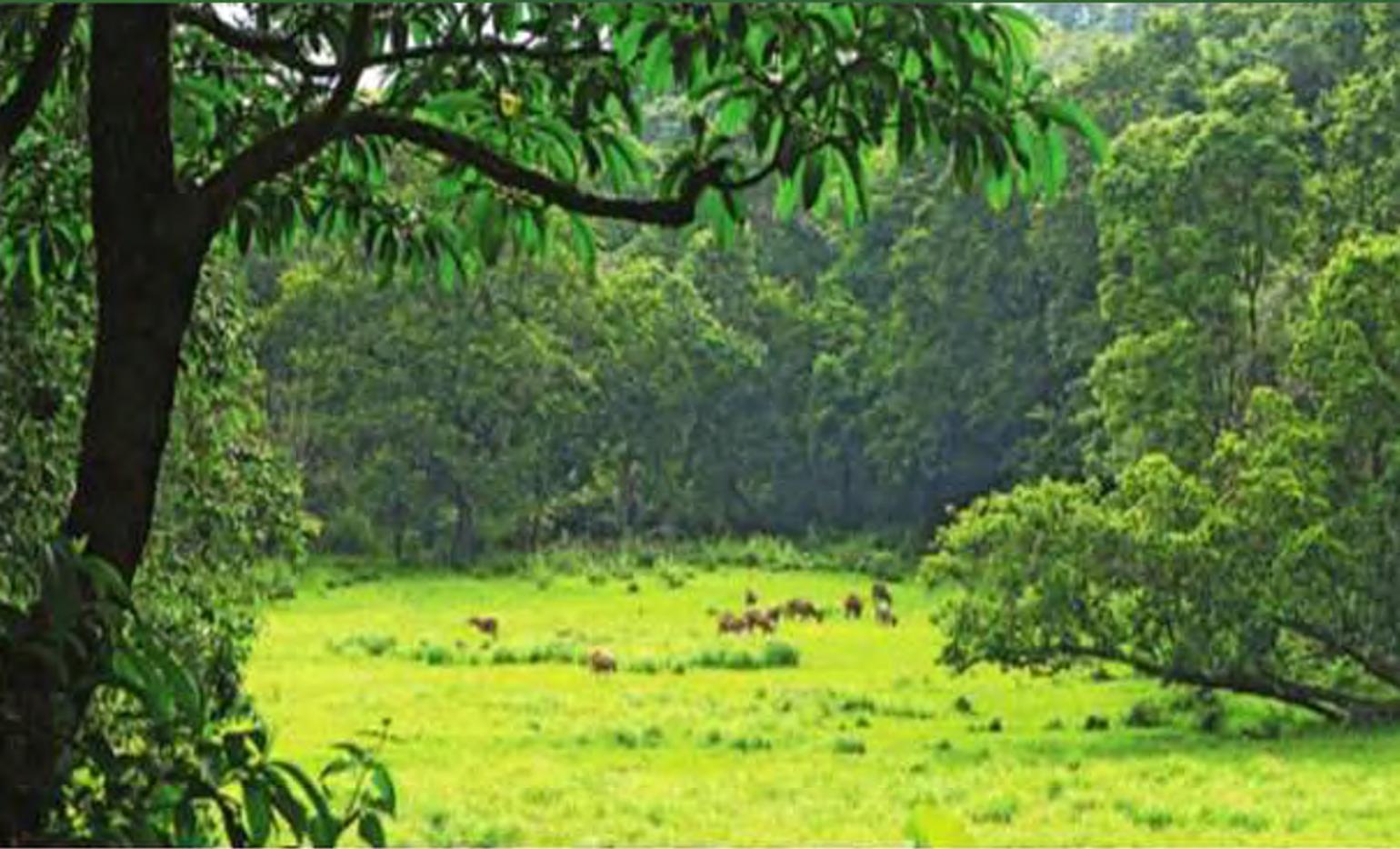




Government of Kerala

COMPENDIUM OF ENVIRONMENT STATISTICS KERALA 2014-15



**DEPARTMENT OF ECONOMICS & STATISTICS
KERALA**



GOVERNMENT OF KERALA

COMPENDIUM OF ENVIRONMENT STATISTICS

KERALA 2014-15

DEPARTMENT OF ECONOMICS & STATISTICS
GOVERNMENT OF KERALA – 695033

P R E F A C E

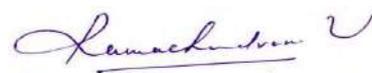
Objective of Environment Statistics is to provide information about the environment, its most important changes over the time and across the locations, and the main factors that influence them. Ultimately, environment statistics aim at providing high quality statistical information to improve knowledge of the environment, to support evidence-based policy and decision making, and to provide information for the general public, as well as for specific user groups. Environment statistics are multidisciplinary and cross-cutting, involving numerous sources and stakeholders

Environment statistics aggregate, synthesize and structure environmental and other data according to statistical methods, standards and procedures. It is the role of environment statistics to process environmental data into meaningful statistics that describe the state and trends of the environment and the main processes affecting them. Not all environmental data are used in the production of environment statistics. The Framework for the Development of Environment Statistics (FDES) provides a framework that marks out environmental data that fall within its scope and then structures, synthesizes and aggregates them into meaningful statistics. Environment statistics support evidence based policy making by enabling the identification of environmental policy issues and the objective quantification of measures and impacts of policy initiatives. They strengthen assessments through quantitative metrics, making analyses more robust through the use of timely and comparable data.

As an endeavor to know our environment, the Department of Economics and Statistics, Government of Kerala, has been bringing out the publication. This publication has been categorized into different chapters so as to make it easy for reference. The Department would like to express gratitude to all parties concerned for their co-operation and assistance in providing the required data.

I appreciate the officers of I & ES Wing in the Publication Division for their efforts for the collection, compilation and tabulation of the data under the leadership of Sri. P.V. Babu, Additional Director (General), who has taken special effort of this publication bringing out and Sri. V.P. Saraphudeen, Joint Director (PPC); Sri. Rajendra Prasad R.S., Asst. Director (PPC); Sri. S. Saseendran, Scrutiny Officer; Smt. Sreelatha S. O., Research Assistant and Smt. Sindu Mol K. G., Statistical Assistant Gr-I of I & ES Division of this Department and those who have dedicated their valuable time in the preparation of this report.

Suggestions, if any, to improve the quality, contents and presentation of this publication are most welcome.



Thiruvananthapuram,
02.04.2018

V. RAMACHANDRAN
DIRECTOR GENERAL

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Environment Statistics

Environment Statistics describe the qualitative and quantitative aspects of the state of the environment and its interaction with human activities and natural events by integrating data from a multitude of different subject areas and sources. Environment statistics is an emerging statistical field in official statistics in most countries and it is indispensable for evidence based policies and decision making to support sustainable development.

The Environmental Impact Assessment (EIA) experience in India indicates that the lack of timely availability of reliable and authentic environmental data has been a major bottle neck in achieving the full benefits of EIA. The environments being a multi-disciplinary subject, a multitude of agencies are involved in collection of environmental data. However, no single organization in India tracks available data from these agencies and makes it available in one place in a form required by environmental impact assessment practitioners. Further, environmental data is not available in enhanced forms that improve the quality of the EIA. This makes it harder and more time-consuming to generate environmental impact assessments and receive timely environmental clearances from regulators. With this background, the Environmental Information Centre (EIC) has been set up to serve as a professionally managed clearing house of environmental information that can be used by MoEF, project proponents, consultants, NGOs and other stakeholders involved in the process of environmental impact assessment in India. EIC caters to the need of creating and disseminating of organized environmental data for various developmental initiatives all over the country.

CHAPTER - I

ENVIRONMENT AND ENVIRONMENT DEGRADATION

Introduction

Environment statistics are environmental data that have been structured, synthesized and aggregated according to statistical methods, standards and procedures. Environment Statistics Kerala is aimed to provide statistical information about the environment and environmental changes over time in different locations of the State. The role of environment statistics is to process environmental and other data into meaningful statistics that bring light on the status and trends of the environment and its impact. The scope of Environment Statistics covers environment and the organism are two dynamic and complex component of nature. It also support to produce quality statistical information to improve awareness of the environment issues give data support to planners and decision makers in this field and to provide information for the general public. Statistical information collected and compiled in this publication is based on the statistical methods, standards and procedures developed by United Nations Statistical Division's (UNSD) Frame work for the Development of Environment Statistics (FDES). Environment regulates the life of the organisms including human beings that interacting systems of physical, biological and cultural elements which are interlinked both individually and collectively.

Human well-being depends upon the living and non-living elements of the environment and the goods and services they provide. Humans need the environment in order to survive and for various social, cultural and economic purposes. The human sub-system uses the environment for habitat, to obtain important physical resources and as a recipient or sink for various residuals. Human societies and their production and consumption patterns affect the environment that supports them and other life forms in general. Environment can be defined as the physical surrounding of human being of whom there is a part on which he/she is depended for their activities like physiological functioning, production and consumption. The physical environment stretches from air, water and land to natural resources like energy carriers, soil and plants, animals and ecosystems. The deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and its impact. It is defined as any change or disturbance to the environment perceived to be undesirable.

Environment Degradation

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife. It is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be entirely natural in origin, or it can be accelerated or caused by human interventions. When natural habitats are disturbed or natural resources depleted, the environment will be degraded. Efforts to counteract this problem including environmental protection and environmental resource management. Air, water, and soil resources which are vulnerable to depletion through overuse, scarcity of natural resources, slow down the sustainable production activity and over consumption which directly effect the economic development.

Social factors:

- ❖ Population - Population impacts in the environment is basically due to the excessive use of natural resources and unscientific disposal of large quantity of solid and liquid wastes which resulted harmful environmental degradation and loss of biodiversity.
- ❖ Poverty - Environment degradation linked with poverty mainly due to pressure extended to surrounding environment for livelihood. Continuous exploitation of natural resources to satisfy the livelihood of the community degraded the environment to an extend which no longer sustainable and lead to more poverty and environmental related problems such as deforestation, poor sanitation, air and water pollution, drought, famine, etc.
- ❖ Urbanization - Deterioration of air and water quality, generation of waste, rural to urban migration, shortage of proper sanitation and housing facilities together contribute to urban poverty and environmental degradation. Direct loss in vegetation, biomass from areas with high probability of urban expansion contributes about 5% of total emission from tropical deforestation and land use change.

Factors affecting Environment degradation:

1. Destruction of natural resources - Land salinization, Soil erosion and the loss of nutrients are the major result of agriculture development and farming activities. Unscientific agricultural practices, over exploitation of water resources, increased rate of usage of fertilizers and pesticides and expansion of non agricultural use of land resulting land degradation and depleting resources.
2. Water pollution – Over use of pesticides and fertilizers and unscientific waste disposals are the major source of contamination of water bodies.
3. Deforestation - Expansion of agriculture land, unplanned expansion of cities, industrialization, tourism, etc contribute a lot for the shrinkage of forest area.
4. Air pollution - Air Pollution creates problems of acidification, urban air quality deterioration and chronic health problems. Urban air quality deterioration is one of the major concerns of present day urban life.

Table : 1.1 Some Impacts of Development Activities on Environment

Development Activities	Major Impacts on Environment
Forest clearing and land resettlements	Climate change and resultant outcome of extinction of rare species of flora and fauna, creation of condition for mosquito breeding leading to infectious diseases such as malaria, dengue etc.
Shifting cultivation in upland agriculture	Soil erosion in upland areas, soil fertility declines due to shorter cultivation cycle.
Agro industries	Environmental pollution through discharge of organic or hazardous waste to water bodies emission of gasses that affect air quality and produce toxic substances.
Introduction of new varieties of cereals	Reduction of genetic diversity of traditional monoculture resulting in instability, danger of mutilation of local strains of fungus, bacteria or virus on new variety
Use of pesticides	Organism develops resistance and new control methods are needed (e.g. in malaria, widespread use of dieldrin as a prophylactic agent against pests of oil palms made the problem worse), creation of complex and widespread environment problems. The pesticides used in agriculture sometimes go into food chain or in water bodies which may result in harmful health hazards.
Timber extraction	Degrades land, erosion of surface soil, reduces production potential of future forests.
Urbanisation and industrialization	Concentration of population in urban centers makes huge demands on production in rural areas and put pressures on land, air and water pollution.
Water resource projects, e.g. Dam, extensive irrigation	Human settlement & resettlement, spread of waterborne diseases, reduction of fisheries, siltation, physical changes e.g. temperature, humidity.

Table : 1.2 Local, Regional and Global Effects of Pollution

Local Effects	Regional	Over Marine Water and Continents	Climate changes due to ozone depletion and the greenhouse effect
<ul style="list-style-type: none"> ▪ Heavy metals in air, soil, water and plants, eg. From industrial emissions ▪ Discharges ▪ Noise ▪ Smell ▪ Air pollutions ▪ Urbanization 	<ul style="list-style-type: none"> ▪ Eutrophication ▪ Contaminants in the soil & water ▪ Landscape changes due to mining & agriculture 	<ul style="list-style-type: none"> ▪ Eutrophication ▪ Acidification ▪ Environment contamination due to Radioactivity 	<ul style="list-style-type: none"> ▪ Climate change ▪ Ozone change

Table: 1.3 Some Major Pollutants and their Sources

Pollutant	Source
Carbon monoxide	Incomplete fuel combustion (e.g. two/four stroke engines)
Sulphur dioxide	Emissions by vehicles and burning of sulphur containing fuel like coal in power plants
Suspended particulate matter	Smoke from domestic, industrial and vehicular sources.
Oxides of nitrogen	Fuel combustion of motor vehicles, emission from power stations and industrial furnaces
Volatile hydrocarbons	Partial combustion of carbonaceous fuels (two stroke engines, industrial processes, disposal of solid wastes).
Oxidants and ozone	Emissions from motor vehicles, photochemical reactions of nitrogen oxides and reactive hydrocarbons
Lead	Emissions from motor vehicles, Battery industries

Table: 1.4 Air Pollution Sources

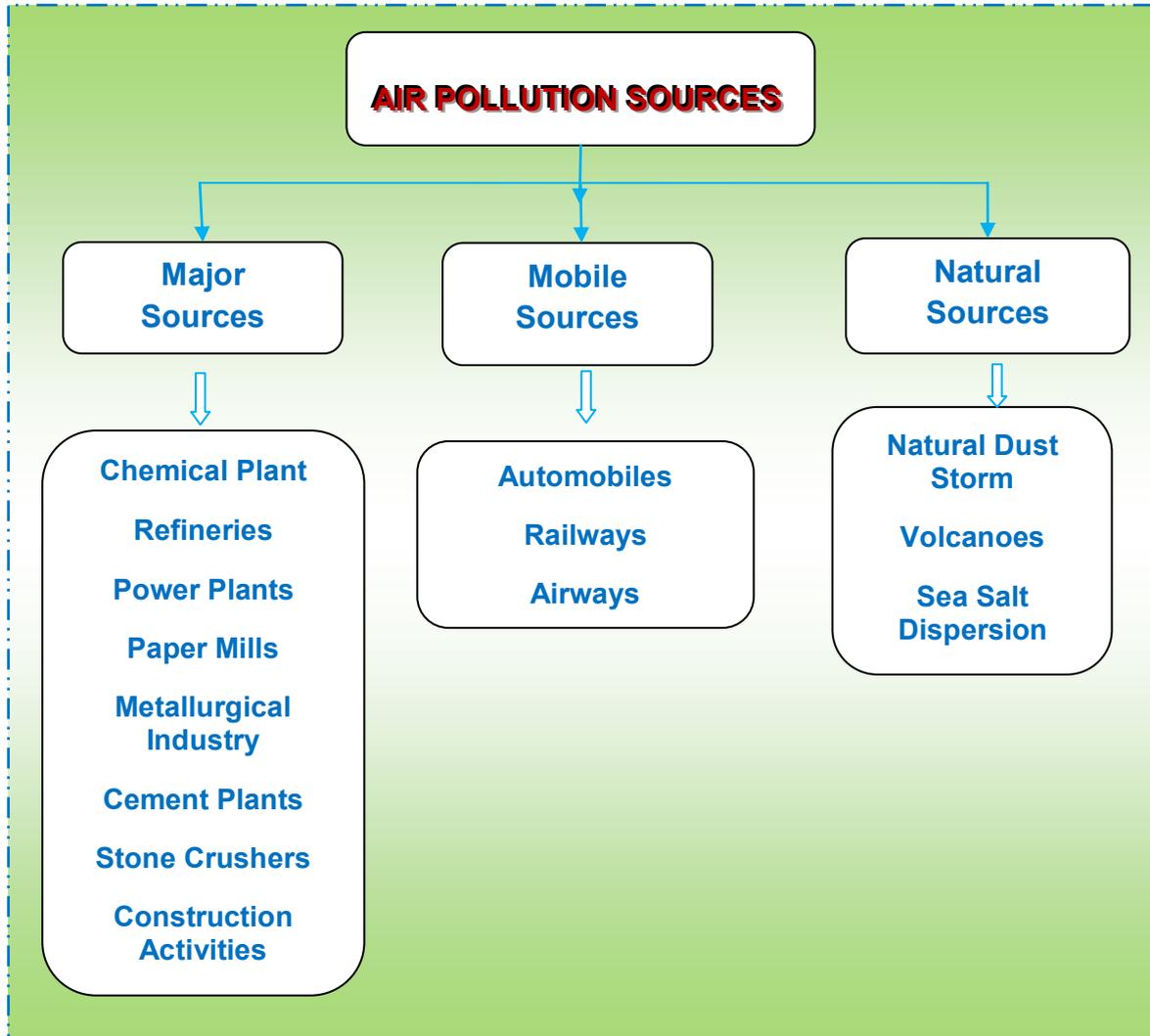


Table : 1.5 Water Born Disease and their Causative Factors

Name of the Disease	Causative Organism
<p>1. Water-borne diseases Bacterial</p> <p>Typhoid Gastroenteritis Paratyphoid Cholera Bacterial dysentery</p> <p>Viral</p> <p>Infectious hepatitis Poliomyelitis Diarrhea Diseases Other symptoms of enteric Diseases</p> <p>Protozoan</p> <p>Amoebic dysentery</p>	<p>Salmonella typhi Vibrio cholerae Shigella paratyphi Enterotoxigenic Escherichia coli Variety of Escherichia coli</p> <p>Hepatitis-A-virus Polio-virus Rota-virus, Norwalk agent, Other virus Echono-virus, Coxsackie – virus</p> <p>Entamoebahystolitica</p>
<p>2. Water-washed diseases</p> <p>Scabies Trachoma Bacillary dysentery</p>	<p>Various skin fungus species Trachoma infecting eyes E. coli</p>
<p>3. Water-based diseases</p> <p>Schistosomiasis Guinea worm</p>	<p>Schistosoma sp. Guinea worm</p>
<p>4. Infection through water related insect vectors</p> <p>Sleeping sickness Malaria</p>	<p>Trapanosoma through tsetse fly Plasmodium through Anaphelis</p>
<p>5. Infection primarily due to defective sanitation</p> <p>Hookworm</p>	<p>Hook worm, Ascaris 2</p>

Table :1.6 Pollutants and their related Health hazards

Pollutants	Health Effects
Carbon Monoxide (from gasoline cars, 2-wheelers, 3-wheelers)	<ul style="list-style-type: none"> ✓ Fatal in large doses ✓ Aggravates heart disorders ✓ Affects central nervous systems ✓ Impairs oxygen carrying capacity of blood
Nitrogen Oxides (from diesel vehicles)	<ul style="list-style-type: none"> ✓ Irritation of respiratory tract
Ozone	<ul style="list-style-type: none"> ✓ Eye, nose and throat irritation ✓ Risk asthmatics, children and those involved heavy exercise
Lead (from petrol vehicles)	<ul style="list-style-type: none"> ✓ Extremely toxic ✓ Affects nervous system and blood ✓ Can impairment development of children ✓ Cause hypertension
Hydrocarbons (Mainly from 2-wheelers and 3-wheelers)	<ul style="list-style-type: none"> ✓ Drowsiness, eye irritation, coughing
Benzene	<ul style="list-style-type: none"> ✓ Carcinogenic
Aldehydes	<ul style="list-style-type: none"> ✓ Irritation of eyes, nose and throat, sneezing, coughing, nausea, breathing difficulties ✓ Carcinogenic in animals
Polycyclic Aromatic Hydro Carbons PAH (from diesel vehicles)	<ul style="list-style-type: none"> ✓ Carcinogenic

CHAPTER - II

DEVELOPMENT OF ENVIRONMENT STATISTICS IN KERALA

Introduction

The Development of Environment Statistics is a flexible, multi-purpose conceptual and statistical framework that is comprehensive and integrative in nature. It point out the scope of environment statistics and provides an organizing structure to guide the collection and compilation of environment statistics at the national level. It brings together data from the various relevant subject areas and sources. It is broad and holistic in nature, covering the issues and aspects of the environment that are relevant for policy analysis and decision making by applying it to cross-cutting issues such as climate change.

