departments like social justice, health, education etc. Involving senior student volunteers / NGOs will ensure constant human resource supply for the functions of CERU.

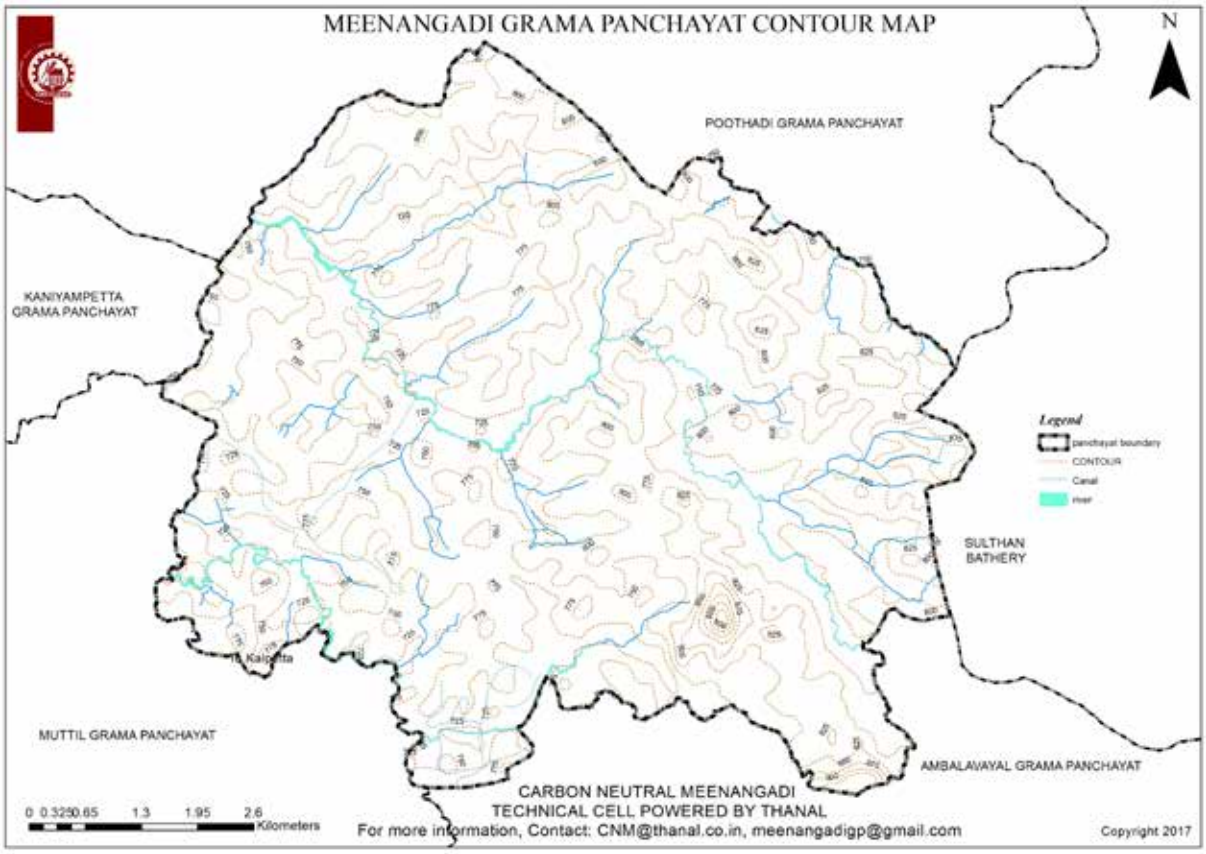
7. Annexure

Annexure 1 Spatial Data of Meenangadi Grama Panchayat

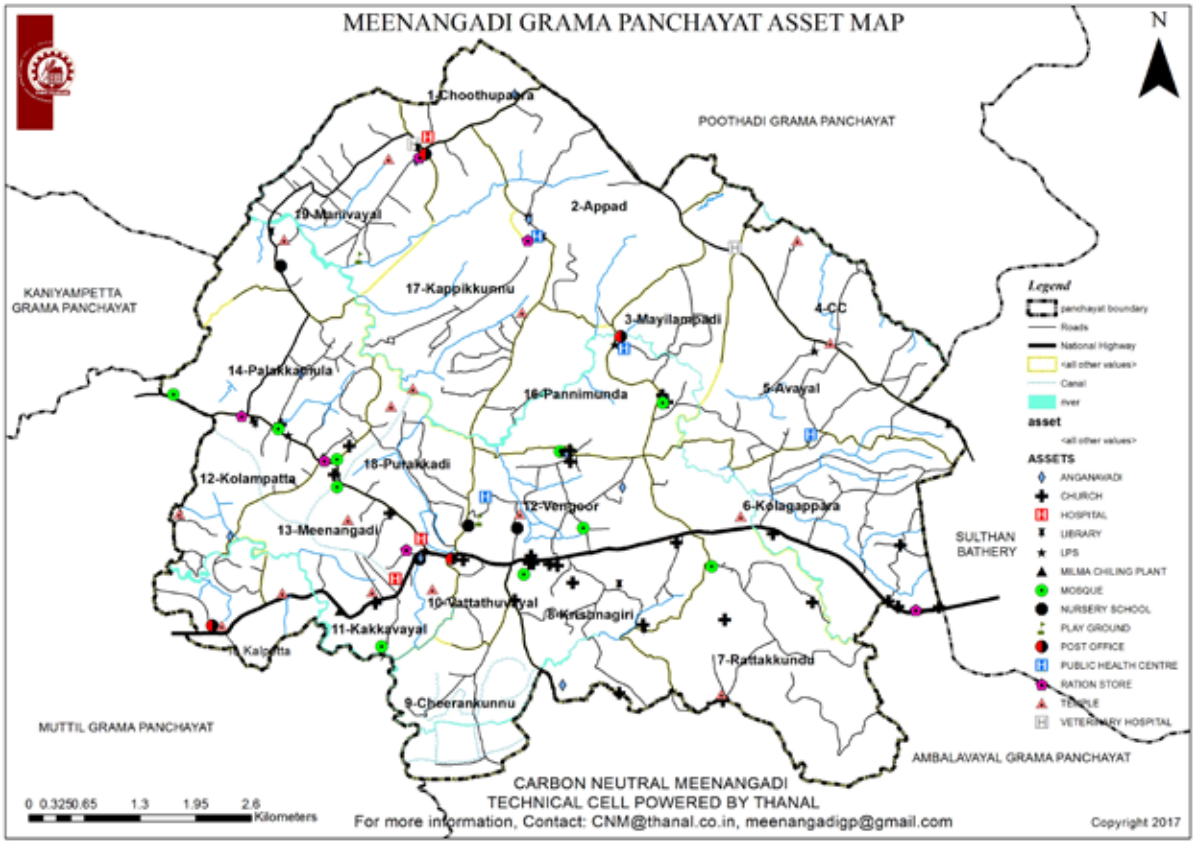
Annexure 1.1



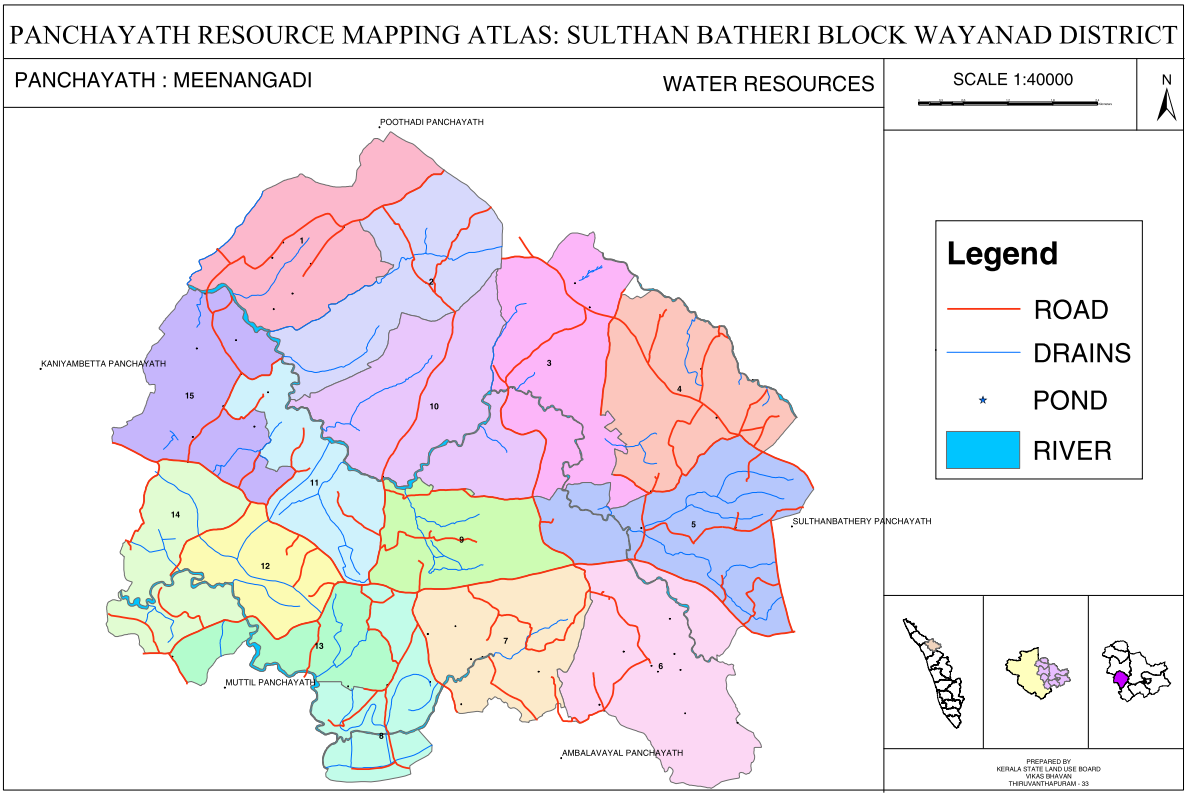
Annexure 1.2



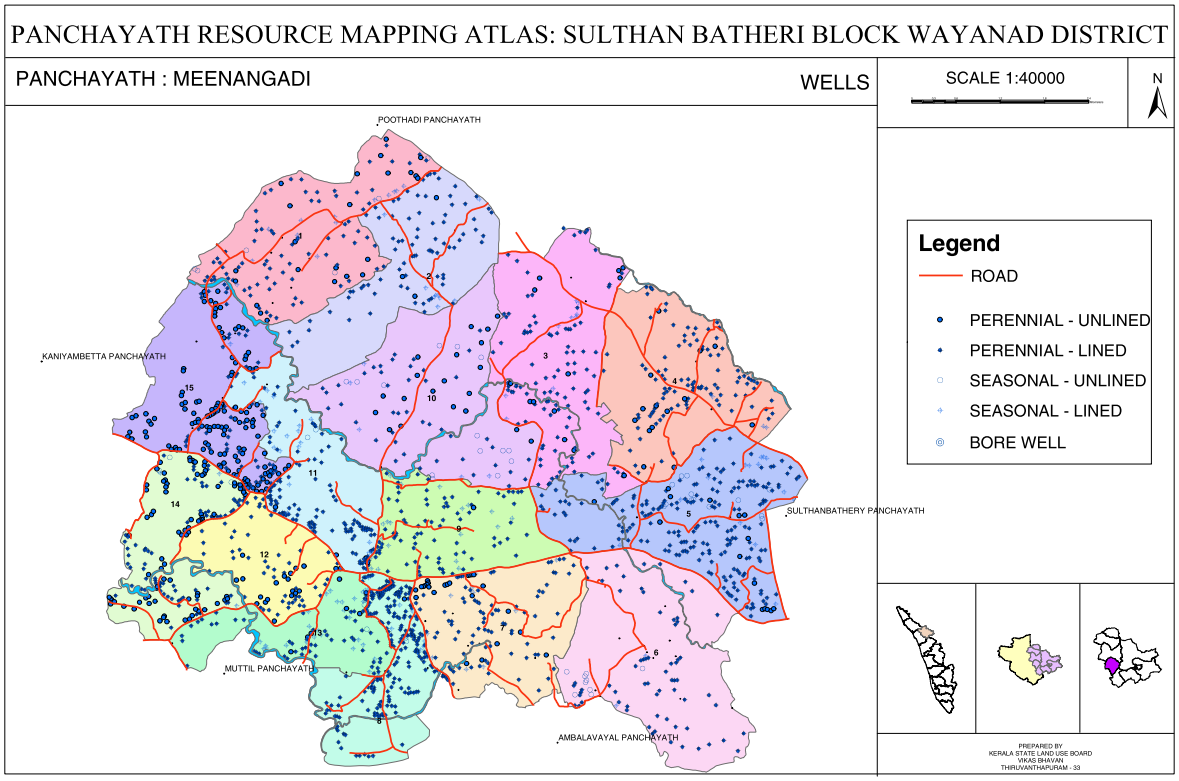
Annexure 1.3



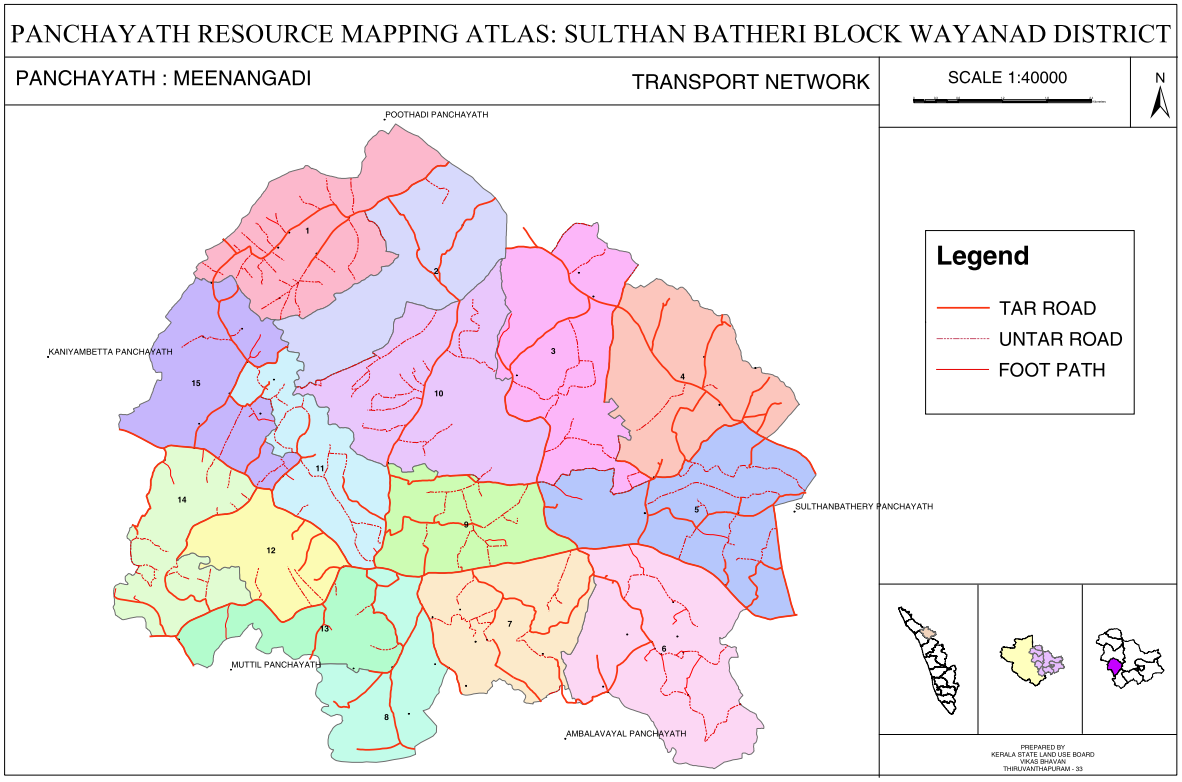
Annexure 1.4



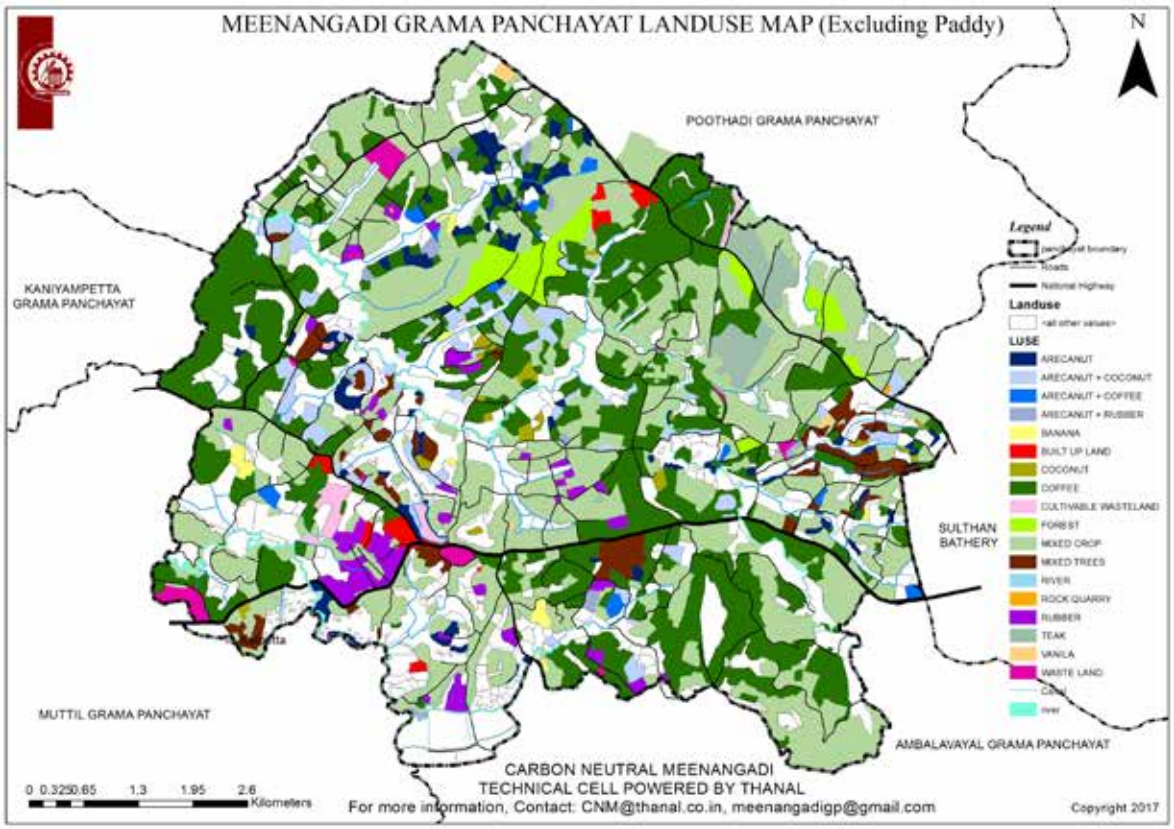
Annexure 1.5



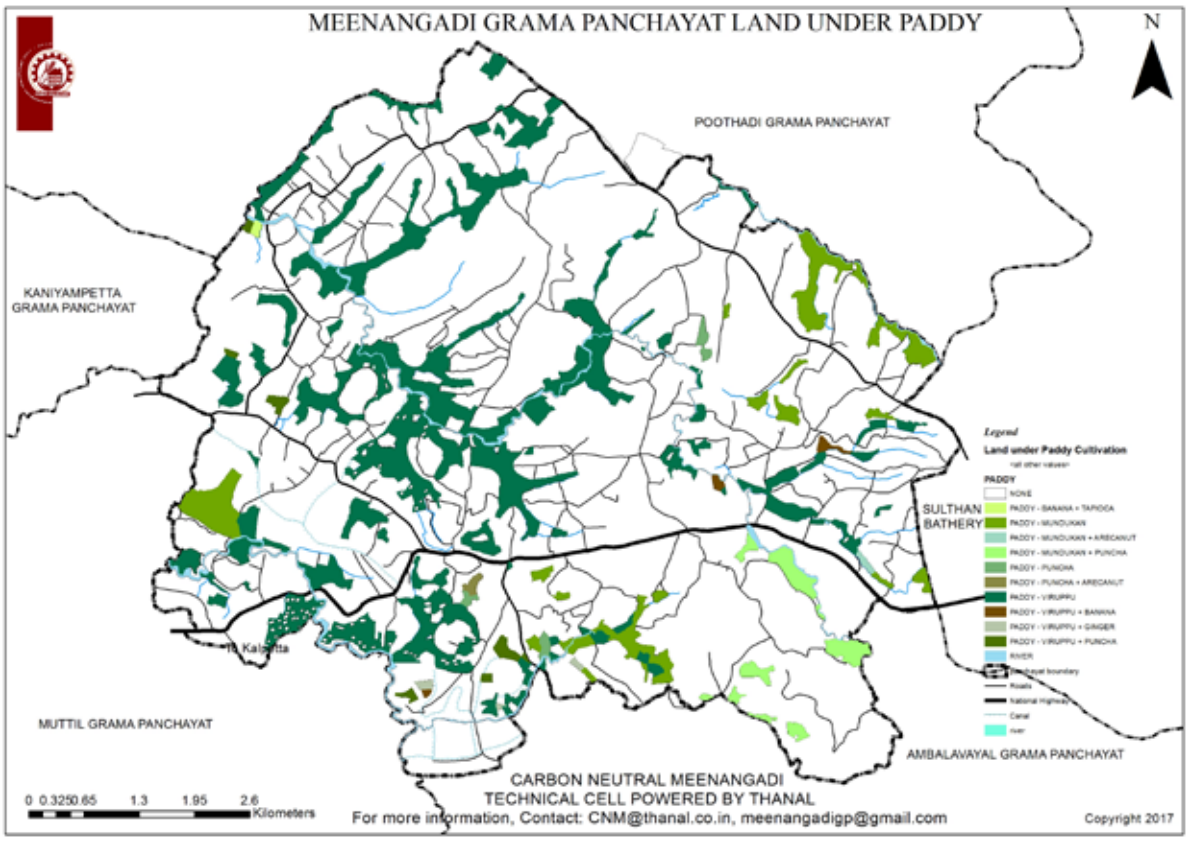