Kerala State is having a total Area of 38,863 Km², population of more than 33 million and a long coastline of 580 Km with a intricate system of backwaters along the coast. The tropical moist forest is Western Ghat is highly undulating terrain and the tropical monsoon climate make the state a unique geographical and environmental entity. The people have a high level of literacy and are generally conscious of healthcare practices, nutritional requirements and hygienic practices resulting in high level of life expectancy, low population growth and low infant mortality rate. The undesirable consequences of the development measures carried out without proper environmental considerations have left their indubitable impacts on the environment in Kerala.

Infrastructure and Environment Statistics Division

According to the recommendation of the 19th COCSSO, it is decided to constitute an Infrastructure and Environment Statistics Division in this Office. Hence I & ES Division came to effect on the lines of Environment Statistics guideline brought out by Central Statistical Office, Ministry of Statistics and Programme Implementation, Govt. of India. So far 4 reports have been released from this division and Environment Statistics 2014-15 is the fifth publication from this division. The data presented in this report are collected from various Agencies and Departments working for the protection of environment or monitor the level of impact on environment.

Environment Statistics is an annual publication of this division covering the areas of Biodiversity, Atmosphere, Land and Soil, Water and Human Settlement and related stress on the environment.

Kerala State Pollution Control Board

Kerala State Pollution Control Board has been constituted for prevention and Control of Water Pollution. It was the first State Board constituted in the country under the Water Act in 1984. The Kerala State Pollution Control Board entrusted with the implementation of the Air Act also. Administrative control over the Board is vested with the Environmental Department of the Government of Kerala and the Ministry of Environment and Forest, Government of India. The activities of the State Boards are co-ordinate by Central Pollution Control Board.

1. The Water Act (Prevention & Control of Pollution)

- Advise the State Government on any matter concerning the prevention, control or abatement of water pollution;
- Plan a comprehensive program for the prevention, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;
- Collect and disseminate information relating to water pollution and the prevention, control or abatement thereof;
- Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution; to collaborate with the Central Board in organising the training of persons engaged or to be engaged in programs relating to prevention, control or abatement of water pollution and to organise mass education programs;
- Inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review plans, specifications or other data relating to plants set up for the treatment of water, works for the purification there of and the system for the disposal of sewage or trade effluents or in connection with the grant of any consent as required by this Act lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters (not being water in an interstate stream) resulting from the discharge of effluents and to classify waters of the State.

2. The Water Cess Act (Prevention & Control of Pollution)

- Receive water consumption returns from persons liable to pay cess;
- Assess the cess payable by the concerned person carrying on any special industry or local authority;
- Allow rebate on the cess payable by any person carrying on any industry or local authority who install requisite plant for treatment of sewage or trade effluent;
- Collect cess from the assesses.

3. The Air Act (Prevention & Control of Pollution)

- ✓ Plan a comprehensive programme for prevention, control and abatement of air pollution and to secure the execution thereof;
- ✓ Advise the State Government on any matter concerning prevention, control or abatement of air pollution.;
- ✓ Collect and disseminate information relating to air pollution;
- ✓ Collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of air pollution and to organise mass education programmes relating thereto;
- ✓ Inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give, by order, such directions to such persons as may be considered necessary to take steps for prevention, control or abatement of air pollution;
- ✓ Lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standards for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into atmosphere from any other source whatsoever not being a ship or an aircraft, provided that different standards for emission may be laid down under this clause for different industrial plants having regard to the quantity and composition of emission of air pollutant into the atmosphere from such industrial plants.

4. The Environment (Protection) Act

- Implement measures for the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property;
- Remedial measures to prevent or mitigate environmental pollution in case of accidents;
- Inspections to check compliance and to collect or seize evidence thereof;
- Collect samples of air, water, soil or other substances;
- Service as Environmental Laboratory;
- Standardised methods for sampling and analysis of various types of environmental pollutants;
- Analyse samples sent by empowered officers;
- Carry out investigations to lay down standards, to monitor and to enforce standards;
- Carry out any other entrusted function;
- Take cognisance of offences.

Hazardous Wastes Rules

- Process applications for and to issue/refuse/renew authorisation for collection, reception, treatment, storage and disposal of hazardous wastes;
- Monitor compliance with the provisions and conditions of authorisation;
- Process and forward to the Ministry of Environment & Forests applications for imports;
- Review matters pertaining to identification and notification of disposal sites.

The Manufacture, Storage and Import of Hazardous Chemical Rules, particularly

- Enforce directions and procedures in respect of isolated storage of hazardous chemicals;

- Preparation of on-site emergency plans;
- Enforce directions and procedures on import of hazardous chemicals;
- Issue direction to importer to take appropriate safety measures, including stoppage of import, if necessary;
- Informing concerned port authority on safety measures;
- Serve improvement notice on persons contravening the Rules.

Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms, Genetically Engineered Organisms or Cells

- Inspect, investigate and take punitive action on behalf of the State Biotechnology Co-ordination Committee in case of violations;
- Supervise, on behalf of the Genetic Engineering Approval Committee, implementation of the terms and conditions of approvals granted by the Committee.

The Chemical Accidents Rules (Emergency Planning, Preparedness and Response)

- To serve in the State Crisis Group;
- To serve in the District Crisis Groups which are the apex bodies in the respective areas to deal with major chemical accidents and to provide expert guidance for handling chemical accidents.

The Biomedical Waste Rules (Management and Handling)

- Receive from institutions generating, collecting, receiving, storing, transporting, treating, disposing and/or handling biomedical wastes applications for authorisation, to process the same and issue/ refuse/ renew/ cancel/ suspend authorisation;
- Compile and furnish to the Central Pollution Control Board annual reports from occupiers / operators;
- Inspect and verify facilities and records;
- Receive and act upon reports of accidents.

The Plastics Manufacture, Sales and Usage Rules

- Receive and process applications for registration for manufacture of virgin/recycled or both plastic carry bags and containers and to issue/refuse/renew/cancel registration.

The Municipal Solid Wastes Rules (Management and Handling)

- Monitor compliance with standards on ground water, ambient air, leachate quality, compost quality and incineration;
- Receive and process application for authorisation for setting up waste processing and disposal facility and to issue / refuse / renew / cancel authorisation;
- Furnish annual reports to the Central Pollution Control Board.

The Noise Pollution Rules (Regulation and Control)

- Regulate and control noise of industrial origin;
- Monitor ambient sound levels;
- Advise the State Government on pollution control.

The Batteries Rules (Management and Handling)

- Receive and verify half yearly returns on sale of new batteries and collection of old batteries;
- Receive and verify half yearly returns on sale and collection of batteries by dealers;
- Receive and verify annual returns from recyclers of used batteries;
- Receive and verify half yearly returns form bulk consumers of batteries;
- Receive and verify half yearly returns by auctioneers of used batteries;
- Ensure compliance with the Rules;
- File annual compliance status report to the Central Pollution Control Board.

Public Liability Insurance Act, 1991

- Make application to court to restrain owner under section 13(1) from handling hazardous substances, to implement the order of the Court under section 13(3)(b) and to recover cost thereof under section 13(4).
- Receive and act upon notice under section 18(b) of intention to make complaint to Court

Western Ghats Development Programme

- The Western Ghat region of Kerala (Sahyadri) stretches over 450 km (28.12%) out of the total length of 1600 km and is spread over 80 Block Panchayats and 537 Grama Panchayats, 31 Taluks in the State with a total geographical area of 38863 Km² and around 50% of the State's population is in the Western Ghat region. Western Ghats plays an important role acting as barrier to southeast monsoons causing substantial rainfall over the hills (more than 3000 mm annually) and the "Sahyadri" gives birth to all the 44 rivers flowing through the State and sustains rich natural forests and minerals. This region is a treasure of plants and animals and is declared as one of the bio diversity hot spots in the world.
- The Western Ghats in Kerala have two major segments, southern segment south of Palakkad Gap and northern segment beyond the gap extending up to the Kodugu boundary. There are three sections of the eastern slopes of Western Ghats falling within Kerala viz. the Pambar- Chinnar basin, the Attappady Plateau drained by Bhavani, and the Wayanad section drained by Kabani. The Western Ghats that rise from low altitude of about 70 m MSL extend up to 2000m MSL on an average on the eastern boundary. Anamudy is the highest peak with an altitude of 2690m MSL.
- Western Ghats that supports a wide range of forest types ranging from tropical wet evergreen forests to grasslands, some 4000 species of flowering plants with high degree of endemism and rich fauna with endemism ranging from 11% to 78% among different groups. Consequently, Western Ghats constitutes not only one of the hotspots of biodiversity in the world, but also one among world's eight hottest hotspots.
- The life supporting and biodiversity rich ecosystems of Western Ghats are threatened today due to habitat pressures.

Western Ghats Development Programme, a centrally sponsored scheme funded by Government of India under the Hill and Rainfall area development scheme to protect the rich biodiversity in this region through generation of the forest cover with People's Participation, Eco-Preservation, Natural Resource Management and Watershed Development Programme.

Department of Environment

Department of Environment is responsible for the coordination of activities of different departments, authorities and local bodies in the State relating to environment and implementation of the Environment Policy of the State. The department will focus on promotional aspects for the protection and conservation of the environment with the help of the concerned government departments, research institutes, regulatory bodies, local bodies and reputed non-governmental organizations, researchers and academicians.

National Centre for Earth Science Studies

National Centre for Earth Science Studies (NCESS) is one of the leading centres of excellence in the field of Earth Science in the country, and is functional for the past 36 years. The CESS, as a scientific establishment carried out extensive research and development work in major components of Geosphere, Hydrosphere, and Atmosphere. The approach and accomplishments of CESS, in understanding and addressing the geological evolution of south India, complexities of the coastal processes and natural hazards, natural resources management have all along been consistent with the national R&D priorities in Earth Sciences and thrust areas of the Ministry of Earth Sciences (MoES). CESS has made important contributions towards understanding the complexities of coastal processes including the mud banks which is unique for the south-west coast of India.

Kerala State Biodiversity Board

Kerala State Biodiversity Board has function as a centre for applied research for conservation of Kerala's biological diversity. The centre is being established for collection, collation, management, analysis, and dissemination of data on biological diversity. The research centre will provide scientific support to Kerala State Biodiversity Board in decision making on matters related to biodiversity, so as to enable the Board to advise the State Government on salient environmental and conservation issues. The centre will also enable the Board for translating the knowledge generated for sustainable development and access

to diverse species enables diversification of livelihood through, planting multiple crops and thus enabling food production throughout the year, or engaging in alternative income-generating activities. The availability of diverse resources also allows different genders, cultural or age groups to engage in and benefit from the resources.

Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI)

Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) formerly known as Tropical Botanic Garden and Research Institute (TBGRI) was founded in 1979 with the objective of establishing a Conservatory Botanic Garden of tropical plant resources. It also undertakes research programmes for the suitable utilization of these resources. Conservation and sustainable utilisation of the plant biodiversity advance knowledge, enjoyment and conservation of plants through excellence in biodiversity research management, horticulture displays and educational. JNTBGRI is reckoned as the biggest conservatory garden in Asia with over 50,000 accessions belonging to 4000 species. Highly coordinated multidisciplinary research is undertaken in the areas of Plant Taxonomy, Conservation Biology, Ethno-botany and Bio-prospecting (Biotechnological, Pharmacological and Photochemical).

National Institute of Oceanography

The National Institute of Oceanography Kochi Regional Centre is one of the 37 Constituent Laboratories of the Council of Scientific and Industrial Research Centres (CSIR) New Delhi. CSIR-NIO was established on 1966 following the international Indian Ocean Expedition in the 1960s. In addition of basic research of observing and understanding special oceanographic characteristics of Indian Ocean, the institute also carries out Oceanographic data collection, environmental impact assessment, and modeling to predict environmental impact. The Institute also provide consultancy on a number of issues including marine environmental protection and coastal zone regulations. With the largest collection of ocean scientists in the country, and equipped with suitable ocean research infrastructure, CSIR-NIO serves as an advanced centre of education in ocean sciences. It has a School of Oceanography under the Academy of Scientific & Innovative Research (AcSIR). In addition, it is a recognized centre for doctoral research by a large number of universities.

Marine biodiversity - The Indian Ocean is a region of very high biological diversity has been analyzing and documenting diversity of all forms of life – microbes, plants and animals - from

various marine ecosystems. National Institute of Oceanography has carried out investigations to unravel interactions between the environment and organisms and the key area of its research is the impact of natural and human-induced stresses such as deoxygenating, eutrophication and acidification on biogeochemistry and ecosystems in fresh water and marine environments. National Institute of Oceanography is actively engaged in monitoring the health of Indian coastal environs.

Kerala University of Fisheries and Ocean Studies (KUFOS)

Kerala University of fisheries and Ocean Studies (KUFOS) is an autonomous institution established on 20th November 2010. KUFOS is the first fisheries university in the country. It provides high quality instructional programmes in fisheries, Ocean Sciences and allied subjects.

Central Marine Fisheries Research Institute

Government of India established the Central Marine Fisheries Research Institute, Kochi under the Ministry of Agriculture and Farmers Welfare and later it joined the ICAR. During the course of over 65 years the Institute has emerged as a leading tropical marine fisheries research institute in the world. CMFRI devoted its research attention towards the estimation of marine fisheries landings, taxonomy of marine organisms and the bio-economic characteristics of the exploited stocks of finfish and shellfish. This research effort contributed significantly to India's marine fisheries development from a predominantly artisanal, sustenance fishery till the early sixties to that of complex, multi-gear, multi-species fisheries.

Cochin University School of Environmental Studies

The School of Environmental Studies, a Centre for higher learning dedicated to environmental protection and sustainable development conceptualized in 1980 was established in 1983 to serve the cause of well-being of the society by imparting knowledge and by providing trained manpower and appropriate environmental technology. To achieve these objectives, the School offers a carefully designed regularly updated curriculum, competence-based consultancy and reaches out to the community with socially relevant extension programmes. Doctoral programme is offered in various facets of Environmental Science and Technology including Environmental Biology, Chemistry, Microbiology,

Meteorology and Toxicology. The School has state of the art laboratories in Environmental Chemistry, Environmental Biology, Environmental Toxicology, Environmental Virology, Environmental Biotechnology, Environmental Microbiology, and Remote Sensing Environmental Resource and Disaster Management. The School of Environmental Studies give equal importance to Research, Teaching and Extension in Environmental Science and Technology with the motto of Environmental protection for a sustainable development aiming at a better tomorrow.

CHAPTER - III

BIO-DIVERSITY OF KERALA

Bio-diversity is defined as 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which includes diversity within species, between species and of ecosystems'. Biodiversity is part of our daily lives and livelihood, and constitutes resources depends upon which families, communities, nations and future generations. Biodiversity reflects the number, variety and variability of living organisms and how these are changed from one location to another and over time. Its role goes beyond ensuring the availability of raw materials to include security, resiliency, social relations, health and freedom for choices.

Loss of bio-diversity has serious economic and social costs. The experience of the past few decades has shown that as industrialization and economic development in the classical sense takes place, patterns of consumption, production and needs, change, straining, altering and even destroying ecosystems.

The different types of bio-diversity include:

1. Genetic diversity;
2. Species diversity;
3. Ecosystem or ecological diversity;
4. Functional diversity

Plant and animal biodiversity as a national and global resource is extremely valuable and inadequately documented. The preservation of biodiversity is both a matter of investment and insurance to sustain and improve agricultural, forestry and fisheries productions also act as a buffer against harmful environmental changes, provide raw materials for scientific and industrial innovations, and safe guard transferring biological richness to future generations.

In the atmosphere, gases such as water vapour, carbon dioxide, ozone and methane act like the glass roof of a greenhouse by trapping heat and warming the planet. These gases are called greenhouse gases. The natural levels of these gases are being supplemented by

emissions resulting from human activities, such as the burning of fossil fuels, farming activities and land-use changes. As a result, the Earth's surface and lower atmosphere are warming, and this rise in temperature is accompanied by many other changes. Climate change affects biodiversity. According to the Millennium Ecosystem Assessment, climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century. Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits.

Plant Diversity in Kerala

The Western Ghat is one of the 25 bio-diversity hotspots in the world. The Western Ghat Region is a treasure of more than 4,500 species of flowering plants of which above 1,500 taxa are endemic in nature. There is also equally rich fauna belt in the state. The diversity of lower plants and animal groups, and the marine flora and fauna in particular even though not fully known, is remarkably rich in the state. An earlier rough estimate had shown that there are about 10,735 plant species indigenous to the state. The latest available total floral wealth of the State is:

Table: 3.1 Flora Statistics

Sl. No.	Category	Kerala
1.	Flowering Plants	4500
2.	Gymnosperms	4
3.	Pteridophytes	236
4.	Bryophytes	350
5.	Lichens	520
6.	Algae	325
7.	Fungi	4800
	TOTAL	10735

Endemic Species

There are about 1272 species of endemic angiosperms out of 3800 species which is about 33.5% of its flora. The endemic flora in the State is mainly palaeotropic in composition, which is a part of the peninsular Indian endemic flora of Gondwanaland origin. There are about 189 endemic plant species identified from Agasthyamala and they seen in small populations over narrow ranges. The recent surveys have discovered 35 new species of plants from this small stretch of forests.