Annexure 1.6



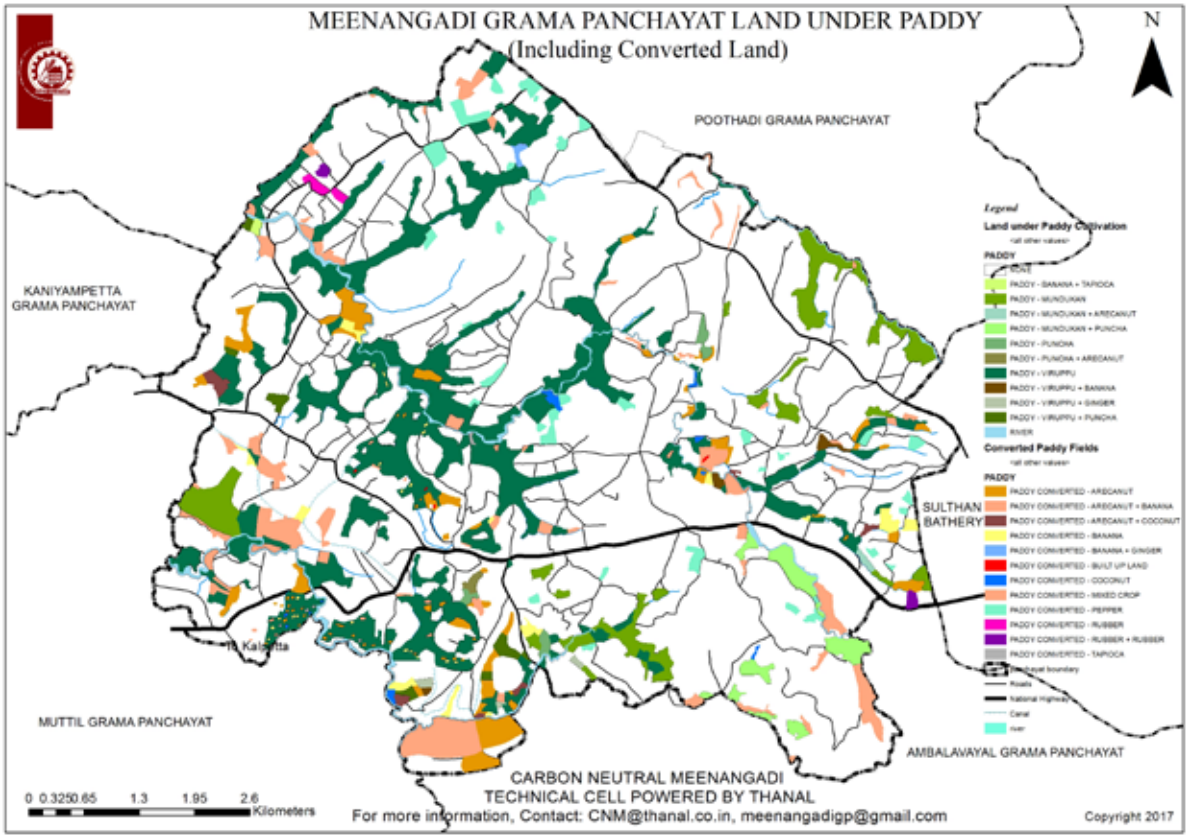
Annexure 1.7



Annexure 1.8



Annexure 1.9



Annexure 2 Checklist of Birds of Meenangadi

#	English Name	Scientific Name
1	Lesser Whistling-Duck	*Dendrocygna javanica*
2	Cotton Pygmy-Goose (Cotton Teal)	*Nettapus coromandelianus*
3	Indian Spot-billed Duck	*Anas poecilorhyncha*
4	Indian Peafowl	*Pavo cristatus*
5	Red Spurfowl	*Galloperdix spadicea*
6	Grey Junglefowl	*Gallus sonneratii*
7	Little Grebe	*Tachybaptus ruficollis*
8	Asian Openbill	*Anastomus oscitans*
9	Woolly-necked Stork	*Ciconia episcopus*
10	Little Cormorant	*Microcarbo niger*
11	Indian Cormorant (Indian Shag)	*Phalacrocorax fuscicollis*
12	Oriental Darter	*Anhinga melanogaster*
13	Purple Heron	*Ardea purpurea*
14	Great Egret	*Ardea alba*
15	Intermediate Egret	*Ardea intermedia*
16	Little Egret	*Egretta garzetta*
17	Cattle Egret	*Bubulcus ibis*
18	Indian Pond-Heron	*Ardeola grayii*
19	Black-crowned Night-Heron	*Nycticorax nycticorax*
20	Black-headed Ibis	*Threskiornis melanocephalus*
21	Black-shouldered Kite (Black-winged Kite)	*Elanus caeruleus*
22	Crested Honey Buzzard (Oriental Honey-buzzard)	*Pernis ptilorhynchus*
23	Crested Serpent-Eagle	*Spilornis cheela*
24	Crested Hawk-Eagle	*Nisaetus cirrhatus*
25	Black Eagle	*Ictinaetus malaiensis*
26	Crested Goshawk	*Accipiter trivirgatus*
27	Shikra	*Accipiter badius*
28	Besra	*Accipiter virgatus*
29	Black Kite	*Milvus migrans*
30	Brahminy Kite	*Haliastur indus*
31	White-breasted Waterhen	*Amaurornis phoenicurus*
32	Grey-headed Swamphen (Purple Swamphen)	*Porphyrio poliocephalus*
33	Eurasian Moorhen	*Gallinula chloropus*
34	Red-wattled Lapwing	*Vanellus indicus*
35	Greater Painted-Snipe	*Rostratula benghalensis*
36	Common Snipe	*Gallinago gallinago*
37	Common Sandpiper	*Actitis hypoleucos*