Table : 3.2 Endemic Species

Sl. No.	Species
1.	Begonia aliciae
2.	Didymocarpus macrostachya
3.	Habenaria flabelliformis
4.	Impatiens anaimudica
5.	I. johnii
6.	I. macrocarpa
7.	I. platyadena
8.	I. verecunda
9.	Ophiorrhiza barnesii
10.	O. caudata
11.	O. munnarensis
12.	Sonerila nemakadensis

Invasive alien species and biodiversity

Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential. Many alien species support our farming and forestry systems, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and out compete native species. Plants, mammals and insects comprise most common types of invasive alien species in terrestrial environments. The threat to biodiversity due to invasive alien species is considered second only to that of habitat destruction. Invasive species cause loss of biodiversity including species extinctions, and changes in hydrology and ecosystem function. Differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability, etc. Growth of human population and human activities related to trade and tourism, the present time is witnessing increased risks associated with alien species introductions.

Protected Areas of Kerala : The Protected areas include a wide range of biomes, extending east from the coral reefs, estuaries, salt marshes, mangroves and beaches of the Arabian Sea through the tropical moist broadleaf forests of the Malabar Coast moist forests to the moist deciduous forests of Western Ghats. Protected area is a geographical space recognized, dedicated and managed through legal or other effective means to achieve the long term conservation of nature with associated ecosystem. District wise protected area along with its area is given in Table : 3.3

Table : 3.3 Protected areas

Sl. No.	Protected Areas	Area (Km ²)	District
1	Periyar Tiger Reserve (PTR)	777	Idukki
2	Neyyar Wildlife Sanctuary	128	Thiruvananthapuram
3	Peechi-Vazhani Wildlife Sanctuary	125	Thrissur
4	Parambikulam Wildlife Sanctuary	285	Palakkad
5	Wayanad Wildlife Sanctuary	344.44	Wayanad
6	Idukki Wildlife Sanctuary	70	Idukki
7	Eravikulam National Park	97	Idukki
8	Peppara Wildlife Sanctuary	53	Thiruvananthapuram
9	Thattekkad Bird Sanctuary	25	Ernakulam
10	Shendurney Wildlife Sanctuary	171	Kollam
11	Chinnar Wildlife Sanctuary	90.44	Idukki
12	Chimmony Wildlife Sanctuary	85	Thrissur
13	SilentValley National Park	89.52	Palakkad
14	Aralam Wildlife Sanctuary	55	Kannur
15	Pampadum Shola National Park	1.318	Idukki
16	Mathikettan Shola National Park	12.817	Idukki
17	Anamudi Shola National Park	7.5	Idukki
18	Mangalavanam Bird Sanctuary	0.027	Ernakulam
19	Kurinjimala Sanctuary	32	Idukki
20	Choolannur Pea Fowl Sanctuary	3.42	Palakkad
21	Kadalundi-Vallikunnu Community Reserve	1.5	Kozhikkode & Malappuram
22	Malabar Wildlife Sanctuary	74.215	Kozhikkode
	TOTAL	2528.197	

Western Ghats

The Western Ghats Region of Kerala covers 450 Kms (28.12%) out of the total length of 1600 Kms. The Kerala region (Sahyadri) of Western Ghats comprises of 72% of the total geographical area of the State and around 50% of the State's population. Western Ghats play an important role in deciding the weather map of the State. The 'Sahyadri' is the birth place of the State river system. The rich natural forests of this region are a treasure house of plants, animals and minerals. The influence of Western Ghats has been remarkable in the preservation of ecology of the State. High rainfalls on the Ghats have blessed the state with tremendous biological values of great variety, Kerala has considerable ecological diversity. The peculiar topography of the state created spatial variation in climate and soil parameters. The high levels of local endemism can be attributed to biogeographic barriers provided by the large valleys.

Biological Values

Western Ghats region in the State has Wettest, most tropical and most biologically diverse forests. Of the seven evergreen forest types recognised in the region are: Cullenia-Mesua; Persea - Dipterocarpus; Dipterocarpus-Mesua; and montane shola. Major biogeographic barriers separate the Wayanad-Nilgiri areas from Anamalai-Periyar and that form the southern Agastyamalai hills. Extreme levels of localised endemism are borne out of the fact that the Kerala area of Agastyamalai has some 109 totally endemic plants, Nilgiri another 95 and Anamalai 39. The area's biological diversity is equally true of animal life. More than half of the country's amphibians are restricted to the Western Ghats. These are endemic reptiles like the Travancore tortoise, birds like the Grey Malabar Hornbill and mammals like the Malabar civet. The forests in Kerala have significant populations of tiger, leopard, elephant, gaur and many lesser ungulates. The Nilgiri Tahr is characteristic of higher mountain grasslands. There are two primates endemic to the area: the Nilgiri Langur and the Lion - tailed macaque. The Silent Valley National Park with its diverse flora and fauna is an example of evergreen forest of immense biological values.

Wayanad Evergreen Forests

Spread across Kerala and Karnataka, this region is the transition zone between the southern Cullenia dominated forest and the drier Dipterocarpus of the north. Floristically very rich, the tract has two small Sanctuaries: while Aralam WLS with an extent of 55 sq km is in Kerala, the Brahmagiri WLS is in Karnataka. Located on the western slopes of the Ghats, Aralam is

rich in wildlife. Elephant, deer, bison are common. The plant life is typical of evergreen and semi-evergreen forests of the Ghats. The altitude varies from 50m to 1145m from MSL. Temperature varies at the foothills from 21°C to 40°C whereas on the higher reaches it is between 8°C and 25°C. The average rainfall is about 300 mm. June to August are the wettest months. It is also an integral part of the Nilgiri Biosphere Reserve which was established for the conservation of the biological diversity of the region.

The Upper Nilgiri of Kerala

The Nilgiri plateau and western slopes contain some of the finest forest Wildlife habitat in India. Two small partially adjacent Protected Areas are located here. One is the Silent Valley National Park of Kerala and the other is the Nilgiri Tahr WLS in Tamil Nadu. Only 89 sq km in extent, the Silent Valley National Park is the Core of the Nilgiri Biosphere Reserve and claims a long unbroken ecological history. The forests belong to the biogeographical class of the Malabar Rain Forests, and relic of the ancient India- Malayan continuum and harbour a thousand species of plants. The Valley has a fair representation of all peninsular mammals. There are also several species of birds, butterflies and moths.

The Anamalai Hills of Kerala

The Anamalai Hills face the Nilgiri plateau across the Palghat Gap. The topography is complex and causes a great diversity of climate and vegetation type. Anamudi (2700m) is the highest peak in the entire Western Ghats. The Palghat Gap has isolated the Anamalai Hills resulting in extensive speciation in several plant and animal groups. Elevation ranges between 150 m and 2500m.

Flora

Western Ghats region is blessed with 7,402 species of flowering plants, 5,588 species are native or indigenous and 376 are exotics naturalised and 1,438 species are cultivated or planted as ornamentals. Among the indigenous species, 2,253 species are endemic to India and of them, 1,273 species are exclusively confined to the Western Ghats. Apart from 593 confirmed subspecies and varieties; 66 species, 5 subspecies and 14 varieties of doubtful occurrence are also reported and therefore amounting 8,080 taxa of flowering plants. An exotic product of Western Ghats is carried to outside India through the Silk Route and Arabian Sea from ancient time onwards.

Table : 3.4 Species in major group of plants - India & Kerala

Sl. No.	Plant Groups	World	India	Kerala	% against India
1	Bryophytes	14,500	2504	465	18.57
2	Pteridophytes	12,000	1267	337	26.59
3	Gymnosperms	650	74	5	6.75
4	Angiosperms	250,000	17,926	4606	25.69

Fauna

The Western Ghats are home to thousands of animal species including at least 325 globally threatened species. Many are endemic species, especially in the amphibian and reptilian classes.

Table : 3.5 Species in Animal groups

Sl. No.	Animal Groups	No. Genera/species
1.	Protozoa	63 genera
2.	Porifera	22 genera
3.	Cnidaria	90 genera
4.	Chaetognatha	18
5.	Platyhelminthes	117 genera
6.	Aschelminthes	265
7.	Acanthocephala	27
8.	Annelida	91
9.	Molludca (Fresh water)	26
10.	Insects	6000
11.	Non-insect Arthropda	600
12.	Echinodermata	8

Vertebrate Diversity of Kerala

Vertebrate Diversity of Kerala is represented by 1,847species in 330 families and 81 orders. Fishes are the most diverse group of vertebrates with 905 species followed by birds with 500 species, reptiles with 173 species, ambhians with 151 species and mammals with 118 species.

Table : 3.6 Species in Taxonomic groups

SI. No.	Taxonomic Group	Orders	Families	Species
1	Fishes	41	172	905
2	Birds	22	88	500
3	Reptiles	3	24	173
4	Amphibians	2	11	151
5	Mammals	13	35	118
	All Vertebrates	81	330	1847

Fishes

As of 2004, 288 freshwater fish species are listed for the Western Ghats, including 35 known from brackish or marine water. There are higher fish richness in the southern part of the Western Ghats than in the northern, and the highest is in the Chalakudy River, which alone holds 98 species. Other rivers with high species numbers include the Periyar, Bharatapuzha, Pamba and Chaliyar, as well as upstream tributaries of the Kaveri, Pambar, Bhavani and Krishna rivers. The most species rich families are the Cyprinids (72 species), hillstream loaches (34 species; including stone loaches, now regarded a separate family), Bagrid catfishes (19 species) and Sisorid catfishes (12 species). The region is home to several brilliantly colored ornamental fishes like Denison's (or red line torpedo) barb, several species of *Dawkinsia* barbs, zebra loach, *Horabagrus* catfish, dwarf pufferfish and dwarf Malabar pufferfish. The rivers are also home to *Osteobrama bakeri*, and larger species such as the Malabar snakehead and Malabar mahseer. According to the IUCN, 97 freshwater fish species from the Western Ghats were considered threatened in 2011, including 12 critically endangered, 54 endangered and 31 vulnerable. An additional 26 species from the region are considered data deficient (their status is unclear at present).

Birds

There are at least 508 bird species and at least 16 species of birds endemic to the Western Ghats including the endangered rufous-breasted laughingthrush, the vulnerable Nilgiri wood-pigeon, white-bellied shortwing and broad-tailed grassbird, the near threatened grey-breasted laughingthrush, black-and-rufous flycatcher, Nilgiri flycatcher, and Nilgiri pipit, and the least concern Malabar (blue-winged) parakeet, Malabar grey hornbill, white-bellied treepie, grey-headed bulbul, rufous babbler, Waynaad laughingthrush, white-bellied blue-flycatcher and the crimson-backed sunbird.

Reptiles

The major population of snake family Uropeltidae of the reptile class is restricted to the region. The region has significant population of vulnerable Mugger crocodiles. The total species of reptiles reported in India is 440 of which 187 seen in Kerala. About 130 of these are restricted to the rain forests. They included turtles, snakes, lizards like geckos, skinks and the agamids. Non Marine reptile species reported from Kerala is 169 of which 59 are endemic.

Amphibians

The amphibians of the Western Ghats are diverse and unique, with more than 80% of the 179 amphibian species being endemic to the rainforests of the mountains. The endangered purple frog was discovered in 2003. Four new species of frogs belonging to the genera *Rhacophorus*, *Polypedates*, *Philautus* and *Bufo* were described from the Western Ghats in 2005. The region is also home to many caecilian species.

Mammals

There are at least 118 mammal species. Of the 16 endemic mammals, 13 are threatened and amongst the 32 threatened species include the critically endangered Malabar large-spotted civet, the endangered lion-tailed macaque, Nilgiri tahr, Bengal tiger and Indian elephants, the vulnerable Indian leopard, Nilgiri langur and gaur.

Marine and Coastal Biodiversity

Tropical marine ecosystems of Kerala coasts include lagoons, mangrove swamps, sandy and rocky shores and open sea front. Apart from fishes Kerala coast has a rich array of Crustaceans, corals, echinoderms, mollusks, turtles etc.

Major threats to marine and coastal ecosystems include:

- ✓ Land-based pollution
- ✓ Overfishing, destructive fishing, and illegal, unreported and unregulated fishing
- ✓ Invasions of exotic species
- ✓ Global climate change

Threats to the Bio-diversity of Kerala

1. Encroachments : The direct impact of encroachment is habitat loss, besides the existence of constant threat on the forests by the fringe people. In addition to their involvement directly in the illegal activities they provide shelter for the unscrupulous offenders of the plains who are engaged in all kinds of illegal activities.

2. Cattle grazing : Grazing by cattle in forest, although not rampant as else where in the country, is identified as a threat to biodiversity in Kerala. The grazing not only removes the biomass and competes with wild herbivores, but also spread contagious diseases to wild animals. The trampling leads to soil erosion and changes the physical properties of soil. Intensive grazing will lead to domination of a single or a few species, changing the species composition of natural vegetation. Cattle grazing speeds up the invasion of weeds.

3. Collection of Fire wood : Firewood collection directly poses threat in the form of removal of biomass, which affects microhabitat of flora and fauna, and indirectly leads to extensive fire and other illegal activities. The proximity of settlements to the forests is the main factor, which determines the intensity of firewood collection. The firewood collection leads to degradation of habitats which subsequently alters the species composition and vegetation types.

4. Man-Animal Conflict : A major problem associated with the conservation of wild animals especially the herbivores like elephants is that of crop depredation and man-slaughter. Animals such as elephants, gaur, sambar, wild boar and birds like peacock, cause extensive damage to the crops. This phenomenon has registered significant increase in recent years due to habitat fragmentation and degradation of natural forests and corridors. Almost all the Protected Areas and Non-Protected Areas of Kerala contain a large number of settlements either inside or on the periphery. This leads to degradation of surrounding habitats.

5. Poaching : The abundance of wild animals and high demand for their products in the clandestine market pose threat to wild animals. Herbivores like gaur, sambar, chital etc are being poached for their meat. A lot of other not so spectacular species of animals ranging from reptiles to birds as well as plants and medicinal herbs are all part of the illegal wildlife trade. The major impact of poaching is species loss and change in their demography apart from extensive fire and other illicit activities.

6. Illegal and unsustainable/unscientific collection of Non-Timber Forest Produce:

Non-Timber Forest Produce collection is one of the major livelihoods of the local people. It consist of a variety of products, which are sources of food, fibre, manure, construction materials, cosmetics and cultural products. The forests in Kerala are very rich in edible products, medicinal plants, toiletries, tans, dyes, gums, resins, rattan, bamboo, grasses and animal products. Although 500 species of NTFP are available in the forests of Kerala, about 120 items are listed as commercially important by the Kerala Forest Department. But as per record more than 200 species are being collected. Considering its widespread nature and higher prioritization, the threat needs to be tackled immediately to conserve biodiversity.

7. Mining : Even though mining is not a severe threat to the biodiversity of Kerala, Sand mining is prevalent in the central and southern parts of Kerala. It is a threat to the stability of a landscape, which results in land sliding and lowering of water table. The removal of habitat will endanger the survival of riparian species since most of them occupied a very narrow habitat niche. At the same time regulated sand mining would help in keeping the health of the streams and reservoirs. Indiscriminate sand mining in some river systems in the state is posing severe threat to the stability of bridges and banks.

8. Mass Tourism and Pilgrimage : Mass Tourism and Pilgrimage are considered to be one of the major and increasing threats to biodiversity conservation. Approximately 13 million people visit forest areas annually either as pilgrims or visitors. Among all the Protected Areas in India, Periyar Tiger Reserve receives a maximum number of tourists. The large influx of people into the forests in short duration makes severe changes to habitat.

9. Forest Fires : Fire is one of the major threats facing the forests of Kerala. The effect of fire depends on the type of vegetation, frequency and intensity of fire and season of burning. Fire causes extensive damage in deciduous forests and grasslands due to heavy fuel load. Only some weeds manage to establish a strong foothold even after severe fire with the help of fire resistant adaptations. The direct impacts of fire are change in vegetation composition and physical properties of soil, soil erosion and loss of habitat.

10. Illicit Felling : Tree felling is one of the severe threats to biodiversity conservation in the state. The primary effect of tree felling on bio diversity is the removal of biomass and loss of habitat for many epiphytic and arboreal species. Tree felling leads to soil erosion and change of the soil properties. In some cases people involved in tree falling set fire to the

forests. The opening up of canopy due to felling changes the microclimate and invite weeds to colonize and in turn changes the structure of vegetation. Apart from the direct impact of loss in terms of money to the state, the indirect impact of felling is the constant conflict between the administrative staff and the people involved in this illegal activity.

11. Invasive species: These are non indigenous or non-native plants and animals that adversely affect the habitats and bio regions they invade economically, environmentally and ecologically. The weed prevents sunlight and oxygen from reaching the water column and submerged plants. By crowding out native aquatic plants, it dramatically reduces biological diversity in aquatic ecosystems. Listed as one of the 100 most dangerous invasive alien species of the world, this aquatic weed native to South America, was introduced to the country as an ornamental plant for cultivation in ponds because of its beautiful, large purple and violet flowers. Today, it invades more than 50 countries in five continents. Examples of animal invasion in the State include like Tilapia fish (*Oreochromis mossambica*), Sucker catfish (*Plecostomus multiradiatus*) and the African Giant Snail (*Achatina fulica*).

Threatened taxa of Kerala



Scientific name: *Gonoproktopterusperiyarensis* Raj, 1941. The local people call it Kariyan due to the slate colour of the body. Periyar barb (English) Kariyan (Malayalam). This species is known from Kallar river, tributary of Pambiyar river to south of Pachakanam estate adjoining to Periyar lake.



Scientific name: *Garrahughi* Silas, 1955. Commonly known as the Cardamonagarra due to its discover from the High ranges. It is adapted to the fast flowing regime of the stream with low water temperature. Heavy soil erosion, pollution and increased pesticide level in the habitat resulted in the decline of the population.



Scientific name: *Tor khudree* Sykes. It is known as Deccan mahseer (English) Kuyil or Katti (Malayalam). Its ranges extends the entire Peninsular India. Habitat alteration, pollution, sand mining, over exploitation, fish poisoning, alien invasive fish species, dynamiting and electrocution are the major threats identified. According to IUCN, its status is endangered.



Scientific name: *Vijayachelyssilvatica* (Henderson, 1912)
Common Name: Cochin Forest Cane turtle (English); Chooralama, Kavalama (Malayalam). In Chalakudy, Kerala, South India. This is a poorly known species, endemic to the Western Ghats of Southern India. Pet trade, very low range of distribution, Habitat destruction are the major threat to the species. According to IUCN, its status is Endangered.



Scientific name: *Cheloniamydas* (Linnaeus, 1758). Commonly called as Green turtle in English and Kadalama in Malayalam. Flesh and Egg is edible. The green turtle is a circumglobalspecies with foraging and nesting occurring throughout the tropics. *Cheloniamydas* is found throughout the Indian River Lagoon. As per IUCN, its status is endangered.