#	English Name	Scientific Name
38	Wood Sandpiper	*Tringa glareola*
39	Whiskered Tern	*Chlidonias hybrida*
40	Rock Pigeon (Feral Pigeon)	*Columba livia (Feral Pigeon)*
41	Spotted Dove	*Streptopelia chinensis*
42	Asian Emerald Dove	*Chalcophaps indica*
43	Grey-fronted Green-Pigeon (Pompadour Green-Pigeon)	*Treron affinis*
44	Yellow-footed Pigeon (Yellow-footed Green-Pigeon)	*Treron phoenicopterus*
45	Green Imperial-Pigeon	*Ducula aenea*
46	Mountain Imperial-Pigeon	*Ducula badia*
47	Greater Coucal	*Centropus sinensis*
48	Asian Koel	*Eudynamys scolopaceus*
49	Banded Bay Cuckoo	*Cacomantis sonneratii*
50	Grey-bellied Cuckoo	*Cacomantis passerinus*
51	Fork-tailed Drongo-Cuckoo	*Surniculus dicruroides*
52	Common Hawk-Cuckoo	*Hierococcyx varius*
53	Barn Owl	*Tyto alba*
54	Indian Scops-Owl (Collared Scops-Owl)	*Otus bakkamoena*
55	Oriental Scops-Owl	*Otus sunia*
56	Jungle Owlet	*Glaucidium radiatum*
57	Brown Hawk-Owl	*Ninox scutulata*
58	Jerdon's Nightjar	*Caprimulgus atripennis*
59	White-rumped Needletail (White-rumped Spinetail)	*Zoonavena sylvatica*
60	Brown-backed Needletail	*Hirundapus giganteus*
61	Indian Swiftlet	*Aerodramus unicolor*
62	Alpine Swift	*Apus melba*
63	Little Swift (Indian House Swift)	*Apus affinis*
64	Asian Palm-Swift	*Cypsiurus balasiensis*
65	Malabar Grey Hornbill	*Ocyceros griseus*
66	Common Kingfisher (Small Blue Kingfisher)	*Alcedo atthis*
67	Stork-billed Kingfisher	*Pelargopsis capensis*
68	White-throated Kingfisher	*Halcyon smyrnensis*
69	Pied Kingfisher	*Ceryle rudis*
70	Green Bee-eater	*Merops orientalis*
71	Blue-tailed Bee-eater	*Merops philippinus*
72	Chestnut-headed Bee-eater	*Merops leschenaulti*
73	Indian Roller	*Coracias benghalensis*
74	Malabar Barbet (Crimson-throated Barbet)	*Psilopogon malabaricus*
75	White-cheeked Barbet (Small Green Barbet)	*Psilopogon viridis*

#	English Name	Scientific Name
76	Brown-capped Pygmy Woodpecker (Indian Pygmy Woodpecker)	*Dendrocopos nanus*
77	Lesser Yellownape	*Picus chlorolophus*
78	Common Flameback (Goldenbacked Three-toed Woodpecker)	*Dinopium javanense*
79	Black-rumped Flameback (Lesser Goldenbacked Woodpecker)	*Dinopium benghalense*
80	Rufous Woodpecker	*Micropternus brachyurus*
81	Greater Flameback	*Chrysocolaptes guttacristatus*
82	Heart-spotted Woodpecker	*Hemicircus canente*
83	Rose-ringed Parakeet	*Psittacula krameri*
84	Plum-headed Parakeet	*Psittacula cyanocephala*
85	Malabar Parakeet (Blue-winged Parakeet)	*Psittacula columboides*
86	Vernal Hanging-Parrot (Indian Lorikeet)	*Loriculus vernalis*
87	Malabar Woodshrike	*Tephrodornis sylvicola*
88	Common Woodshrike	*Tephrodornis pondicerianus*
89	Bar-winged Flycatcher-shrike	*Hemipus picatus*
90	Ashy Woodswallow	*Artamus fuscus*
91	Common Iora	*Aegithina tiphia*
92	Small Minivet	*Pericrocotus cinnamomeus*
93	Orange Minivet	*Pericrocotus flammeus*
94	Large Cuckooshrike	*Coracina macei*
95	Black-headed Cuckooshrike	*Lalage melanoptera*
96	Brown Shrike	*Lanius cristatus*
97	Long-tailed Shrike	*Lanius schach*
98	Indian Golden Oriole	*Oriolus kundoo*
99	Black-naped Oriole	*Oriolus chinensis*
100	Black-hooded Oriole	*Oriolus xanthornus*
101	Black Drongo	*Dicrurus macrocercus*
102	Ashy Drongo	*Dicrurus leucophaeus*
103	White-bellied Drongo	*Dicrurus caerulescens*
104	Bronzed Drongo	*Dicrurus aeneus*
105	Greater Racket-tailed Drongo	*Dicrurus paradiseus*
106	Black-naped Monarch	*Hypothymis azurea*
107	Indian Paradise-Flycatcher	*Terpsiphone paradisi*
108	Rufous Treepie	*Dendrocitta vagabunda*
109	House Crow	*Corvus splendens*
110	Large-billed Crow	*Corvus macrorhynchos*
111	Jerdon's Bushlark	*Mirafra affinis*
112	Oriental Skylark	*Alauda gulgula*

#	English Name	Scientific Name
113	Malabar Lark	*Galerida malabarica*
114	Dusky Crag-Martin	*Ptyonoprogne concolor*
115	Barn Swallow	*Hirundo rustica*
116	Hill Swallow (House Swallow)	*Hirundo domicola*
117	Red-rumped Swallow	*Cecropis daurica*
118	Grey-headed Canary-Flycatcher	*Culicicapa ceylonensis*
119	Cinereous Tit (Great Tit)	*Parus cinereus*
120	Indian Tit (Indian Yellow Tit)	*Machlolophus aplonotus*
121	Velvet-fronted Nuthatch	*Sitta frontalis*
122	Flame-throated Bulbul (Ruby-throated Bulbul)	*Pycnonotus gularis*
123	Red-vented Bulbul	*Pycnonotus cafer*
124	Red-whiskered Bulbul	*Pycnonotus jocosus*
125	Yellow-browed Bulbul	*Iole indica*
126	Square-tailed Bulbul (Black Bulbul)	*Hypsipetes ganeesa*
127	Green Warbler	*Phylloscopus nitidus*
128	Greenish Warbler	*Phylloscopus trochiloides*
129	Large-billed Leaf Warbler	*Phylloscopus magnirostris*
130	Thick-billed Warbler	*Iduna aedon*
131	Blyth's Reed-Warbler	*Acrocephalus dumetorum*
132	Zitting Cisticola	*Cisticola juncidis*
133	Common Tailorbird	*Orthotomus sutorius*
134	Grey-breasted Prinia	*Prinia hodgsonii*
135	Ashy Prinia	*Prinia socialis*
136	Plain Prinia	*Prinia inornata*
137	Oriental White-eye	*Zosterops palpebrosus*
138	Tawny-bellied Babbler	*Dumetia hyperythra*
139	Dark-fronted Babbler	*Rhopocichla atriceps*
140	Indian Scimitar-Babbler	*Pomatorhinus horsfieldii*
141	Puff-throated Babbler	*Pellorneum ruficeps*
142	Brown-cheeked Fulvetta	*Alcippe poioicephala*
143	Rufous Babbler	*Turdoides subrufa*
144	Jungle Babbler	*Turdoides striata*
145	Yellow-billed Babbler	*Turdoides affinis*
146	Asian Fairy-bluebird	*Irena puella*
147	Asian Brown Flycatcher	*Muscicapa dauurica*
148	Brown-breasted Flycatcher	*Muscicapa muttui*
149	Indian Robin	*Copsychus fulicatus*
150	Oriental Magpie-Robin	*Copsychus saularis*