	<p>Scientific name: <i>Varanus bengalensis</i> Daudin, 1802. Known as Bengal Monitor lizard in English and Udumbu in Malayalam. The flesh is said to have medicinal value. The greatest threat to this species is hunting as it is hunted commercially for its skin, and its meat is commonly eaten. The fat is also used in traditional medicine. However, IUCN included it in Least Concern category.</p>
	<p>Scientific name: <i>Rhacophorus lateralis</i> Boulenger, 1883. This species is restricted to two small areas of the southern Western Ghats of India in Kerala (Wayanad Wildlife Sanctuary and its surroundings) and Karnataka (Coorg and its surroundings) at an elevation of approximately 800m asl. It might occur a little more widely than current records suggest. IUCN has listed in the endangered category.</p>
	<p>Scientific name: <i>Bos gaurus</i> C.H. Smith, 1827. Known as Guar or Indian Bison in English and Kattupothu in Malayalam. Poaching, loss and alteration of the habitat, competition with the domestic cattle, diseases, etc. IUCN has listed in the Vulnerable category.</p>
	<p>Scientific name: <i>Platacanthomys lasiurus</i> Blyth 1859. It is known as Malabar Spiny Dormouse, Malabar Spiny Tree Mouse, Spiny Tree Mouse. This species is endemic to Western Ghats of India ranging from Shivamogge, Karnataka in the north to Peppara Wildlife Sanctuary in Thiruvananthapuram district. Habitat loss, changes in land use are major threats to the species. It is very sensitive to change in quality of habitat and to human interference. In some areas of its occurrence it is threatened due to harvest for medicinal purpose.</p>
	<p>Scientific name: <i>Pachliopta hector</i> (Linnaeus, 1758). Its common name in English is Crimson Rose. It is stated to be endemic to Sri Lanka and southern India, but its range may extend along the east coast of Orissa, south Bihar, West Bengal and into Sikkim and parts of northeast India.</p>
	<p>Scientific name: <i>Hypolimnasmisippuz</i> (Linnaeus). Commonly known as Danaid Eggfly. Loss and alteration of the habitat, pollution, pesticide, fungicide and weedicide application, industrial pollution, etc. are the threats to the species. It Included in the Wildlife Protection Act Schedule 1.</p>



Scientific name: *Lissemys punctata* (Lacépède, 1788). It is commonly known as Indian Flap-shelled Turtle, Indian Flapshell Turtle. It is exploited for flesh, carapace and plastron. Over exploitation, Loss and alteration of the habitat, pollution, pesticide, fungicide and weedicide application, industrial pollution are the threats. It is included in the Wildlife Protection Act (1972) Schedule 1 and the IUCN listed in the lower Risk category.

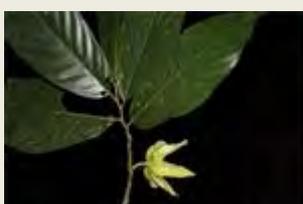


***Glyptopetalum grandiflorum* Bedd.**

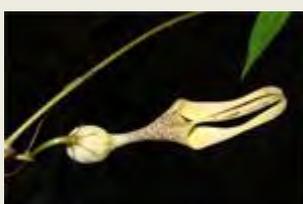
Family : Celastraceae
 Habit : Small tree
 Habitat: Evergreen forests
 Distribution : So far known only from the windward evergreen forests in the Wayanad and Kannur region of Southern Western Ghats
 IUCN status : Endangered



***Humboldtia unijuga* Bedd.** Family: Caesalpiaceae
 Habit: Small tree
 Habitat: Evergreen forest
 Distribution: So far known only from the middle elevation evergreen forests in the Agasthyamala phytogeographical region of southern Western Ghats
 IUCN status: Endangered



***Polyalthia shendurunii* Basha & Sasidh.**
 Family: Annonaceae
 Habit: Tall tree
 Habitat: Evergreen forests
 World distribution: So far known only from the evergreen forests of Agasthyamala phytogeographical region of southern Western Ghats
 IUCN status: Endangered



Scientific name: ***Ceropogia decaisneana* Wight**
 Common name: Palaancheera (Malayalam)
 Description: Herbaceous tuberous twiners in low altitude rocky grassland areas
 Economic value: Leaves edible, others not known
 Distribution: Western Ghats
 Endemism: Endemic to southern Western Ghats
 Threat to the species: Habitat disturbances

	<p>Scientific name: <i>Goniothalamuswynaadensis</i> (Bedd.) Bedd. Description: Third storey undergrowth in evergreen forests Distribution: Southern Western Ghats Endemism: Endemic to windward region of Nilgiri phytogeographical region of Southern Western Ghats Threat to the species: Habitat disturbances</p>
	<p>Scientific name : <i>Ixoralawsonii</i> Gamble Description: Sub-shrub in shola forests Economic value : Not known Distribution: Southern Western Ghats Endemism: Endemic to windward region of Nilgiri phytogeographical region of Southern Western Ghats Threat to the species: Habitat disturbances</p>
	<p>Scientific name : <i>Miliusanilagirica</i> Bedd. Description: Shrubs in evergreen forests at higher altitudes Economic value : Not known Distribution: Southern Western Ghats Endemism: Endemic to Windward region of Nilgiri phytogeographical region of Southern Western Ghats Threat to the species: Habitat disturbances</p>
	<p>Scientific name : <i>Triasstocksii</i> Benth. Description: Epiphyte in evergreen and semi-evergreen forests Distribution: Southern Western Ghats Endemism: Endemic to Southern Western Ghats Threat to the species: Habitat disturbances</p>
	<p><i>Elephas maximus</i> Linnaeus, 1758 Asian Elephant (Endangered)</p>
	<p>Ophiophagushannah (Cantor, 1836) Hamadryad, King Cobra (Vulnerable)</p>
	<p><i>Buceros bicornis</i> Linnaeus, 1758 Great Hornbill (Near Threatened)</p>

Table : 3.7 Endangered Forest Species in Kerala

Sl. No.	Species	Family	Habit
1.	Acampe congesta	Orchidaceae	Herbs
2.	Adenosma malabaricum	Scrophulariaceae	Herbs
3.	Anaphalis barnesii	Compositae	Herbs
4.	Arisaema attenuatum	Araceae	Herbs
5.	Arisaema auriculata	Araceae	Herbs
6.	Arisaema peltatum	Araceae	Herbs
7.	Hydnocarpus macrocarpa	Flacourtiaceae	Trees
8.	Atuna travancorica	Rosaceae	Trees
9.	Bombax scopulorum	Bombacaceae	Trees
10.	Buchanania barberi	Anacardiaceae	Trees
11.	Buchanania lanceolata	Anacardiaceae	Trees
12.	Bulbophyllum aureum	Orchidaceae	Herbs
13.	Calamus travancoricus	Arecaceae	Shrubs
14.	Ceropegia beddomei	Asclepiadaceae	Climbers
15.	Cirrhopetalum avreum	Orchidaceae	Herbs
16.	Clematis bourdillonii	Ranunculaceae	Climbers
17.	Colubrinma travancorica	Rhamnaceae	Shrubs
18.	Cyclea fissicalyx	Menispermaceae	Climbers
19.	Cynometra beddomei	Fabaceae	Trees
20.	Cynometra travancorica	Fabaceae	Trees
21.	Dalbergia beddomei	Fabaceae	Lianas
22.	Dialium travancoricum	Fabaceae	Trees
23.	Didymocarpus macrostachya	Gesneriaceae	Herbs
24.	Dysoxylum beddomei	Meliaceae	Trees
25.	Dysoxylum ficiforme	Meliaceae	Trees
26.	Eugenia argentea	Myrtaceae	Trees
27.	Eugenia discifera	Myrtaceae	Trees
28.	Garcinia imberti	Guttiferae	Trees
29.	Haplothismia exannulata	Burmanniaceae	Herbs
30.	Hedyotis beddomei	Rubiaceae	Herbs
31.	Hedyotis bourdillonii	Rubiaceae	Herbs
32.	Hedyotis wynaadensis	Rubiaceae	Herbs
33.	Hyalisma janthina	Triuridaceae	Herbs
34.	Hydrobryum johnsonii	Podostemaceae	Herbs

35.	Cinnamomum travancoricum	Lauraceae	Trees
36.	Impatiens aliciae	Balsaminaceae	Herbs
37.	Impatiens anaimudica	Balsaminaceae	Herbs
38.	Impatiens cochinica	Balsaminaceae	Herbs
39.	Impatiens coelotropis	Balsaminaceae	Herbs
40.	Impatiens concinna	Balsaminaceae	Herbs
41.	Impatiens johnii	Balsaminaceae	Herbs
42.	Impatiens leptura	Balsaminaceae	Herbs
43.	Impatiens macrocarpa	Balsaminaceae	Herbs
44.	Impatiens munnarensis	Balsaminaceae	Herbs
45.	Impatiens pandata	Balsaminaceae	Herbs
46.	Impatiens platyadena	Balsaminaceae	Herbs
47.	Impatiens pallidiflora	Balsaminaceae	Herbs
48.	Impatiens rivulicola	Balsaminaceae	Herbs
49.	Impatiens verecunda	Balsaminaceae	Herbs
50.	Inga cynometroides	Fabaceae	Tree
51.	Ipsea malabarica	Orchidaceae	Herbs
52.	Isachne fischeri	Gramineae	Herbs
53.	Isachne setosa	Gramineae	Herbs
54.	Ixora johnsonii	Rubiaceae	Herbs
55.	Jambosa bourdillonii	Myrtaceae	Trees
56.	Janakia aryalpathra	Periplocaceae	Herbs
57.	Limnopoia meeboldii	Gramineae	Herbs
58.	Litsea travancorica	Lauraceae	Trees
59.	Loesnerinella bourdilonii	Celastraceae	Climber
60.	Madhuca bourdillonii	Sapotaceae	Trees
61.	Meteoromyrtus wynaadensis	Myrtaceae	Trees
62.	Morinda reticulata	Rubiaceae	Climber
63.	Nilgirianthus asper	Acanthaceae	Shrubs
64.	Nilgirianthus barbatus	Acanthaceae	Shrubs
65.	Nilgirianthus beddomei	Acanthaceae	Shrubs
66.	Nilgirianthus ciliatus	Acanthaceae	Shrubs
67.	Nilgirianthus decurrens	Acanthaceae	Herbs
68.	Nilgirianthus foliosus	Acanthaceae	Herbs
69.	Nilgirianthus lupulinus	Acanthaceae	Herbs
70.	Nilgirianthus neilgherrensis	Acanthaceae	Herbs
71.	Nilgirianthus perrottetianus	Acanthaceae	Herbs

72.	Nilgirianthus punctatus	Acanthaceae	Herbs
73.	Nilgirianthus urceolaris	Acanthaceae	Herbs
74.	Ochlandra beddomei	Bambusaceae	Trees
75.	Ochreinauclea missionis	Rubiaceae	Trees
76.	Oianthus beddomei	Asclepiadaceae	Twiners
77.	Ophiorrhiza barnesii	Rubiaceae	Herbs
78.	Ophiorrhiza candata	Rubiaceae	Herbs
79.	Ophiorrhiza incarnata	Rubiaceae	Herbs
80.	Ophiorrhiza munnarensis	Rubiaceae	Herbs
81.	Orophea uniflora	Annonaceae	Shrub
82.	Otonophelium stipulaceum	Sapindaceae	Trees
83.	Palaquium bourdillonii	Sapotaceae	Trees
84.	Paphiopedilum druryi	Orchidaceae	Herbs
85.	Phaenanthus malabaricus	Annonaceae	Trees
86.	Phlebophyllum lawsonii	Acanthaceae	Shrubs
87.	Plectronia pergracilis	Rubiaceae	Shrubs
88.	Poeciloneuron indicum	Bonnetiaceae	Trees
89.	Poeciloneuron pauciflorum	Bonnetiaceae	Trees
90.	Pogostemon travancoricus	Labiatae	Herbs
91.	Polyalthia rufescens	Annonaceae	Trees
92.	Pterospermum reticulatum	Sterculiaceae	Trees
93.	Sageraea grandiflora	Annonaceae	Trees
94.	Schefflera bourdillonii	Araliaceae	Climbers
95.	Silentvalleya nairii	Gramineae	Herbs
96.	Smithia venkobarrowii	Fabaceae	Shrubs
97.	Sonerila nemakadensis	Melastomataceae	Herbs
98.	Strobilanthes dupenii	Acanthaceae	Herbs
99.	Syzygium bourdillonii	Myrtaceae	Trees
100.	Syzygium palghatense	Myrtaceae	Trees
101.	Syzygium travancorcum	Myrtaceae	Trees
102.	Taeniophyllum scaberulum	Orchidaceae	Herbs
101.	Tephrosia wynaadensis	Fabaceae	Herbs
102.	Toxocarpus palghatensis	Asclepiadaceae	Herbs
103.	Vanilla wightiana	Orchidaceae	Herbs
105.	Vernonia anaimudica	Compositae	Herbs
106.	Vernonia heynei	Compositae	Herbs
107.	Vernonia multibracteata	Compositae	Herbs

Source: Kerala Forest Department

Table : 3.8 District Wise Forest Area 2014-15

(Area in Km²)

Sl. No.	District	Geographic Area	Reserved Forest Area	Protected Forest	Total Forest Area
1.	Thiruvananthapuram	2192	460.1831	3.651	463.8341
2.	Kollam	2491	827.875	12.6922	840.5672
3.	Pathanamthitta	2642	1532.2257	1.568	1533.7937
4.	Kottayam	2203	100.8450	0	100.8450
5.	Idukki	5019	2679.072	34.6506	2713.7226
6.	Ernakulam	2407	823.8302	0	823.8302
7.	Thrissur	3032	1018.438	4.3137	1022.7517
8.	Palakkadu	4480	860.2	667.1564	1527.3564
9.	Malappuram	3550	325.3261	398.592	723.9181
10.	Kozhikode	2344	47.3658	243.0856	290.4514
11.	Wayanadu	2131	566.511	340.5337	907.0447
12.	Kannur	2966	143.7275	97.8442	241.5716
13.	Kasargod	1992	86.0221	33.7083	119.7304
TOTAL		38863	9471.6215	1837.7956	11309.4171 *

Source : Forest Statistics 2015

* Difference due to an area of 0.0583Km² because of the forest lands available in Nenjangud, Mysore and Pollachi which are outside the territorial boundaries of Kerala.

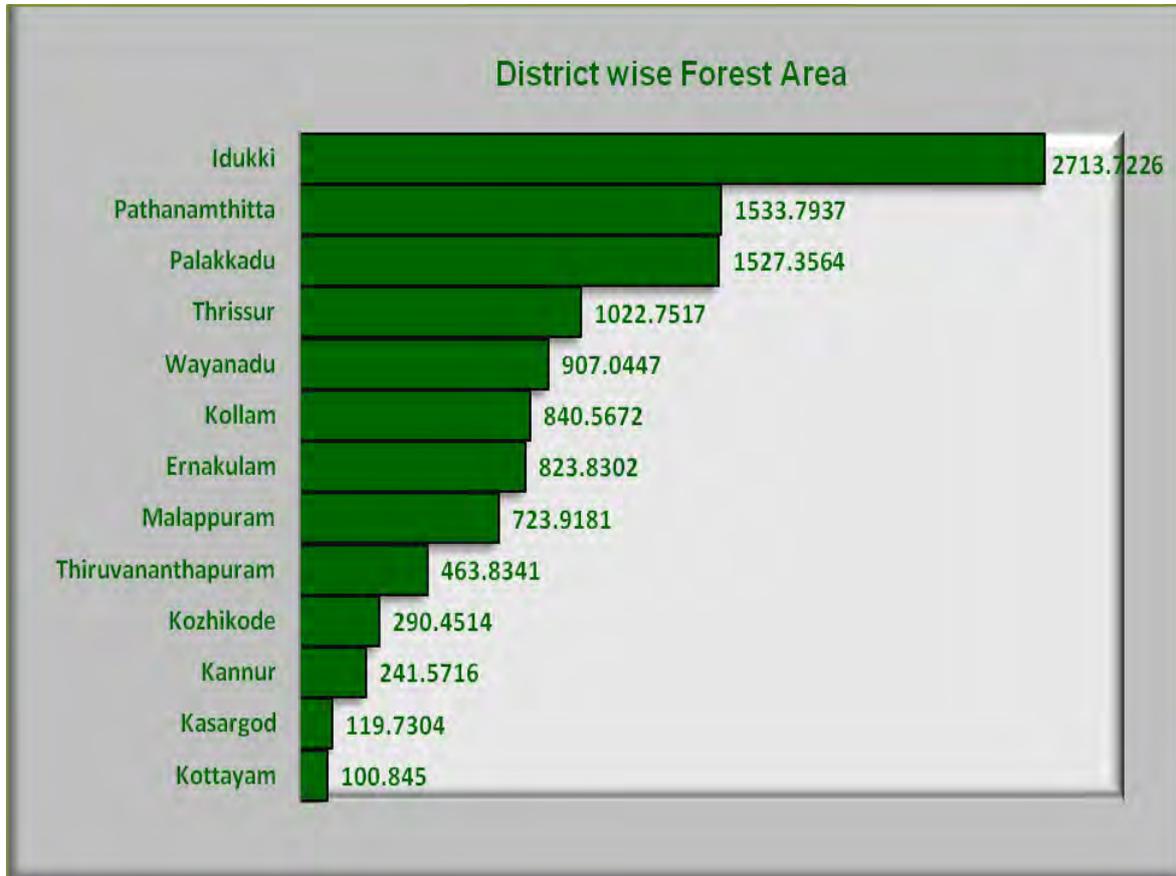


Table : 3.9 Division wise area of Forest 2014-15

Area in Km²

Sl. No.	Division	Reserve Forest	Proposed Reserve	Vested Forest + EFL	Total	% of Total
Southern Circle, Kollam						
1.	Thiruvananthapuram	359.1240	5.8253	3.6510	368.6003	3.26
2.	Thenmala	123.4320	-	7.7350	131.1670	1.16
3.	Achencovil	284.3298	-	0.2082	284.5380	2.52
4.	Ranni	1050.3360	7.1600	1.5680	1059.0640	9.36
5.	Punalur	280.0510	-	0.1690	280.2200	2.48
6.	Ranni	320.6430	11.0210	-	331.6640	2.93
	Total	2417.9158	24.0063	13.3312	2455.2533	21.71
High Range Circle, Kottayam						
7.	Kothamangalam	316.8451	-	0.1576	317.0027	2.80
8.	Munnar	440.4900	175.2750	2.4500	618.2150	5.47
9.	Marayoor	13.9720	47.2600	0.0760	61.3080	0.54
10.	Mankulam	90.0600	-	-	90.0600	0.80
11.	Kottayam	627.2870	-	31.9670	659.2540	5.83
	Total	1488.6541	222.5350	34.6506	1745.8397	15.44
Central Circle, Thrissur						
12.	Vazhachal	413.9440	-	-	413.9440	3.66
13.	Chalakydy	279.7098	-	-	279.7098	2.47
14.	Malayattoor	617.2411	0.5248	-	617.7659	5.46
15.	Thrissur	293.7430	-	4.3137	298.0567	2.64
	Total	1604.6379	0.5248	4.3137	1609.4764	14.23

Eastern Circle, Palakkad						
16.	Mannarkkad	150.7322	-	271.7213	422.4535	3.74
17.	Nilambur North	57.9196	0.0171	340.7032	398.6399	3.52
18.	Nilambur South	267.3894	-	57.8888	325.2782	2.88
19.	Palakkad	73.4100	-	162.0847	235.4947	2.08
20.	Nenmara	205.5170	-	150.2104	355.7274	3.15
Total		754.9682	0.0171	982.6084	1737.5937	15.37
North Circle, Kannur						
21.	Kozhikode	24.3998	22.9660	243.0856	290.4514	2.57
22.	Wayanad North	134.0240	15.0640	65.8527	214.9407	1.90
23.	Wayanad South	66.1381	6.8449	274.6810	347.6640	3.07
24.	Kannur	121.3702	0	65.2014	186.5716	1.65
25.	Kasaragode	86.0221	0	33.7083	119.7304	1.06
Total		431.9542	44.8749	682.5290	1159.3581	10.25
Agastyavanam Biological Park						
26.	Thiruvananthapuram	212.0000	-	-	212.0000	1.87
27.	Shenthuruni	166.4200	-	4.5800	171.0000	1.51
Total		378.4200	-	4.5800	383.0000	3.38
Field Director (Project Tiger), Kottayam						
28.	Periyar East	618.0000	-	-	618.0000	5.46
29.	Periyar West	157.0000	-	-	157.0000	1.39
30.	Munnar	276.8450	-	-	276.8450	2.45
31.	Idukki	130.5240	-	-	130.5240	1.15
Total		1182.3690	-	-	1182.3690	10.45

Wildlife Circle, Palakkad						
32.	Parambikulam	274.1408	-	-	274.1408	2.42
33.	Wayanadu (WL)	344.4400	-	-	344.4400	3.05
34.	Silent Valley	154.3800	-	83.1400	237.5200	2.10
35.	Peechi	122.0644	3.4200	-	125.4844	1.11
36.	Aralam	22.3572	-	32.6428	55.0000	0.49
	Total	917.3824	3.4200	115.7828	1036.5852	9.17
	Grand Total	9176.3016	295.3781	1837.7957	11309.4754	

Note : Reconciliation process on forest area is being done. The figures furnished above are subject to minor variations in this process.