#	English Name	Scientific Name
151	Blue-throated Flycatcher (Blue-throated Blue-Flycatcher)	*Cyornis rubeculoides*
152	Tickell's Blue-Flycatcher	*Cyornis tickelliae*
153	Malabar Whistling-Thrush	*Myophonus horsfieldii*
154	Rusty-tailed Flycatcher	*Ficedula ruficauda*
155	Blue-capped Rock-Thrush	*Monticola cinclorhynchus*
156	Pied Bushchat	*Saxicola caprata*
157	Orange-headed Thrush	*Geokichla citrina*
158	Indian Blackbird	*Turdus simillimus*
159	Southern Hill Myna	*Gracula indica*
160	Rosy Starling	*Pastor roseus*
161	Brahminy Starling	*Sturnia pagodarum*
162	Chestnut-tailed Starling	*Sturnia malabarica*
163	Malabar Starling (Blyth's Starling)	*Sturnia blythii*
164	Common Myna	*Acridotheres tristis*
165	Jungle Myna	*Acridotheres fuscus*
166	Jerdon's Leafbird (Jerdon's Chloropsis)	*Chloropsis jerdoni*
167	Golden-fronted Leafbird (Golden-fronted Chloropsis)	*Chloropsis aurifrons*
168	Nilgiri Flowerpecker	*Dicaeum concolor*
169	Purple-rumped Sunbird	*Leptocoma zeylonica*
170	Crimson-backed Sunbird (Small Sunbird)	*Leptocoma minima*
171	Purple Sunbird	*Cinnyris asiaticus*
172	Long-billed Sunbird (Loten's Sunbird)	*Cinnyris lotenius*
173	Little Spiderhunter	*Arachnothera longirostra*
174	Western Yellow Wagtail	*Motacilla flava*
175	Grey Wagtail	*Motacilla cinerea*
176	White-browed Wagtail (Large Pied Wagtail)	*Motacilla maderaspatensis*
177	Paddyfield Pipit	*Anthus rufulus*
178	Common Rosefinch	*Carpodacus erythrinus*
179	House Sparrow	*Passer domesticus*
180	Chestnut-shouldered Petronia (Yellow-throated Sparrow)	*Petronia xanthocollis*
181	Baya Weaver	*Ploceus philippinus*
182	White-rumped Munia	*Lonchura striata*
183	Black-throated Munia	*Lonchura kelaarti*
184	Scaly-breasted Munia (Spotted Munia)	*Lonchura punctulata*
185	Tricolored Munia (Black-headed Munia)	*Lonchura malacca*

Annexure 3 Checklist of Trees in the Homesteads of Meenangadi

#	Botanical Name	English Name	Local Name
1	*Aegel marmelose*	Indian Bael	Koovalam
2	*Anacardium occidentale*	Cashew	Kashumavu
3	*Annona reticulata*	Custard Apple	Seethappazham
4	*Anona muricata*	Soursop	Aathichakka
5	*Areca catechu*	Areca nut	Adakka
6	*Artocarpus hirsutus*	Wild Jackfruit Tree	Aanjili / Ayani plavu
7	*Artrocarpus hetrophyllus*	Jackfruit	Plavu
8	*Azardica indica*	Neem	Veppu
9	*Bauhinia variegata*	Kachnar	Mandaram
10	*Borassus flabelifer*	Palmyra Palm	Pana
11	*Cinnamomum cassia*	Cinnamon Tree	Vayana
12	*Cassine paniculata*	Panicled Cassine	Thannimaram
13	*Chrysophyllum cainito*	Star apple	Star apple
14	*Cinnamomum malabatrum*	Cinnamon Tree	Vayana
15	*Citrus aurantifolia*	Key lime	Narakam
16	*Citrus limetta*	Sweet lime	Mousambi / Sathukkudi
17	*Citrus limon*	Lemon	Naranga
18	*Citrus maxima*	Pomelo Tree	Bumblymass naranga
19	*Citrus medica*	Citron	Kari Naranga
20	*Citrus reticulata*	Mandarin Orange	Orange
21	*Cocos nucifera*	Coconut Tree	Thengu
22	*Dalbergia latifolia*	Rosewood	Eeetti
23	*Delonix regia*	Gulmohar	Gulmohar
24	*Ealeocarpus ganitrus*	Eucalyptus	Eucaly
25	*Erythrina indica*	Indian Coral Tree	Murikku
26	*Ficus auriculata*	Banyan Tree	Aal maram
27	*Gmelina arborea Roxb*	Beechwood	Kumizhu
28	*Gracinia cambogia*	Malabar Tamarind	Kudampuli
29	*Gravillea robusta*	Silver Oak	Silver Oak
30	*Grewia tillifolia vahl*	Dhaman	Chadachi / Unnam
31	*Hevea brasiliensis*	Rubber	Rubber
32	*Japtropha curcas*	Jatropha	Kadalaavanakk
33	*Litchi chinensis*	Lychee	Lychee
34	*Macaranga peltata*	Macaranga	Vatta / Poriyani
35	*Mangifera indica*	Mango Tree	Maavu

36	*Manilkara zapota*	Sapodilla	Sappotta
37	*Michelia champaca*	Champak	Chempakam
38	*Mimusops elengi*	Bulletwood	Elanji
39	*Murraya koenigii*	Curry leaf	Kariveppu
40	*Myristica fragrans*	Nutmeg	Jathi
41	*Nephelium lappaceum*	Rambuttan	Rambuttan
42	*Persea americana*	Avocado	Avocado
43	*Phyllanthus emblica*	Indian Gooseberry	Nelli
44	*Pimenta dioica*	Allspice	Allspice
45	*Pouteria campechiana*	Egg Tree	Muttappazham
46	*Terminalia cattappa*	Badam Tree	Badam
47	*Psidium guajava*	Guava	Perakka
48	*Pterocarpus marsupium*	Indian Kino Tree	Venga
49	*Punica granatum*	Pomegranate	Maathalam
50	*Pyrus malus*	Apple	Apple
51	*Simarouba glauca*	Paradise Tree	Lekshmi Tharu
52	*Swietenia macrophylla*	Mahogany	Mahogany
53	*Syzygium aquem*	Water Apple	Jampakka
54	*Syzygium aromaticum*	Clove	Grampoo
55	*Syzygium caryophyllatum*	Dwarf black plum tree	Naval
56	*Syzygium jambos*	Rose apple	Seema Champa
57	*Syzygium samarangense*	White wax apple	Champa
58	*Tamarindus indica*	Tamarind Tree	Puli
59	*Tectona grandis*	Teak	Thekku
60	*Terminalia eliptica*	Thembavu / Karimaruthu	Thembavu / Karimaruthu
61	*Theobroma cacao*	Cocoa	Cocoa
62	*Lagerstroemia microcarpa*	Venthekku	Venthekku / Vellilavu
63	*Butea monosperma*	Flame of the Forest	Chamatha Maram
64	*Spathodea campanulata*	African Tulip Tree	Spathodea
65	*Strychnos nux vomica*	Nux Vomica	Kanjiram

Annexure 4 Green Protocol and Material Use Policy Guidelines for Meenangadi

Green Protocol Guidelines:

1. Phase out all disposable products especially made of plastics and or multilayers. Avoid single use throw away products, plastic carry bags, non woven poly propylene carry bags, cups / plates / cutleries made of plastic / Styrofoam / multi layers/ tetra packs, straws etc.
2. Phase out products with micro beads, micro plastic fibres. Products such as face wash, cigarette filters, pillows with micro fibre fillings, bean bags need to be avoided
3. PVC flooring / wall papers, toys made of PVC, PVC curtains / PVC Flex banners, need to be avoided
4. Do not use plastic bottles as drinking water bottles / infant feeding bottles
5. Avoid bottled water. Carry refillable water bottle and consume fresh juices / local beverages. Ensure water dispensers in the events
6. Buy in bulk and buy local to reduce plastic packaging
7. Carry cloth bags / containers for shopping to avoid disposable bags and containers
8. Share reusable materials and products with people whom you know.
9. Do not burn waste especially plastic.
10. Do not use plastic decorative at home, Stay away from recycled and cheap plastic products like toys / utensils.
11. Segregate discards at homes / Institutions / events into bio degradable, paper, plastics, glass, metal, and hazardous.
12. Do compost at home / utilize biogas plant to recover bio degradable waste.
13. Grow organic vegetables at home / roof top / balcony, wherever you can.
14. Shift to LED lighting, Brushless DC fans and other energy efficient devices including wind / solar energy as alternate source of energy.
15. Utilize energy efficient cooking / heating devices such as pressure cooker, solar cooker, solar water heater, solar dryers, thermo boxes, energy efficient stoves etc.
16. Phase out use of pesticides and detergents at home
17. Install proper and scientific septic tank for your conventional flush toilets.
18. Make a soak pit to manage grey water at home / grow herbs or grass like plantains, yams, vetiver grass, lemon grass etc. to purify grey water.