Source : Forest Statistics 2015

Classification of Forest Areas

Classification of forest areas are mainly in 7 types - Tropical Wet Evergreen and Semi Evergreen, Tropical Moist Deciduous, Tropical Dry Deciduous, Montane Sub-tropical Temperate shoals, Plantations, Grass lands and others. The area of Tropical Wet Evergreen and Semi Evergreen forest is 3877.4413 Km², Tropical Moist Deciduous forest is 3615.9840 Km², Tropical Dry Deciduous forest is 391.3636 Km², Montane Sub-tropical Temperate shoals is 386.4210 Km², Plantations are 1527.1937 Km², Grass lands covers 501.0865 and others are 1009.9853 Km². The classification of Total Forest Area is given in the chart.

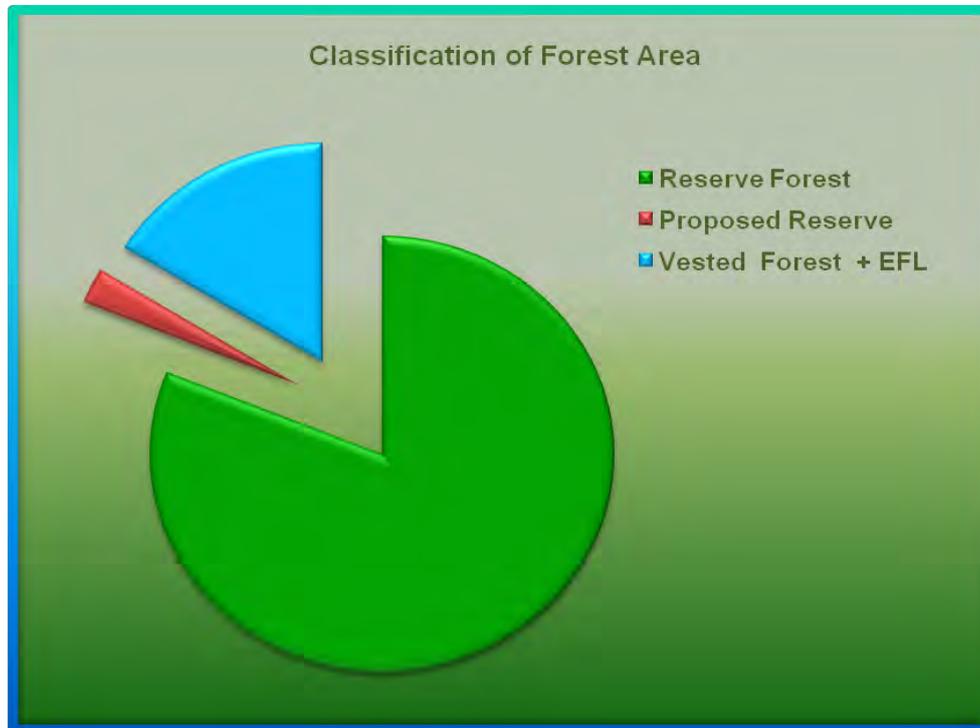


Table : 3.10 Classification of Forest Types 2014-15

Sl. No.	Type of Forest	Area (Km ²)	% to Total
1.	Tropical Wet Evergreen and Semi Evergreen	3877.4413	34.28
2.	Tropical Moist Deciduous	3615.9840	31.97
3.	Tropical Dry Deciduous	391.3636	3.46
4.	Montane Sub-tropical Temperate shoals	386.4210	3.42
5.	Plantations	1567.4374	13.86
6.	Grass Lands	501.0865	4.43
7.	Others	969.7416	8.58
	Total	11309.4754	

Source : Forest Statistics 2015

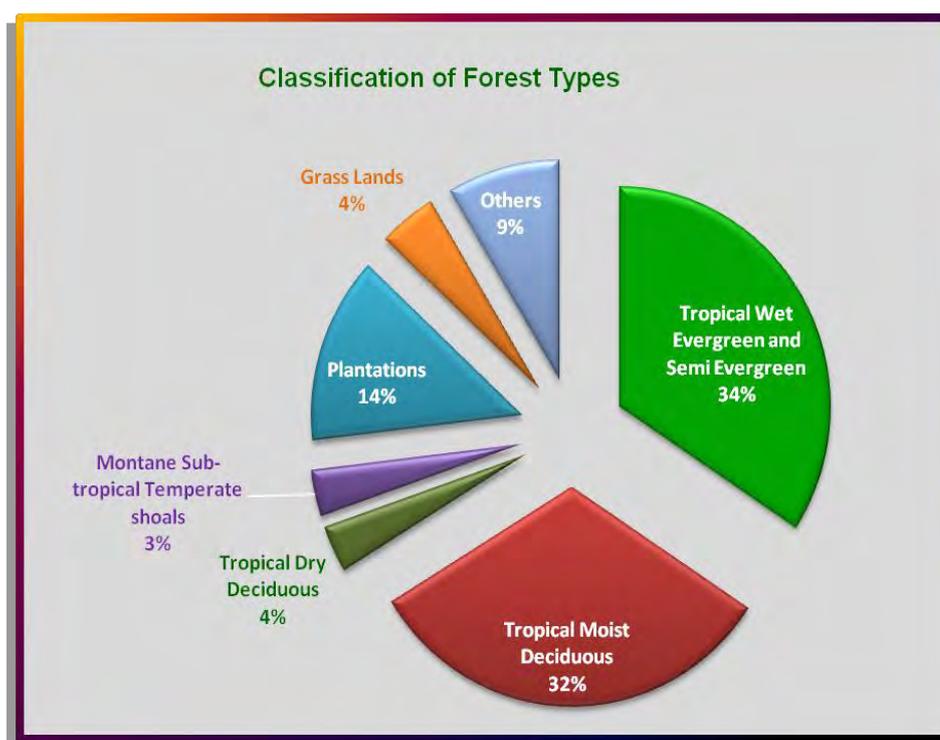


Table : 3.11 Classification of Forest Area according to utilisation 2014-15

Sl. No.	Mode of Utilisation	Area (Km ²)	% to Total
1.	Dense Forest / Degraded Forest	8754.2168	77.41
2.	Plantations	1567.4374	13.86
3.	Area under Lease	604.4537	5.34
4.	Forest Land diverted under FCA	383.3675	3.39
	Total	11309.4754	

Source : Forest Statistics 2015

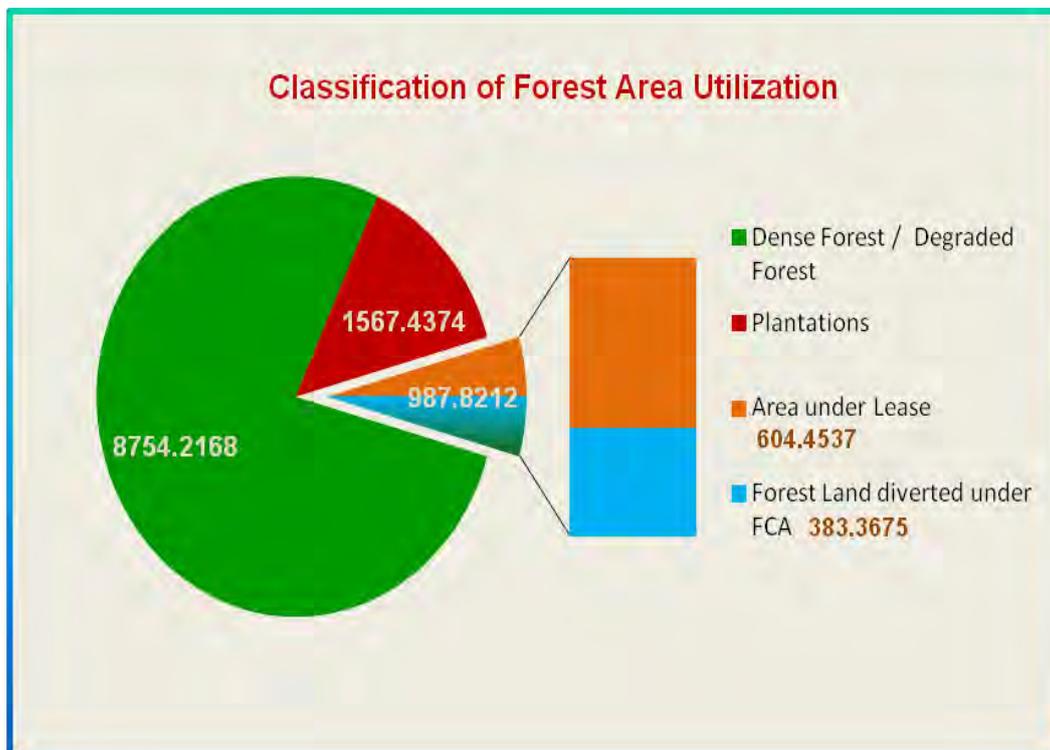


Table : 3.12 District wise Ecologically Fragile Land (EFL) Area

Sl. No.	District	Area (ha)
1.	Thiruvananthapuram	885.26
2.	Kollam	273.72
3.	Idukki	1411.82
4.	Thrissur	80.04
5.	Palakkad	5270.69
6.	Malappuram	1285.09
7.	Kozhikode	1544.99
8.	Wayanad	3004.86
9.	Kannur	491.26
10.	Kasaragode	662.90
	TOTAL	14910.63

Source : Forest Statistics 2015

Table : 3.13 District wise Forest cover in Kerala 2014-15

Sl. No.	District	Geographic Area	2014 Assessment				Percent to GA
			Very Dense	Moderate Dense	Open Forest	Total	
1.	Thiruvananthapuram	2193	60	718	539	1317	60.05
2.	Kollam	2491	99	671	632	1402	56.28
3.	Pathanamthitta	2641	158	1202	382	1742	65.96
4.	Alappuzha	1414	0	45	67	112	7.92
5.	Kottayam	2203	12	530	341	883	40.08
6.	Idukki	5019	349	2081	1340	3770	75.11
7.	Ernakulam	2407	12	282	412	706	29.33
8.	Thrissur	3033	181	454	490	1125	37.09
9.	Palakkadu	4480	317	677	767	1761	39.31
10.	Malappuram	3549	142	417	916	1475	41.56
11.	Kozhikode	2344	30	316	706	1052	44.88
12.	Wayanadu	2131	142	1256	301	1699	79.73
13.	Kannur	2966	21	346	971	1338	45.11
14.	Kasaragode	1992	0	306	551	857	43.02
TOTAL		38863	1523	9301	8415	19239	49.50

Source : Forest Statistics 2015

Table : 3.14 Comparative situation of Forest Cover in Kerala

Area in Km²

Sl. No.	District	Assessment				
		2010	2011	2012	2013	2014
1.	Thiruvananthapuram	1350	1349	1349	1316	1317
2.	Kollam	1337	1330	1330	1395	1402
3.	Pathanamthitta	1758	1755	1755	1754	1742
4.	Alappuzha	38	38	38	113	112
5.	Kottayam	895	889	889	890	883
6.	Idukki	3932	3930	3930	3852	3770
7.	Ernakulam	696	695	695	698	706
8.	Thrissur	933	931	931	1068	1125
9.	Palakkadu	1575	1575	1575	1628	1761
10.	Malappuram	1211	1209	1209	1255	1475
11.	Kozhikode	591	591	591	690	1052
12.	Wayanadu	1775	1775	1775	1776	1699
13.	Kannur	641	641	641	866	1338
14.	Kasaragode	592	592	592	621	857
TOTAL		17324	17300	17300	17922	19239

Source : Forest Statistics 2015

Table : 3.15 Division wise Area of Plantation (species wise) 2014-15

Sl. No.	Division	Hardwood	Softwood	Mangroves	Bamboo, Cane and Reeds	Others	Total
1.	Thiruvananthapuram	3898.060	278.240	0	65.080	1223.274	5464.654
2.	Thenmala	2423.550	319.680	0	0	1374.490	4117.720
3.	Punalur	4055.018	680.040	0	234.350	1738.730	6708.138
4.	Achenkovil	2777.980	0	0	0	1312.477	4090.457
5.	Ranni	3463.620	0	0	400.952	2231.260	6095.832
6.	Konni	8496.380	32.480	0	912.900	655.871	10097.631
7.	Kottayam	4218.090	85.540	0	191.900	962.067	5457.597
8.	Munnar	770.520	4399.200	0	579.360	1272.210	7021.290
9.	Kothamangalam	4668.447	304.040	0	236.850	1125.387	6334.724
10.	Marayoor	0	866.820	0	0	0	866.820
11.	Mankulam	42.250	117.600	0	405.250	324.630	889.730
12.	Malayatoor	5743.083	31.098	0	320.270	2974.778	7069.228
13.	Vazhachal	3933.870	479.510	0	370.940	2871.780	7656.100
14.	Chalakkudy	4592.590	107.800		38.600	1031.850	5770.840
15.	Thrissur	2271.766	97.450	0	696.860	7146.680	10212.756
16.	TS Perumbavoor	61.490	0	0	0	0	61.490

17.	Nenmara	1369.200	146.540	0	90.040	1702.218	3307.998
18.	Palakkad	1892.960	108.820	0	173.430	1390.410	3565.620
19.	Mannarkkad	564.480	143.920	0	50.000	402.630	1161.030
20.	Nilambur (South)	4508.570	0	0	0	471.320	4979.890
21.	Nilambur (North)	4206.660	0	0	734.754	3885.248	8826.662
22.	Kozhikkode	273.230	1048.785	5.000	87.100	1009.130	2423.245
23.	Wayanad (South)	2668.580	1054.030	0	76.000	1430.120	5228.730
24.	Wayanad (North)	868.710	299.410	0	0	2315.130	3483.250
25.	Kannur	683.188	0	251.979	102.100	4070.664	5107.931
26.	Kasaragod	1212.520	0	116.210	467.212	1675.697	3471.639
27.	Thiruvananthapuram Wildlife	88.080	135.760	0	1115.468	1347.501	2686.809
28.	Peechi Wildlife	531.000	0	0	132.250	1141.887	1805.137
29.	Parambikulam Wildlife	8747.466	0	0	0	0	8747.466
30.	Silent Valley Wildlife	437.300	57.890	0	0	94.000	589.190
31.	Wayanad Wildlife	7486.802	429.670	0	0	2987.899	10904.371
32.	Aaralam Wildlife	291.300	0	0	0	30.000	321.300
33.	NSC, Kalady	162.217	0	0	0	56.250	218.467
	Total	87408.976	11224.323	373.189	7481.666	50255.588	156743.742

Source : Forest Statistics 2015

Table : 3.16 Species wise distribution of Plantation Area

Sl. No.	Species	Area (Ha.)	% to total Plantation
1.	Teak	76734.962	48.449
2.	Teak & Soft wood	14482.874	9.144
3.	Accacia Mangium	3589.465	2.266
4.	Accacia	5752.314	3.970
5.	Eucalyptus	6566.155	4.146
6.	Cane	1908.872	1.240
7.	Bamboo	5057.442	3.329
8.	Rosewood	55.130	0.035
9.	Mahagani	360.556	0.228
10.	Sandalwood	73.840	0.047
11.	Other Hardwood	264.130	0.167
12.	Reeds	515.352	0.325
13.	Cinnamon	0	0
14.	Pepper	70.000	0.044
15.	Medicinal Plants	2027.111	1.330
16.	Gravelia Robusta	576.728	0.364
17.	Pine	552.800	0.349
18.	Albezzia	120.330	0.076
19.	Anjili	393.340	0.248
20.	Kambakam	185.240	0.117
21.	Elavu	600.980	0.379
22.	Rubber	86.370	0.055
23.	Balsa	36.040	0.023
24.	Wattle	2187.610	1.381
25.	Matti	497.310	0.314
26.	Cashew	4849.459	3.062
27.	Agave	41.640	0.026
28.	Alnus	74.350	0.047
29.	Sesbania	21.070	0.013
30.	Casuarina	138.870	0.088
31.	Silver Oak	108.530	0.069
32.	Mangroves	373.189	0.235
33.	Fruit	366.543	0.231
34.	Miscellaneous	28075.141	18.203
	TOTAL	156743.742	

Source : Forest Statistics 2015

Biosphere Reserves in Kerala

The 17 Biosphere Reserves in India, which protect larger areas of natural and include National Parks and/or preserves, along buffer zones that are open to some economic uses. Protection is granted not only to the flora and fauna of the protected region, but also to the human communities who inhabit these regions and their ways of life.

Nilgiri Biosphere Reserve

The Nilgiri Biosphere Reserve encompasses 5,520 km² in the State of Tamil Nadu (2537.6 km²), Karnataka (1527.4 km²) and Kerala (1455.4 km²). It forms an almost complete ring around the Nilgiri Plateau.

Ecology: Corresponding to their altitudinal and climatic gradients, the natural vegetation changes from tropical wet evergreen forest along the western slopes to montane stunted Shola forest amidst the grassy down on the upper plateau and on the east, progressively drier deciduous forests ending in thorny scrub. This setting is home for a variety of animals—the lion-tailed macaque in the evergreen forests, the Nilgiri tahr in the grassy downs, the black buck in the dry scrub and the tiger and the elephant throughout the region.

Fauna and Flora: Fauna includes over 100 species of mammals, 350 species of birds, 80 species of reptiles; about 39 species of fish, 31 amphibians, 60 species of reptiles 316 species of butterflies and innumerable invertebrates. Rare animals include the tiger and the Nilgiri Tahr. The reserve has very rich plant diversity. Of 3300 species, 1232 are endemic.

Agasthyamalai Biosphere Reserve

The Agasthyamalai Biosphere Reserve (ABR) was established in 2001 and includes 3,500 km² out of which 1828 km² is in Kerala and 1672 km² is in Tamil Nadu. The Western Ghats, Agasthyamalai Sub-Cluster, including all of Agasthyamalai Biosphere Reserve, is under consideration by the UNESCO World Heritage Committee for selection as a World Heritage Site. Agasthyamala is located in this biosphere area.

Location: Biosphere reserve straddles the border of Kollam and Thiruvananthapuram districts in Kerala and Tirunelveli and Kanyakumari districts in Tamil Nadu. It is composed of Neyyar, Peppara and Shendurney wildlife Sanctuaries and their adjoining areas of Achencoil, Thenmala, Konni, Punalur, Thiruvananthapuram divisions and Agasthyavanam special division in Kerala. The reserve cover parts of Tirunelveli and Kanyakumari Districts in Tamil Nadu and Thiruvananthapuram, Kollam and Pathanamthitta Districts in Kerala.

Ecology: The reserve includes the Indian Ecoregions of South Western Ghats moist deciduous forests, South Western Ghats montane rain forests and Shola. It is the habitat for 2,000 varieties of medicinal plants, of which at least 50 are rare and endangered species. Rare animals include the Tiger, Asian Elephant and Nilgiri Tahr.

Protected Area: The protected area of the reserver includes Neyyar, Peppara and Shenduruny wildlife sanctuaries of Kerala and Kalakkad-Mundanthurai Tiger Reserve of Tamil Nadu.

Fauna and Flora: The proposed Agasthyamalai Biosphere Reserve is a pristine paleotropic region with a very high floral endemism and tremendously rich biodiversity, locked up in an area exhibiting an overall representation of the biota of the southern Western Ghats. The site represents the richest centre of endemic plants, abode of all vegetation types met within the peninsula, richest repository of medicinal plants, the southern-most haven of endangered animals including primates, amphibians, reptiles and fishes and a treasure house of wild relatives of domesticated crops.

Table : 3.17 Biosphere Reserves in Kerala

Sl. No	Name of reserve	Area Sq.Km	Forest areas in the State
1	Nilgiri	1455.4	Wayanad Wildlife Sanctuary Silent valley National Park Nilambur South (New Amarambalam, Karimpuzha) Mannarkkad (Attappady) Palakkad (Siruvani Reserved Forests) Nilambur North, (Chakkikuzhy, Kozhipara, Punchakolly, Ex.Karulai Range (Nilambur Kovilakom) Kozhikode (kuttyadi, Thamarassery, Vested Forests) Wayanad South (Kalpetta)
2	Agastyamalai	1828	Neyyar Peppara Shendurney wildlife sanctuaries Achencoil Thenmala Konni Punalur and Thiruvananthapuram territorial divisions and Agasthyavanam Biological Park Range.

Source : Kerala Forest & Wildlife Department

Wildlife Conservation

According to Forest Statistics 2015, Kerala has 3213.24 Km² of forests under protected areas (National Parks, Wildlife Sanctuaries and Community Reserves) and forms 28% of the total forest area. The list of Wildlife Sanctuaries, National Parks, and Community Reserve & Biosphere Reserve are given below.

Table : 3.18 List of Wildlife Sanctuaries, National Parks, Community Reserve and Biosphere Reserves

Sl. No.	Name	District	Area (Km ²)	Year of Formation
Wildlife Sanctuaries				
1	Periyar WLS (Tiger Reserve), Idukki **	Idukki	925.000	1950
2	Neyyar WLS, Thiruvananthapuram	Thiruvananthapuram	128.000	1958
3	Peechi-Vazhani Wildlife Scantuary.	Thrissur	125.000	1958
4	Parambikulam WLS (Tiger Reserve)	Palakkad	643.660	1973
5	Wayanad WLS, Wayanad	Wayanad	344.440	1973
6	Idukki WLS, Idukki	Idukki	70.000	1976
7	Peppara WLS, Thiruvananthapuram	Thiruvananthapuram	53.000	1983
8	Thattekkadu Bird Sanctuary, Ernakulam	Ernakulam	25.000	1983
9	Shenduruniey WLS, Kollam	Kollam	171.000	1984
10	Chinnar WLS, Idukki	Idukki	90.440	1984
11	Chimmony WLS, Thrissur	Thrissur	85.000	1984
12	Aralam WLS, Kannur	Kannur	55.000	1984
13	Mangalavanam Bird Sanctuary.	Ernakulam	0.0274	2004
14	Kurinjimala Sanctuary, Idukki	Idukki	32.000	2006
15	Choolannur Pea Fowl Sanctuary	Palakkad	3.420	2007
16	Malabar Sanctuary.	Kozhikkode	74.215	2009
17	Kottiyoor WLS, Kannur	Kannur	30.3798	2011

National Parks				
1	Eravikulam National Park.	Idukki	97.000	1978
2	Silent Valley National Park.	Palakkad	237.520	1984
3	Anamudi Shola National Park.	Idukki	7.500	2003
4	Mathikettan National Park.	Idukki	12.817	2003
5	Pambadum Shola National Park, Idukki	Idukki	1.318	2003
Community Reserve				
1	Kadalundi – Vallikunnu Community Reserve	Kozhikkode & Malappuram	1.500	2007
TOTAL			3213.24 Km²	
Biosphere Reserve				
1	Agasthyamala Biosphere Reserve	Thiruvananthapuram & Kollam	1828.00	2001
2	Nilgiri Biosphere Reserve	Palakkad	1455.40	1986

Source: Forest Statistics 2015

Timber and Non-Timber forest products of Kerala

Forest Products collection is one of the major livelihoods of the local people. It consists of a variety of products, which are sources of food, fibre, manure, construction materials, cosmetics and cultural products. The users of NTFP range from local individuals to multinational companies. With the development of modern techniques, the number of products and uses based on NTFP has increased by many folds. Studies indicate NTFP collectors are amongst the lowest-income groups in India, often receiving a mere 5-20% of the value for their products (SPWD,1993). About 69% of the forest based employment is related to NTFP. The forests of Kerala are very rich in NTFP including edible products, medicinal plants, toiletries, tans, dyes, gums, resins, rattan, bamboo, grasses and animal products. Although 500 species of NTFP are available in the forests of Kerala, about 120 items are listed as commercially important by the Kerala Forest Department.

Table : 3.19 Out turn of Major Forest Produce 2014-15

Sl. No.	Item	Unit	Quantity
1	Teak Poles	MT	12232.942
2	Sawn wood	MT	744.600
3	Firewood	MT	6.036
4	Sandal Wood	Kg	14817.891
5	Bamboo	MT	88190.769
6	Reeds	MT	8751.931
7	Other	MT	5759.127

Source : Forest Statistics 2014-15

Category wise outturn of Timber classified according to utility is given below:-

Table : 3.20 Outturn of Timber based on utility 2014-15

SI. No.	Category	Unit	Quantity
1.	Industrial wood	M3	24579.813
2.	Plywood	"	322.144
3.	Matchwood	"	231.534
4.	Bobbin wood	"	77.952
5.	Pencil wood	"	3.242
6.	Packing case wood	"	107.689
7.	Pulpwood		
a)	Eucalyptus	MT	5960.454
b)	Accasia	"	77155.838
c)	Bamboo	"	8751.931
d)	Reeds	"	5759.127
8.	Miscellaneous		
a)	Timber	M3	4979.651
b)	Firewood	MT	14817.891
c)	Teak poles	MT	12232.942
d)	Other poles	MT	744.600
e)	Billets	MT	1324.574
f)	Sawn wood	MT	1324.574
g)	Sandal wood	Kg	88190.769

Source : Forest Statistics 2014-15

Table : 3.21 Procurement of Minor Forest Produces

Sl. No.	Name	Quantity (kg)
1.	Ayurvedic Herbs	1038878.65
2.	Spices	1772
3.	Fibre	6184.5
4.	Grass other than fodder	148198
5.	Incensive Plants	14346.4
6.	Honey	61317.7
7.	Bee's Wax	219.5
8.	Vegitable Oil Seeds	1578
9.	Medicinal Trees	750
	TOTAL	1273244.75

Source : Forest Statistics 2015

Table : 3.22 District Wise Mangrove Area

Sl.No.	District	Area in Ha
1	Thiruvananthapuram	23
2	Kollam	58
3	Pathanamthitta	0
4	Alappuzha	90
5	Kottayam	80
6	Idukki	0
7	Ernakulam	260
8	Thrissur	21
9	Palakkadu	0
10	Malappuram	12
11	Kozhikode	293
12	Wayanadu	0
13	Kannur	755
14	Kasaragode	79
TOTAL		1671

CHAPTER - IV

ATMOSPHERE

Atmospheric Pollution

Many forms of atmospheric pollution affect human health and the environment at levels from local to global. These contaminants are emitted from diverse sources, and some of them react together to form new compounds in the air. Industrialized nations have made important progress toward controlling some pollutants in recent decades, but air quality is much worse in many developing countries. Until a decade ago pollution was not a matter of concern for Kerala. Increasing use of fossil fuel in the transport and industrial sectors is adversely affecting the air quality. Major cities like Thiruvananthapuram, Kochi and Kozhikode in the State have been experiencing growth in urban spread. Unplanned growth has resulted in degradation of air quality due to crowding and traffic congestion. Air quality deterioration in urban areas is mainly due to increased use of fuels in transport sector. Improper collection and disposal of garbage is causing the waste to rot before it is removed. Scientific disposal facilities are inadequate even in major cities in the State. Garbage is mostly burned in the open causing air pollution. Vehicular movements and unrestrained use of loud speakers are mainly responsible for the noise pollution in the urban areas.

A recent study conducted by the State Pollution Control Board (SPCB) reveals that there is a sudden rise in air pollution, especially in the respirable suspended particulate matter (RSPM) and a subsequent fall in Oxygen content in many parts of the State. A trend analysis of major towns in the past decade shows that more than 10 tonnes exceeded the RSPM levels of 60 microgram per cubic meter (Mg/Md) which is the upper limit as per the National Ambient Air Quality Monitoring Programme (NAMP) standards.

Pollution from industries are mainly contributed by the four major industrial areas of the state, three in Ernakulam and one in Kanjikkode at Palakkad. Bulk of the Major/Medium industries and the maximum number of vehicle are in Ernakulam which naturally resulted in an adverse impact in the air quality. In the case of solid, hazardous and biomedical wastes the average waste generation per capita in Kerala is high compared to the national average. The database of WHO regarding the air pollution monitoring from 1600 cities all over the world includes 124 cities are from India of which eight are from Kerala.

Table : 4.1 Air Pollution Monitoring Cities in Kerala 2014-15

Rank	City	Particulate Matter upto 10 Micrometer (PM 10)	Particulate Matter upto 2.5 Micro metre (PM 2.5)
1	Thiruvananthapuram	52	23
2	Kollam	39	17
3	Pathanamthitta	23	10
4	Alappuzha	46	20
5	Kottayam	55	24
6	Kochi	64	28
7	Thrissur	73	32
8	Kozhikkode	57	25

Atmosphere

Atmosphere is considered to be the most essential entity that support and protect life on earth. The principal constituents of the lower atmosphere are:

- ✓ Nitrogen – 78% by volume
- ✓ Oxygen – 21%
- ✓ Argon – 0.9%
- ✓ Carbon dioxide – 0.033%

Green House Gas Emission in Kerala

Kerala has a fragile and closed ecosystem. In Kerala the emission rate of CO₂ and other green house gases (GHG) are comparatively low. A study by Cochin University of Science and Technology reveals that sea level rise and climate changes which effects monsoon are very much linked to green house gas emission. Considering the population of Kerala as 334 lakhs (2011 census provisional figures) the total green house gas emissions will be 50.08 million tonnes. However the actual emissions for the state could be far below this range for the fact that relative contribution of power for Energy, Industry and agriculture sector is from hydroelectric power.

Due to population pressure, forest areas are under threat which leads to the higher concentration of CO₂ in atmosphere. Similarly coconut husk retting which is a major activity in the coastal areas of the State generates methane along with Hydrogen sulphide. On the average, nearly 7.5 million house holds in Kerala need 37.5 million Kg of firewood. The production of petroleum products is at 221.136 MMT in year 2014-15 as against 220.756MMT achieved in 2013-14, showing a marginal increase of about 0.17%. During the year 2014-15, the consumption of petroleum products in India was 164.987 MMT with a growth of 4.15% as compared to consumption of 158.407 MMT during 2013-14.

Ozone Depletion

Ozone depletion occurs when chlorofluoro carbon (CFCS) formerly found in aerosol spray cans and refrigerants are released into the atmosphere. These gases, through several chemical reactions, cause the ozone molecules to break down, reducing ozone's ultraviolet (UV) radiation absorbing capacity. CFCS are used in a variety of industrial, commercial and household applications. Depletion of ozone layer results in increased levels of ultraviolet radiation reaching the earth's surface. This leads to higher rates of skin cancer, cataract and damage to people's immune systems. Small increase in ultra violet radiation diminishes the

productivity of important food crops and reduce levels of plankton in other ocean adversely affecting marine food supplies. Because CFCs can remain in the atmosphere for up to 100 years, continued accumulations of these chemicals pose ongoing threats even after their use has been discontinued.

There are many other substances that lead to ozone layer depletion such as hydrochlorofluoro carbons (HCFCs) and volatile organic compounds (VOCs). Such substances are found in vehicular emissions, by-products of industrial processes, aerosols and refrigerants. All these ozone depleting substances remain stable in the lower atmospheric region, but as they reach the stratosphere, they get exposed to the ultraviolet rays. This leads to their breakdown and releasing of free chlorine atoms which reacts with the ozone gas, thus leading to the depletion of the ozone layer.

Hydrochlorofluoro Carbons (HCFC) is used mainly in the air conditioning, refrigeration, polyurethane foam manufacturing and cold chain sectors and must be replaced with better alternatives. The scenario is not different in Kerala which is considered to be a typical fast growing urbanised society. The refrigerant consumption shows a rapid growing trend in our state. The fact according to European Union report that HCFC gases are mostly used by split air conditioning units, car ACs and commercial refrigeration thus becomes a major threat which we will have to face in the near future.

Humidity

As the State stretches from north to south with the Arabian Sea in its west, relative humidity is in general high over the State. In the period January to March afternoon humidity reduce to 60-63%, varying from 35% in the interior to 71 % in the coastal area. The diurnal variation in relative humidity during this period is maximum and ranges from 4 to 16%, depending upon the proximity of the sea. The relative humidity in the monsoon period rises to about 85% for the state. The variation in this period is minimum.

Temperature:

Compared to other Indian states, Kerala lies closer to the equator. Yet Kerala is bestowed with a pleasant and equable climate through out the year. This is because of the land's nearness to the sea and the presence of the fort like Western Ghats on the east. Kerala would have been a dry land because of the dry winds blowing from the north, but for the Western Ghats which prevent this wind from entering the land. Kerala receives copious rain

(average 3000 mm a year) each year. The temperature in Kerala normally ranges from 28° to 32° C (82° to 90° F) on the plains but drops to about 20° C (68° F) in the highlands. The Highlands of Kerala, which is an area of major tourist attraction, enjoys a cool and invigorating climate the year-round. Owing to its diversity in geographical features, the climatic condition in Kerala is diverse. It can be divided into 4 seasons - winter, summer, South-West Monsoon and North-East Monsoon. Winter in Kerala starts with the end of the northeast monsoons i.e. from the later part of November lasting till the middle of February. During this season temperature is comparatively low but as mentioned earlier it does not vary much from other seasons. In the highlands of Kerala, where the climate is cool throughout the year, winter temperatures often fall below 10°C. Winter season in Kerala witnesses the lowest amount of rainfall.

Rainfall

Rainfall is the major source of ground water recharge and the rainfall pattern plays an important role on the water levels in the phreatic aquifers and also to the deeper aquifers. Almost all the districts recorded normal rainfall during the month of June to September due to the influence of south-west monsoon season. The total rainfall ranged from 2936 to 3132 mm during the period from April 2014 to March 2015. The maximum rainfall was recorded in Kozhikode district and the minimum in Trivandrum district. During the southwest monsoon season, Trivandrum district recorded 1948 mm and Kozhikode district recorded 3871 mm, which are the lowest and highest rainfall respectively and remaining all the districts were received normal rainfall. The thunderstorm rains in the pre-monsoon months of April and May and that of monsoon months are locally known as 'EDAVAPATHI'. Rainfall during northeast monsoon season is known as 'THULAVARSHAM' in local language. The southwest monsoon sets-over the southern parts of the State by about 1st June and extends over the entire State by 5th June. June and July are the rainiest months, each accounting individually to about 33% of annual rainfall.

The diversity of the geographical features of the state has resulted in a corresponding diversity in climate. The High Ranges have a cool and bracing climate throughout the year, while the plains are hot and humid. The average level of annual rainfall is quite high when compared to other Indian states. The state basically enjoys 4 types of climate such as winter, summer, South West Monsoon and North East Monsoon.