Material Use Policy

The idea behind Material use Policy is to create a sustainable environment and to contribute towards a healthy environment. The conscious measures taken towards making eco-friendly institution/homes will change the overall approach towards the Green Protocol. Material use Policy will primarily include the purchasing decisions of materials from an environment perspective. The main aim is to reduce waste products in the office / institutions/homes. These policies will assist in promoting practices that conserve natural resources, improve the public and worker health, and at the same time making a conscious financial decision. The office has to ensure the following guidelines are taken into account before the purchase or the decision is made.

1. Necessity – Double check whether the intended product is necessary. Check whether the same utility is available from a similar product which is already purchased and left unutilized. Check whether an existing product can be upgraded for sharing. For example keeping stationery in a common space in the office so that everyone in the office can access will eliminate buying stationery for each table.
2. Next best alternative – Enquire for alternative products and or options for the intended product/service. Weigh the pros and cons before making a purchase.
3. Environmental Stewardship / EPR – Check with the manufacturer / supplier to ensure there is adequate environmental stewardship / Extended Producer Responsibility attached to the product, where the supplier / manufacturer is willing to share the responsibility of final dispose.
4. Durability – Check whether the product is durable or disposable. Also ensure that the product is future ready and will not get obsolete in a short span of a time.
5. Reusability /Recyclability – Check whether the product can be reused with maintenance, upgradation or it can be recycled at the end of its life period.
6. Toxicity – Check for less toxic products, or product with minimum toxic burden
7. Local Livelihood – Check whether the product / process support local livelihood

Annexure 5 List of trees for planting

The following aspects / criterions were followed to choose list of trees for planting in Meenangadi.

- o Indigenous/Exotic
- o Contribution to Carbon sequestration
- o Economic value(Timber)
- o Growth rate
- o Canopy area
- o Germination of seeds(Percentage)
- o Medicinal property
- o Religious value

#	Botanical Name	English Name	Local Name
1	*Aegle marmelos*	Bael tree/Wood apple	koovalam
2	*Artocarpus hirsuteus*	Wild jack tree	Ayini/Anjili
3	*Azardica indica*	Neem tree	Veppu
4	*Cinnamomum zeylanicum*	Cinnamon tree	Nattu Karuvappatta
5	*Cinnamomum malabatrum*	Cinnamon tree	Ilavangham/Vazhana
6	*Mangifera indica*	Mango	Mavu
7	*Dalbergia latifolia*	Indian Rosewood	Veetti
8	*Hopia parviflora*	Malabar Iron wood	Thambakam
9	*Haldina cordifolia*	Kadamba tree	Manjakadambu
10	*Pterocarpus marsupium*	Indian kino tree	Venga
11	*Schleichera oleosa*	Lac tree	Poovam, puvathi
12	*Tamarindus indica*	Tamarind	Puli
13	*Tectona grandis*	Teak	Thekku
14	*Terminalia elliptica*	Indian laurel tree	Kari maruthu
15	*Terminalia paniculata*	Flowering murdah	Pulla maruthu
16	*Gmelina arborea*	White teak	Kumizhu/Kumbil
17	*Aposora mahagani*	Mahagoni	Mahagani
18	*Lagerstroemia microcarpa*	Naked beauty of the forest	Ven Thekku
19	*Atrocarpus heterophyllus*	Jackfruit	Plavu
20	*Bambusa bambos*	Bamboo	Mula
21	*Cassia fistula*	Golden shower tree	Kanikkonna
22	*Melia azedarach*	Indian lilac	Malaveppu
23	*Anthocephalus chinensis*	Bur-flower tree	Kadambu
24	*Ailanthus triphysa*	Matchwood tree	Matti/Perumaram
25	*Cassine paniculata*	Thanni	Thanni

Annexure 6 List of trees for Pledging in Tree Bank

#	Botanical Name	English Name	Local Name
1	*Bambusa bambos*	Bamboo	Mula
2	*Artocarpus hirsuteus*	Wild jack tree	Ayini/Anjili
3	*Mangifera indica*	Mango	Mavu
4	*Tamarindus indica*	Tamarind	Puli
5	*Atrocarpus heterophyllus*	Jackfruit	Plavu
6	*Alstonia scholaris (Lin.) R. Br*	Devil tree	Ezhilam pala
7	*Azardica indica*	Neem tree	Veppu
8	*Ficus auriculata*	Fig tree	Athimaram
9	*Ficus benghalensis linn.*	Indian banyan tree	Peral
10	*Ficus exasperata*	Sandpaper fig tree	Vella Athimaram
11	*Garcinia gummi-gutta*	Malabar Tamarind	Kudambuli
12	*Ficus religiosa*	Peepul tree	Arayal
13	*Mimusops elengi Linn.*	Bullet wood	Ilanji
14	*Pongamia pinnata (Linn.) Pierre*	Indian beech tree	Ungu
15	*Santalum album*	Indian Sandalwood	Chandanam
16	*Saraca asoca*	Asoka tree	Asokam
17	*Pterocarpus marsupium*	Indian kino tree	Venga
18	*Syzygium cumini*	Jamun	Njaval
19	*Aegle marmelos*	Bael tree/Wood apple	koovalam
20	*Cinnamomum verum (Cinnamomum zeylanicum)*	Cinnamon tree	Nattu Karuvappatta
21	*Cinnamomum malabatrum*	Cinnamon tree	Ilavangham/Vazhana
22	*Dalbergia latifolia*	Indian Rosewood	Veetti
23	*Haldina cordifolia*	Kadamba tree	Manjakadambu
24	*Tectona grandis*	Teak	Thekku
25	*Hopia parviflora*	Malabar Iron wood	Thambakam

8. References / Readings

1. Ramachandra T.V., S. (2012). *Decentralized carbon footprint analysis for opting climate change mitigation strategies in India, Renewable and sustainable energy reviews.*
2. Department of Environment and Climate Change, G. o. (2014). State Action Plan on Climate Change. Kerala: Department of Environemnt and Climate Change.
3. Depatment of Town and Country Planning, G. o. (2014). *Integrated District Development Plan - Wayanad.* Govt. of Kerala.
4. Indian Network for Climate Change Assessment. (2010). *India:Green House Gas Emissions 2007.* Ministry of Environment and Forest, Government of India.
5. Department of Soil Survey and Conservation, G. o. (2016-17). *Soil Series Study of Meenangadi (un published).* Unpublished.
6. Department, I. M. *Weather data.* IMD.
7. Ministry of Environment, F. a. (2015, October 2). *India's Intended Nationally Determined Contribution is Balanced and Comprehensive: Environment Minister*. Retrieved 03 4, 2018, from www.pib.nic.in: www.pib.nic.in/newsite/PrintRelease.aspx?relid=128403
8. Ramachandra, T.V., Shwetmala, (2009), Emissions from India's transport sector: Statewise synthesis, Atmospheric Environment, doi:10.1016/j.atmosenv.2009.07.015
9. FAO. (2018). *Agroecology Knowledge Hub*. Retrieved May 3, 2018, from FAO.org: http://www.fao.org/agroecology/overview/en/
10. IPCC (Intergovernmental Panel on Climate Change) (2006) guidelines, IPCC Guidelines for National Greenhouse Gas Inventories.
11. Amit Garg, P R Shukla (2009), IIM Ahmedabad, Regional and Sectoral Assessment of Green House Gas emissions in India, Atmospheric Environment, Vol. 35/15, pp 2679-2695
12. TERI, WRI India, (2015) , India Specific Road Transport Emission Factors, India GHG Program
13. Aaron Atteridge, NituGoel et al, (2009) Reducing GHG emissions in India, Financial mechanisms and opportunities for EU-India collaboration, Stockholm Environment Institute Report

14. WRI, C40 Cities, ICLEI (2014) Global Protocol for Community scale Green House Gas inventory

15. Bader N, Bleischwitz R. (2009) Study report comparative analysis of local GHG inventory tools. Germany;

16. IPCC (Intergovernmental Panel on Climate Change): (2007), AR4 (Fourth Assessment Report compiled by the IPCC)

17. Singhal KK, Mohini M, Jha AK, Gupta PK (2005). Methane emission estimates from enteric fermentation in Indian livestock: dry matter intake approach. Current Science; 88(1):119–27.

18. Vashum KT, Jayakumar S (2012) Methods to Estimate Above-Ground Biomass and Carbon Stock in Natural Forests - A Review. J EcosystEcogr 2:116. doi:10.4172/2157-7625.1000116

19. Gupta PK, Jha AK, Koul S, Sharma P, Pradhan V, Gupta V, et al (2007). Methane and nitrous oxide emission from bovine manure management practices in India. Environmental Pollution;146:219–24.

20. Parashar DC, Mitra AP, Gupta PK, Rai J, Sharma RC, Singh N, et al. Methane Budget from Paddy Fields in India. Chemosphere 1996;33(4):737–57.

21. NEERI (National Environmental Engineering Research Institute) (2005). Assessment of status of Municipal Solid Waste Management in metro cities, state capitals, class-1 cities and class-II towns. Nagpur, India.

22. Garg A, Bhattacharya S, Shukla PR, Dadhwal VK. (2001) Regional and sectoral assessment of greenhouse gas emissions in India. Atmospheric Environment;35:679–2695

23. Sovacool BK, Marilyn AB. Twelve metropolitan carbon footprints (2010): A preliminary comparative global assessment. Energy policy;38(9):4856–69.

24. MoEF (Ministry of Environment and Forestry) (2009), India's Forest and tree cover: contribution as carbon sink. URL:/http://moef.nic.in/modules/aboutthe-ministry/CCD/Contri_carbon_sink.pdfS.

25. Ramachandra TV (2010). Mapping of fuelwood trees using geoinformatics. Renewable and Sustainable Energy Reviews;14(2):642–54.

26. Bhattacharya T, Pal DK, Velayutham M, Chandran P, Mandal C (2000). Total carbon stock in Indian soils: issues, priorities and management. In: Special Publication of the International Seminar on Land Resource Management for Food, Employment and Environment Security (ICLRM). Soil Conservation Society of India, New Delhi. p.1–46

27. Menikpura, S.N.M., et al., Integrated Solid Waste Management: an approach for enhancing climate co-benefits through resource recovery, Journal of Cleaner Production (2013), http://dx.doi.org/10.1016/j.jclepro.2013.03.012

28. Ravindranath NH, Ostwald M (2008) Methods for estimating above-ground biomass. In N. H. Ravindranath, and M. Ostwald, Carbon Inventory Methods: Handbook for greenhouse gas inventory, carbon mitigation and roundwood production projects. Springer Science + Business Media B.V 113-14.

29. Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K (2006) IPCC Guidelines for National Greenhouse Gas Inventories Volume - IV Agriculture, Forestry and other and-use. Institute of Global Environmental Strategies (IGES), Hayama, Japan

30. Ramachandran A, Jayakumar S, Haroon RM, Bhaskaran A, Arockiasamy DI (2007) Carbon sequestration: estimation of carbon stock in natural forests using geospatial technology in the Eastern Ghats of Tamil Nadu, India. Current Science 92: 323-331.

31. Kale MP, Rava SA, Roy PS, Singh SS (2009) Patterns of carbon sequestration in forests of Western Ghats and study of appllicability of remote sensing in generating carbon credits through afforestation/reforestation. Journal of Indian Society Remote Sensing 37: 457-471.

32. Bijalwan A, Swamy SL, Sharma CM, Sharma NK, Tiwari AK (2010) Land-use, biomass and carbon estimation in dry tropical forest of Chhattisgarh region in India using satellite remote sensing and GIS. Journal of Forestry Research 21: 161-170.

33. Pandey U, Kushwaha SP, Kachhwaha TS, Kunwar P, Dadhwal VK (2010) Potential of Envisat ASAR data for woody biomass assessment. Tropical Ecology 51: 117-124.

34. Thakur T, Swamy SL (2010) Analysis of land use, diversity, biomass, C and nutrient storage of a dry tropical forest ecosystem of India using satellite remote sensing and GIS techniques. International Forestry and Environment Symposium 15: 273-278.

35. Kumar R, Gupta SR, Singh S, Patil P, Dhadhwal VK (2011) Spatial distribution of forest biomass using remote sensing and Regression models in Northern Haryana, India. International Journal of Ecology and Environmental Sciences 37: 37-47.

36. India State of Forest Report (2011) Forest Survey of India, FSI (Ministry of Environment and Forest), Dehradun, India.

37. Sheikh MA, Kumar M, Bussman RW, Todaria NP (2011) Forest carbon stocks and fluxes in physiographic zones of India. Carbon Balance Manag 6.

38. India State of Forest Report (2009) Forest Survey of India, FSI (Ministry of Environment and Forest), Dehradun, India.

39. How much carbon does a tropical tree sequester Dexter B. Dombro, Tree Nation, UNEP.

Thanal Trust

*Thanal (Thanal in Malayalam means protection and support) is one of the oldest environmental organization in Kerala which was founded in 1986. Thanal focuses on **environmental health** and **justice**. Our vision is **PEOPLE**, **PLANET** and **SUSTAINABILITY** and our mission is **Crafting Change for the Future**.*

Thanal lead campaigns / projects at grassroots level, handhold communities to find environmental solutions, network with other groups at national and international levels to exchange ideas / experiences, facilitate information exchange and mentor for environmental leadership.

Thanal take up research in the interest of public on matters pertaining to environment and climate, provide technical support and consultancy services for environmental solutions, facilitate alternate livelihood programmes for local economic growth, do policy advocacy for governments and support social enterprises.

For more information visit www.thanal.co.in

Thanal
OD-3, Jawahar Nagar, Kawdiar P.O. Thiruvananthapuram, Kerala, India PIN 695003
Tel: +91 471 2727150. Email: climate@thanal.co.in Web: www.thanal.co.in