Table : 4.2 Rainfall Distribution of Kerala for the year 2014-15

Sl. No.	Districts	2014						2015						2014-15		
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Actual	Normal	Departure %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Thiruvananthapuram	118.5	342.3	305.9	288.3	128.6	52.3	9.6	0.4	50.6	254.9	336.8	60.6	1948.8	1803.1	8.1
2.	Kollam	283.5	496.5	359.4	386.6	151.7	33.5	7.7	32.9	41.1	276.3	226.4	185.0	2480.6	2491.1	-0.4
3.	Pathanamthitta	425.5	663.4	408.8	401.2	64.6	94.0	7.8	18.3	75	458.2	177.0	186.1	2979.9	2956.7	0.8
4.	Alappuzha	354.5	552.1	288.9	311.0	93.8	54.4	3.2	5.2	97.1	236.7	177.8	235.7	2410.4	2840.5	-15.1
5.	Kottayam	486.1	695.7	427.6	468.4	156.5	24.7	9.1	4.4	131.7	294.5	239.9	306.8	3245.4	2930.8	10.7
6.	Idukki	873.8	749.4	590.6	421.6	127.1	40.1	1.4	14.4	80.1	261.4	165.9	436.3	3762.1	3303.2	13.9
7.	Ernakulam	625.6	745.9	454.5	434.8	118.5	94.8	2.4	0.5	37.2	229.3	176.2	367.2	3286.9	3028.7	8.5
8.	Thrissur	544.0	573.5	374.6	407.9	94.1	9.3	0.9	0.0	38.4	130.8	188.4	463.2	2825.1	3063.7	-7.8
9.	Palakkad	566.8	484.7	342.7	282.5	40.2	40.7	0.0	2.0	27.1	182.4	245.6	281.8	2496.5	2288.3	9.1
10.	Malappuram	804.3	573.5	376.5	371.1	121.3	12.1	0.0	0.0	37.2	167.0	187.2	411.5	3061.4	2835.1	8.0
11.	Kozhikode	1041.9	713.7	509.8	331.6	105.6	77.2	0.0	0.0	35.3	86.3	189.5	780.5	3871.4	3514.0	10.2
12.	Wayanad	1015.3	582.8	422.1	251.2	32.8	83.0	0.1	0.0	45.8	131.0	203.3	304.3	3071.7	3250.9	-5.5
13.	Kannur	969.9	748.5	509.7	256.8	97.4	21.1	5.0	0.0	12.3	93.9	172.5	803.0	3690.1	3318.3	11.2
14.	Kasargod	710.4	843.3	572.4	311.8	27.0	57.7	0.9	0.0	36.3	116.9	151.8	846.5	3675.0	3619.7	1.5
	State (Average)	651.7	626.7	430.5	355.5	99.5	47.5	48.1	5.8	50.6	208.4	201.8	406.2	3132.3	2936.7	6.7

Source: Agriculture Statistics 2014-15, DES

Table : 4.3 District wise Annual Average Rainfall 2014-15 (in mm)

SI. No.	District	Normal Rainfall (mm)	Actual Rainfall (mm)	% Departure
1	Thiruvananthapuram	1948.80	1803.10	8.1
2	Kollam	2480.60	2491.10	-0.4
3	Pathanamthitta	2979.90	2956.70	0.8
4	Alappuzha	2410.40	2840.50	-15.1
5	Kottayam	3245.40	2930.80	10.7
6	Idukki	3762.10	3303.20	13.9
7	Ernakulam	3286.90	3028.70	8.5
8	Thrissur	2825.10	3063.70	-7.8
9	Palakkad	2496.50	2288.30	9.1
10	Malappuram	3061.40	2835.10	8.0
11	Kozhikkode	3871.40	3514.00	10.2
12	Wayanad	3071.70	3250.90	-5.5
13	Kannur	3690.10	3318.30	11.2
14	Kasargode	3675.00	3619.70	1.5
	STATE AVERAGE	3132.30	2936.70	6.7

Source: Agricultural Statistics 2014-15, DES

Geographical Details

Geographically, Kerala roughly divides into three climatically distinct regions. These include the eastern high lands, the central midlands and the western low lands. Located at the extreme southern tip of the Indian sub continent, Kerala lies near the centre of the Indian tectonic plate (the Indian Plate); as such most of the state (notwithstanding isolated regions) is subject to comparatively little seismic or volcanic activity. Geologically pre-Cambrian & Pleistocene formations comprise the bulk of Kerala's terrain. Kerala is subjected to humid tropical wet climate which is mostly experienced by Earth's rainforests. The extreme eastern side experiences drier tropical wet climate, with an average annual rainfall of 2924 mm, whereas the low lands averages only 1250 mm of rainfall annually. The eastern high lands comprise the states wettest region receiving an excess of 5,000 mm rainfall annually. So the State experience some 120 to 140 rainy days every year. The south west monsoon starts from June and continues till September. Kerala gets most of its rain from seasonal monsoons. The maximum temperature throughout the year is around 36.7° C. The milky cold and pleasant weather can be experienced at its best in December and January. The climate is humid and hot during April to June, which is the period through which summer extends itself.

Kerala State experiences three distinct seasons they being, the South west monsoon (June to September), the North East monsoon (October-December) and the Pre monsoon (January-May) The pre monsoon season is generally dry and receives only scanty rainfall. The South West monsoon is the major rainfall contributor to the state, providing an average 43% of the annual rainfall in Southern Districts and 83% of annual rainfall in the northern districts. The North East provides about 33% of the annual rainfall in Southern districts and 9% of annual rainfall in the northern districts. The reliability of the expected rainfall in the South West Monsoon is about 96% while that of North East Monsoon is only about 40%. The hydrological year in the state begins on 1st June and ends on 31st May which based on the long period average data of onset of South West Monsoon.

Rain fall Details

Annual average rainfall data for the period 1.4.14 to 31.3.2015 is given below.

Period	Actual (mm)	Normal (mm)	Departure %
1.4.2014 to 31.3.2015	2936.7	3132.3	6.7%

Average rainfall data in different parts of the state during the year (ie. south west monsoon, North east monsoon, winter season, pre monsoon period mentioned separately) received from Director, Indian Meteorological Department, Thiruvananthapuram.

Ambient Air Quality Data

The Kerala State Pollution Control Board is monitoring ambient air quality at 30 locations in the State. The location fall under the categories of industrial, commercial, residential and sensitive. Of the 30 stations 24 come under National Ambient Air Quality Monitoring Programme (NAMP) and 6 under State Ambient Air Quality Monitoring Programme (SAMP). Sulphur dioxide, Nitrogen Oxides and Respirable Suspended Particulate Matter (below 10 micron size) (RSPM) are monitored regularly. Ambient air monitoring is conducted 24 hours a day for 2 days every week at each station. Sulphur dioxide (SO₂) and Nitrogen oxides (NO_x) are monitored at four hour interval and Respirable Suspended Particulate Matter (RSPM) at eight hour interval. Monitoring of remaining parameters under NAAQS is in the implementation level. The monitoring and method of analysis are according to the National Ambient Air Quality Standards (NAAQS).

Table: 4.4 Air quality in important Cities in Kerala

SI.No.	District	Annual Average mg/m ³					
		So 2	Air quality	NOX	Air quality	PM10	Air quality
1	Thiruvananthapuram	3	L	13	L	38	M
2	Kollam	2	L	8	L	46	M
3	Kochi	2	L	14	L	33	M
4	Thrisur	2	L	5	L	30	L
5	Malappuram	10	L	23	M	58	M
6	Kozhikkodu	4	L	20	L	53	M
SO ₂ Sulphur Dioxide, NO _x Nitrogen Dioxide PM10 Particulate Matter having an aerodynamic diameter L- Low; M- Medium							

Source: Kerala State Pollution Control Board

Table : 4.5 Ambient Air Quality Data 2015 - Annual Average

Sl. No.	District	Monitoring Location	Sulphur Dioxide $\mu\text{g}/\text{m}^3$ (50 $\mu\text{g}/\text{m}^3$, max)	Nitrogen Dioxide $\mu\text{g}/\text{m}^3$ (40 $\mu\text{g}/\text{m}^3$, max)	Respirable Suspended Particulate Matter $\mu\text{g}/\text{m}^3$ (60 $\mu\text{g}/\text{m}^3$, max)	Category
1	Thiruvananthapuram	Filatex, Veli	7.35	25.04	53	Industrial
		SMV School, Over Bridge	7.82	26.14	56	Sensitive
		Cosmopolitan Hospital, Murinjapalam	7.32	25.59	55	Sensitive
		Pettah Station	7.35	25.04	53	Residential
2	Kollam	Kadappakada Station	4.46	10.03	47	Residential & Others
		KMML, Chavara	5.52	10.12	44	Industrial
3	Pathanamthitta	Makkankunnu	2.00	13.68	24	Residential & Others
4	Alappuzha	DC Mills, Pathirappally	2.00	4.5	47	Industrial
		Thodankulangara	2	4.5	43	Industrial
5	Kottayam	Nagambadam	5.24	21.42	60	Residential & Others
		Vadavathur	5.24	21.42	60	Industrial
6	Idukki	Thodupuzha	2.00	4.50	29	Residential & Others
7	Ernakulam	Eloor Methanam	2.00	20.1	35	Residential
		Eloor TCC	2.00	21.19	45	Industrial
		South Overbridge	2.75	9.06	46	Residential & Others
		Vyttila	3.09	9.43	41	Residential Rural & Others

		Irumpanam	2.66	5.98	25	Industrial
		Kalamassery	2.94	7.92	43	Industrial
		M.G.Road	3.09	6.51	48	Residential & Others
		Kuttipadam	3	7.2	45	Residential & Others
8	Thrissur	Poomkunnam	2.00	8.01	50	Residential & Others
9	Palakkad	Kanjikkode	2.00	7.57	47	Industrial
10	Malappuram	Kakkancherry	2.00	13.46	43	Industrial
11	Kozhikode	Kozhikode City	2.00	24.1	56	Residential & Others
		Nallalam	2.00	17.9	41	Industrial
12	Wayanadu	Sulthan Batheri	2.00	4.50	37	Sensitive
13	Kannur	Kannur	2.00	4.55	63	Residential Rural & Others
		Mangattuparambu	2.80	4.50	40	Residential Rural & Others
14	Kasaragod	Kasargod	2.06	5.48	31	Residential Rural & Others
		Kanhangadu	2.05	6.99	38	Residential Rural & Others

Source: Kerala State Pollution Control Board, Water & Air Quality Directory 2015,

Table : 4.6 Ambient Air Quality Standards in Respect of Noise

SI.No.	Category Area	Limit in dB(A) Leq	
		Day time	Night time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence zone	50	40

Source: Kerala State Pollution Control Board

Note:

1. Day time is reckoned from 6 A.M to 10 P.M.
2. Night time is reckoned from 10 P.M to 6 A.M.
3. Silence zone is referred as areas within 100 meters around premises such as hospitals, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.
4. Use of Vehicle horns, loudspeakers and bursting of crackers shall be banned in these zones.

Table:4.7 Effects of Noise Pollution in Human Health

A. Noise Hazards		B. Noise Nuisances	
Stage I	Stage II	Stage III	Stage IV
Threat to survival	Causing injury	Curbing Efficient Performance	Diluting comfort and enjoyment
(a) Communication interference	(a) Neural-humoral stress response	(a) Mental Stress	(a) Invasion of privacy
(b) Permanent hearing loss	(b) Temporary hearing loss	(b) Task Interference	(b) Disruption of social Interaction
	(c) Permanent hearing loss	(c) Sleep interference	(c) Hearing Loss

Source: Kerala State Pollution Control Board

Table:4.8 The detail of Indian standards for maximum permissible limits for industrial effluent discharges

Sl. No.	Parameter	Into Inland Surface Waters Indian Standards 2490 (1974)	Into Public Sewers Indian Standards: 3306 (1974)	On land for Irrigation Indian Standards: 3307 (1974)	Marine Coastal Area
1	2	3	4	5	6
1	pH	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.1
2	Biological oxygen demand (for 5 days at 20oC)	30	350	100	100
3	Chemical oxygen demand	250	-	-	250
4	Suspended solids	100	600	200	
5	Total dissolved solids (inorganic)	2100	2100	2100	-
6	Temperature (°C)	40	45	-	45
7	Oil and grease	10	20	10	20
8	Phenolic Compounds	1	5	-	5
9	Cyanides	0.2	2	0.2	0.2
10	Sulphides	2	-	-	5
11	Fluorides	2	15	-	15
12	Total residual chlorine	1	-	-	1
13	Pesticides	-	-	-	-
14	Arsenic	0.2	0.2	0.2	0.2
15	Cadmium	2	1	-	2
16	Chromium (hexavalent)	0.1	2	-	1
17	Copper	3	3	-	3
18	Lead	0.1	1	-	1
19	Mercury	0.01	0.01	-	0.01
20	Nickel	3	3	-	5
21	Selenium	0.05	0.05	-	0.05
22	Zinc	5	15	-	15
23	Chlorides	1000	1000	600	-
24	Boron	2	2	2	-
25	Sulphates	1000	1000	1000	-
26	Sodium (%)	-	60	60	-
27	Ammoniacal nitrogen	50	50	-	50
28	Radioactive materials				
29	Alpha emitters (milli curie/millilitre)	10^{-7}	10^{-7}	10^{-8}	10^{-7}
30	Beta emitters (μ curie/millilitre)	10^{-6}	10^{-6}	10^{-7}	10^{-6}

Source: Compendium of Environment Statistics India 2015

Table:4.9 Average Gaseous composition of Dry air in the Troposphere

Sl. No.	Gas	Percent by volume (%)	Parts per million (ppm)
1.	Nitrogen	78.080000	780840.00
2.	Oxygen	20.946000	209460.00
3.	Argon	0.934000	9340.00
4.	Carbon dioxide	0.039000	390.00
5.	Neon	0.001818	18.18
6.	Helium	0.000524	5.24
7.	Methane	0.000179	1.79
8.	Krypton	0.000114	1.14
9.	Hydrogen	0.000055	0.55
10.	Xenon	0.000009	0.09
11.	Ozone	Variable	-0.001.03 (variable)

Source: Compendium of Environment Statistics 2015 India

Rapidly increasing industrialization, urbanization, population, growth and demand for transportation along with meteorological conditions influence air pollution in many Indian cities. In general combustion is the chief contributor to outdoor air pollution. In most cities, the major source of combustion is fuel use, which tends to increase along with the population size and economic activity.

The air breathe can become contaminated with pollutants viz. Sulphur dioxide (SO₂), oxides of Nitrogen (NO_x), Carbon monoxide (CO), Ozone (O₃) and particulate matter form various natural and manmade sources. In recent years, the focus of ambient air quality largely includes not only criteria air pollutants, but also other toxic air pollutants.

Particulate Pollutants

Particulate matter (PM) is a complex mixture of suspended solid and liquid particle in semi equilibrium. The particles constituents vary greatly in size, composition, concentration, depending on origin and age. The size distributions of airborne particles are important for health impact. The particles larger than 10µm in diameter are deposited almost exclusively in the nose and throat whereas those smaller than 1µm reach the lower regions of the lung. The intermediate size range gets deposited between these two extremes of the respiratory tract. Outdoor (ambient) PM size ranges from approximately 0.001-100 µm in aerodynamic diameter. PM is considered as the single best indicator of potential harm. There are two main size categories for PM measured in ambient air.

Environment Protection Rules Schl: 38

i. Implementation of the following Pollution Control Measures:

- a) Dust containment cum suppression system of the equipment.
- b) Construction of wind breaking walls
- c) Construction of metalled roads within the premises
- d) Regular cleaning and wetting of the ground within the premises.
- e) Growing of a green belt along the periphery.

ii) Quantitative standards for the SPM:

The suspended particulate matter contribution value at a distance of 40 meters from a controlled isolated as well as from a unit located should be less than 600 mg NM³. The measurements are to be conducted at least twice a month for all the 12 months in a year.

Table:4.10 Summaries of Health Effects of Basic Air Pollutant

Pollutant	Health Effects
Carbon Monoxide	Poor reflexes
	Ringing in the ears
	Headache
	Dizziness
	Nausea
	Breathing difficulties
	Drowsiness
	Reduced work capacity
	Comatose State(can lead to death)
Lead (Pb)	Kidney damage
	Reproductive system damage
	Nervous system damage (including brain dysfunction and altered neuro physical behaviours)
Oxides of Nitrogen (NO ₂)	Increased risk of viral infections
	Lung irritation (including pulmonary fibrosis and emphysema)
	Higher respiratory illness rates
	Airway resistance
	Chest tightness and discomfort
	Eye burning
	Head ache
Ozone (O ₃)	Respiratory system damage(lun damage from free radicals)
	Reduces mental activity
	Damage to cell lining(especially in nasal passage)
	Reduces effectiveness of the immune system
	Headache
	Eye irritation
	Chest discomfort
	Breathing difficulties
	Chronic lung diseases (including asthma and emphysema)
Nausea	
Sulphur dioxide (SO ₂)	Aggravates heart and lung diseases
	Increase the risk for respiratory illness (including chronic bronchitis, asthma, pulmonary emphysema)
	Cancer(may not show for decades after exposure)
Respirable Particulate matter (PM 10)	Respiratory illness (including chronic bronchitis increased asthma attacks, pulmonary emphysema)
	Aggravates heart disease

Source: Kerala State Pollution Control Board

Table:4.11 Category-wise Growth of Motor vehicles in Kerala 2014-15

Sl. No.	Type of vehicles	2010-11	2011-12	2012-13	2013-14	2014-15
1	Goods Vehicles					
	Four wheelers and above	294395	322450	354296	373218	411347
	Three wheelers including tempos	117266	128452	206901	140278	154610
2.	Buses					
	Stage carriages	19897	21457	34161	28386	31286
	Contract carriages/ Omni	119150	124290	137731	132144	145645
3.	Cars and station wagons					
	Cars	1060861	1226691	1358728	1538246	1702926
	Station wagons					
	Taxis	163407	175638	128250	194358	214214
	Jeep	73700	73700	74167	73700	73700
4.	Three wheelers					
	Auto rickshaws	518741	575763	602547	663241	730999
	Motorised Rickshaws	61	0	0	0	0
5.	Two wheelers					
	Motorised cycles	1017	0	0	0	0
	Scooters/ Motor cycles	3610838	4127227	5041495	5288529	5828816
6.	Tractors	12224	13740	14183	15030	15297
7.	Tillers	5335	5399	5399	5414	5967
8.	Trailers	2324	2407	2744	2411	2657
9	Others	46106	68325	88071	93011	103781
	TOTAL	6045322	6865539	8048673	8547966	9421245

Source: Transport Commissionerate

Table:4.12 Newly Registered Motor Vehicles in Kerala 2014-15

Sl. No.	Classification of Vehicles	TVM	KLM	PTA	ALP	KTM	IDK	EKM	TSR	PKD	MLP	KZD	WYD	KNR	KSD	NS	TOTAL
1.	Multiaxiled Articulated Vehicles	25	7	0	7	16	9	37	0	11	25	9	2	7	5	0	160
2.	Trucks & Lorries	544	372	37	367	392	299	559	347	444	419	307	90	150	132	0	4459
3.	Four Wheelers	1360	863	578	661	813	214	1427	1086	974	1269	1128	282	1336	588	0	12579
4.	Three Wheelers	698	367	228	314	203	91	946	459	340	785	380	115	573	266	0	5765
5.	Stage Carriage	42	46	43	46	69	24	84	78	70	101	73	26	97	47	24 9	1095
6.	Contract Carriage	422	165	366	197	290	80	631	397	381	416	124	29	104	64	0	3666
7.	Private Service Vehicles	61	34	14	6	15	13	30	10	5	13	6	1	10	5	0	223
8.	Other Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	Motor Cabs	1289	719	671	861	1197	220	1568	1096	582	1126	603	224	439	301	0	10896
10.	Maxi Cabs/Taxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.	Other Taxi	25	11	7	16	23	6	47	14	11	34	10	16	23	13	0	256
12.	LMV 3 Seater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.	LMV 4 to 6 Seater	3698	1798	1179	1678	1769	569	5399	1697	1426	2365	1665	669	2135	1724	0	27771
14.	Motor Cycle Hire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.	Other Transport Vehicles	73	45	13	48	26	17	75	47	21	25	41	20	12	15	0	478

Sl. No.	Classification of Vehicles	TVM	KLM	PTA	ALP	KTM	IDK	EKM	TSR	PKD	MLP	KZD	WYD	KNR	KSD	NS	TOTAL
16.	Scoters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.	Mopeds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.	Motor Cycle including above & below 95cc	75180	57165	27629	41950	33886	10665	101745	51747	44349	65916	49350	8227	44344	13811	0	625964
19.	Cars	21705	11055	5046	10123	14176	4215	24593	11963	11181	15857	18070	2536	14328	9886	0	174734
20.	Jeeps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.	Omni Buses	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
22.	Tractors	6	6	2	14	38	9	16	41	23	52	11	13	23	14	0	268
23.	Trailors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.	Others	111	244	221	291	440	131	592	460	387	446	488	245	508	398	0	4962
	GRAND TOTAL	105239	72897	36034	56579	53353	16562	137752	69442	60205	88849	72265	12495	64089	27269	249	873279

Source: Kerala State Transport Commissionerate

Table:4.13 No. of Motor vehicles having valid Registration in Kerala 2014-15

Sl. No.	District	Good Vehicles		Buses		Four wheelers			Three Wheelers	Two Wheelers	Tractors / Trailors				Total
		Four Wheelers & above	Three wheelers including tempos	Stage Carriages	Contract carriages/ Omni buses	Cars	Taxis	Jeeps	Auto rickshaws	Scooter / Motor cycles	Tractors	Tillers	Trailers	Others	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Thiruvananthapuram	32817	14618	12141	8062	198766	32466	8115	75882	766635	634	246	146	25119	1175647
2	Kollam	24996	6344	1022	3463	103195	15889	3115	40875	460477	136	65	46	2273	661896
3	Alappuzha	14282	1363	1042	2217	56959	2427	2456	20397	263659	279	89	13	10415	375598
4	Pathanamthitta	25488	11802	1053	8613	61193	13191	3225	51491	438587	1176	414	120	2344	618697
5	Kottayam	31010	12263	1793	14565	84588	19996	5756	80149	353944	524	609	226	698	606121
6	Idukki	10399	2990	457	1334	24508	3792	11789	26035	125620	1276	222	156	4206	212784
7	Ernakulam	76846	19686	2793	22943	320960	36753	7256	96887	1004536	1380	151	408	27373	1617972
8	Thrissur	36656	15682	2156	14231	191270	24536	4612	74093	621106	829	846	368	1059	987444
9	Palakkad	29536	12424	1290	3903	86633	9103	3210	69300	426320	3000	1384	276	1517	647896
10	Malappuram	38298	33254	2335	36061	160835	25869	5454	64574	427459	1778	523	152	18370	814962
11	Kozhikkode	34514	9716	2002	5072	209549	3894	5015	51821	510286	1339	16	111	1434	834769
12	Wayanad	5744	2015	533	576	26532	4132	4116	6765	74163	1135	345	28	3008	129092
13	Kannur	39700	10203	2142	23525	113566	15920	5346	51037	242881	1038	330	249	6383	512320
14	Kasargod	11063	2249	527	1081	64371	6248	4235	21694	113144	769	174	112	380	226047
	Total	411349	154609	31286	145646	1702925	214216	73700	731000	5828817	15293	5414	2411	104579	9421245

Source: Economic Review 2015

Table:4.14 Complying Status of Grossly Polluting Industries

Sl. No.	Name and Address of Industry	Sector	Category of Industry	Date of commencement of Industry	Effluents recipient water body or lakes		Concerned recipient River		Effluent		BOD (Kg/day) and other pollution load		ETP status
					Name	Dist. From industry (km)	Name	Distance from the discharge point of recipient waterbody	Quality Compliance (Yes/No)	Quantity in KLD	Before treatment	After treatment	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Binani Zinc Ltd., Edayar, Ernakulam	PU	Zinc	1967	River Periyar	40 m	River Periyar	Discharge directly into river	Yes	550	pH SS Sulphate Cd Zinc Fluoride	8.5 55 550 0.11 2.75 8.25	OPRS
2	Indian Rare Earth Ltd., Eloor, Ernakulam	PU	Mineral Processing	1952	River Periyar	0.1 km	River Periyar	Discharge directly into river	Yes	4	pH SS COD Amm.N2 Phosphate Sulphide Zinc Flouride Lead	9 40 100 20 2 0.8 2 0.8 0.4	OPRNS
3	FACT Ltd., Udyogamandal, Eloor, Ernakulam	CU	Fertilizer	1966	River Periyar	300 m	River Periyar	Discharge directly into river	No	12000	pH SS Phosphate Sulphide Hex.Chr O & G Free Amm Amm Nitra Nitrate TKN As. V Fluoride CN	8 1200 60 1.2 120 48 900 120 1800 2.4 2.4 18 2.4	OPRNS
4	FACT Ltd.,	CU	Petrochemic	1990	River	200 m	River	Discharge	Yes	5040	BOD	151.2	OPRS

	Petrochemical Division, Udyogamandal P.O., Eloor, Ernakulam		al		Periyar		Periyar	directly into river			pH SS COD O & G Free NH3 Amm.NH3 TKN Nitrate Phenolic Compounds	8.5 151.2 1260 50.4 25.2 252 504 100.8 5.04	
5	Cochin Minerals & Rutilites Ltd., Edayar, Ernakulam	PU	Chemical	1992	River Periyar	500 m	River Periyar	Discharge directly into river	Yes	250	pH SS O & G HC Total Chr.	8.5 25 2.5 0.25 25 0.5	OPRS
6	Hindustan Insecticides, Eloor, Ernakulam	CU	Pesticides	1958	Kuzhikan dom thode	1750 m	River Periyar	Through Kuzhikandom thode	No	1024	pH SS TDS O & G SO2 Chlorine	9 102.4 2150.4 10.24 1024 1024	OPRNS RNS
7	Sudchemie (India) Pvt. Ltd., Edayar, Ernakulam	PU	Chemical	1969	River Periyar	10 m	River Periyar	Discharge directly into river	Yes	450	pH SS O & G Hex Chr Zinc Free NH3 Total Chr. Amm.N2	9 45 4.5 0.045 2.25 2.25 0.9 22.5	OPRS
8	Cochin Leathers Pvt. Ltd., IDA, Edayar, Muppathadom P.O., Ernakulam	PU	Tannery	1993	River Periyar	125 m	River Periyar	Discharge directly into river	Yes	43	BOD pH SS O & G Hex. Chr. Chloride Sulphide Total Chr.	1.29 8.5 4.3 0.43 0.0043 43 0.086 0.086	OPRS
9	TMS Leathers Pvt. Ltd., IDA,	PU	Tannery	2004	River Periyar	150 m	River Periyar	Discharge directly into	Yes	1010	BOD pH	3.03 9	OPRNS

	Edayar, Muppathadom P.O., Ernakulam						river				SS Hex. Chr. Sulphide O & G		10.1 0.0101 0.0101 1.01	
10	Sreesakthi Paper Mills Ltd., IDA, Edayar, Ekm.	PU	Pulp & Paper	1993	River Periyar	1 km	River Periyar	Discharge directly into river	No	10	BOD pH SS		0.3 9 1	OPRNS
11	Hindustan Organic Cemics Ltd., Ambalamugal, Ernakulam	CU	Petrochemical	1988	Chithrapuzha	>100m	Chithrapuzha River	Discharge directly into Chithrapuzha	Yes		BOD	41 2.8	9.6	OPRS
12	Cochi Refinery, Ambalamugal, Ernakulam	CU	Oil Refinery	1966	Chithrapuzha	>100m	Chithrapuzha River	Discharge directly into Chithrapuzha	Yes		BOD	24 21 03	20.43	OPRS
13	Gramox Paper and Boards, Puthuppady, Muvattupuzha, Ernakulam	PU	Pulp & Paper	1995		>100m	Kothamangalam River		Yes		BOD	12 3.5	23.92	OPRS
14	Nitta Gelatin India Pvt. Ltd., Kathikudam P.O., Koratty (via) Thrissur-680308.	PU	Ossein Manufacture	1979	Chalakydy River	0.5 km	Chalakydy River	0.5km	Yes	6290	BOD	15 72 5	151	OPRS
15	Sree Sakthi Paper Mills, Chalakydy Thrissur	PU	Duplex Board	1995	Chalakydy River	0.005 km	Chalakydy River	0.005km	No		BOD		292	OPRNS company has requested to give permission to discharge effluent to the river and they have proposed augmentation of existing ETP to achieve

														quality compliance.	
16	Sitaram Textiles, Thrissur.	CU	Bleaching and dyeing process stopped and hence no effluent generation												
17	Vaigai Threads (Former Madura coats Ltd)	PU	Polyster & Cotton finished thread		Perumbi thoode	0.25km	Chalaku dy River	3.5km	Yes	11.7	No process effluent as there is no dyeing and bleaching and effluent from floor washing and canteen treated in ETP and discharged satisfactorily.			OPRS	
18	United Breweries Limited, Kanjikode West P. O., Palakkad – 678623.	PU	Fermentation Industry	1970	Naraka mpilly River	500m	Kalpath y River, tributary of Bharath apuzha	5km		400	BOD	345.6	10.4		
19	United Spirits Limited, Former McDowell & Co. Ltd) Cherthala, Alapuzha	PU	Distillery		Vemban adu Lake	Banks of the lake	Vemban adu lake	Banks of lake	No	270	BOD	313.2	4.1	OPRNS	
20	Tata Tea Ltd., Munnar, Idukki	CU	Food & Vegetables	1964	No effluent discharge to water bodies. Entire effluent discharged is recycled.										OPRS
21	Hindustan News prints Ltd., Newsprint Nagar, Kottayam.	CU	Pulp & Paper	1983	Muvattu puzha River	2km	Muvattu puzha River	2km	Yes	38384	BOD	1013.3	1152	OPRS	
22	MRFLtd. Vadavathoor, Kottayam.	PU	Rubber Industry	1959	Meenan thara River	2km	Meenan thara River	2km	Yes	200	BOD	155	6	OPRS	
23	Canara Paper Mills Pvt. Ltd., Chethipuzha, Changanachery, Kottayam.	PU	Craft Paper	1985	Chethip uzha Canal	50m	Vemban at Kayal	8km	Yes	5	1.8	0.64.5		OPRS	
24	Kollam Dairy, Thevally, Kollam.	CP	Milk Processing	1986	Ashtam udy lake	0.01km					BOD	180	23.5	OPRS	

Source: Kerala State Pollution Control Board

Table:4.15 Pattern of Power Consumption and Revenue Collected during 2014-15

Sl. No.	Category Voltage	No. of consumers	% of consumers to total	Consumption (MU)	Consumption as % of total	Rervernue collected (lakh)	Revenue as % of total
1.	a Domestic Paying group	8972356	78.49	9365.78	50.83	317655.62	32.15
	b Non paying group	15591	0.14	1.48	0.01		
2	Commercial	1236628	10.82	2056.2	11.16	217238.4	21.99
3	Public lighting	4072	0.04	346.43	1.88	13781.34	1.39
4	Agriculture	461333	4.04	298.28	1.62	6044.41	0.61
5	Industrial LT & HT1	143766	1.26	2939.25	15.95	328619.96	33.26
6	General & Others	597130	5.22	2659.47	14.43	61956.13	6.27
7	Railway Traction	8		205.31	1.11	11310.21	1.14
8	Bulk supply	11		554.06	3.01	31328.5	3.17
	Total	11430895	100.00	18426.26	100	987934.57	100

Source: Economic Review 2015

Table:4.16 Districtwise Wind Power Installed Capacity (Mw)

Sl.No	District	2013-14	2014-15
1	Thiruvananthapuram		NIL
2	Kollam		
3	Pathanamthitta		
4	Alappuzha		
5	Kottayam		
6	Idukki	14.25MW	
7	Ernakulam		
8	Thrissur		
9	Palakkadu	20.625MW	
10	Malappuram		
11	Kozhikode		
12	Wayanadu		
13	Kannur		
14	Kasargod		

Source: ANERT

Table:4.17 Cumulative Achievement of Bio Gas Plant in Kerala 2015

Sl. No.	District	2014-15	
		*MNRE Scheme	State Scheme
1.	Thiruvananthapuram	13	103
2.	Kollam	7	187
3.	Pathanamthitta	22	219
4.	Alappuzha	20	301
5.	Kottayam	126	326
6.	Idukki	255	270
7.	Ernakulam	123	248
8.	Thrissur	147	167
9.	Malappuram	23	188
10.	Palakkad	59	89
11.	Kozhikkode	64	89
12.	Wayanad	93	67
13.	Kannur	47	144
14.	Kasargod	41	61
	TOTAL	1040	2459

Source: ANERT

*Ministry of New and Renewable Energy

Table:4.18 Energy Source in Kerala 2014-15

Sl. No.	Source of Energy	Installed Capacity (MW)
1	Hydel KSEBL	2024.15
2	Thermal KSEBL	159.96
3	Wind KSEBL	2.03
4	NTPC	359.60
5	Thermal IPP	198.93
6	Hydel Captive	33.00
7	Hydel IPP	25.16
8	Wind IPP	32.85
	Total	2835.68

Source: Economic Review 2015

Table:4.19 Details of Power availability (MU) 2014-15

Sl. No.	Source of Energy	Internet Generation (MU)
1	Hydel Generation	7134.00
2	KSEBL-Thermal Generation	207.70
3	Wind	1.06
4	Total Internet Generation	7342.76
5	Less: Auxillary Consumption	55.97
6	Power Purchase from CGSs	14996.00
7	Power Purchase from IPPs	1110.69
8	Total energy Availability	21928.81
9	Energy Requirement	21556.65
10	Surplus/Deflect	-369.17

Source: Economic Review 2015

Table:4.20 Transmission & Distribution Lines 2014-15

Sl. No.	Year	Transmission and Distribution Lines(KM)					LT
		220 KV	110 KV	66KV	33KV	22KV	
1	2013-14	2765	4260	2202	1719	53579	264117
2	2014-15	2801	4298	2203	1762	55386	268753

Source: Kerala State Electricity Board

Table:4.21 Generation of Power at different Station in MU 2014-15

Sl. No.	Station	2014-15
1.	Pallivasal	212
2.	Sengulam	151
3.	Neriamangalam	346
4.	Neriamangalam Extn	
5.	Panniyar	155
6.	Poringalkuthu	151
7.	Poringalkuthu LBE	107
8.	Sabarigiri	1225
9.	Sholayar	238
10.	Kuttiadi	738
11.	Kuttiadi Extn	
12.	Kuttiadi Addl. Extn	
13.	Kuttiadi Tail Race	8
14.	Idukki	2493
15.	Idamalayar	373
16.	Kallada	69
17.	Kanjikode Wind Farm	-
18.	Peppara	5
19.	Lower Periyar	578
20.	Mattupetty	4
21.	Kakkad	193
22.	Malampuzha	5
23.	Urumi I & II	13
24.	Chempukadavu I & II	11
25.	Malankara	34
26.	Lower Meenmutty	5
27.	Poozhithode	11
28.	Ranni – Perinadu	7
29.	Vilangadu	0
30.	Peechi	2

Source: Kerala State Electricity Board

Table:4.22 Category wise Sale of Energy in Kerala

Sl. No.	Category	2014-15
1.	Domestic	9364.9
2.	Commercial	2976.37
3.	Industrial LT	1342.07
4.	Industrial HT & EHT	3320.79
5.	Public Lighting	358.41
6.	Agriculture	310.3
7.	Railways	205.31
8.	Licencee	554.11
9.	Export	358.09
	TOTAL	18790.35

Source: Kerala State Electricity Board

Table:4.23 Electricity Generating Capacity of Kerala (MW)

Sl. No.	Sector	Generating capacity				
		2010-11	2011-12	2012-13	2013-14	2014-15
1	Public (State)	2234.43	2245.40	2244.30	2245.23	2186.14
2	Public (Central)	359.60	359.60	359.60	359.60	359.60
3	Private	263.58	574.78	274.78	286.89	289.94
	Total	2857.60	2879.80	2878.70	2891.72	2835.68

Source: Kerala State Electricity Board

Table:4.24 Electricity Generating Capacity of Kerala (MU)

Sl. No.	Sector	Generating capacity				
		2010-11	2011-12	2012-13	2013-14	2014-15
1	Public (State)	7371.85	8303.45	5348.14	8177.94	8113.52
2	Public (Central)	1008.23	486.36	1517.6	947.15	2158
3	Private	385.06	221.78	274.62	514.61	1563.87

Source: Kerala State Electricity Board

Table:4.25 Generating Capacity, Maximum Demand and Load Factor

Sl.No	Year	Installed Capacity	Energy input to system excl.aux.cons. & ext.losses (Gen+Purchases- Export) (MU)	Maximum demand (MW)	Load factor (%)
1.	1991-92	1477.00	7153.62	1308.80	62.39
2.	1992-93	1477.00	7219.79	1403.00	58.74
3.	1993-94	1484.00	7809.17	1459.60	61.08
4.	1994-95	1503.53	8794.39	1614.60	62.18
5.	1995-96	1505.30	9274.07	1651.40	64.11
6.	1996-97	1508.53	8771.25	1572.00	63.69
7.	1997-98	1775.81	9394.67	1785.80	60.05
8.	1998-99	2046.33	11164.61	1896.20	67.21
9.	1999-00	2350.71	11880.98	2177.00	62.30
10.	2000-01	2422.61	12464.00	2316.00	61.43
11.	2001-02	2605.91	12518.31	2333.00	61.25
12.	2002-03	2608.71	12391.13	2347.00	60.27
13.	2003-04	2621.31	12280.87	2426.00	57.79
14.	2004-05	2623.86	12504.84	2420.00	58.99
15.	2005-06	2650.41	13331.03	2578.00	59.03
16.	2006-07	2662.96	14427.96	2742.00	60.07
17.	2007-08	2676.66	15065.15	2745.00	62.65
18.	2008-09	2744.76	15293.41	2765.00	63.14
19.	2009-10	2752.96	16982.29	2998.00	64.66
20.	2010-11	2869.56	17340.28	3119.00	63.47
21.	2011-12	2878.36	18938.81	3348.00	64.57
22.	2012-13	2880.22	19877.16	3268.00	69.43
23.	2013-14	2891.72	20525.16	3588.00	65.30
24.	2014-15	2835.63	21573.16	3602.00	68.37

Source: Kerala State Electricity Board

CHAPTER - V

LAND AND SOIL

Land is degraded when it suffers a loss of intrinsic qualities, decline in its capabilities or loss in its productive capacity. Land degradation may be due to natural or human causes or it may be due to combination of both. Considering the characteristics of soil, drainage/wetness, erosion, runoff etc., Kerala has 18 land capability subclass associations of five broad land capability (LC) classes (KSLUB, 1995 and 2002). The broad LC classes are Class II (Good cultivable land), Class III (Moderately good cultivable land), Class IV (Fairly good cultivable lands), Class VI (Well suited for forestry or grazing), and Class VIII (Land suited only for wildlife and recreation). The soil of Kerala has limitations for sustained use under irrigation. Only about 37% of the area of Kerala is suitable for irrigation with certain limitations.

Land Use Patterns

The total geographical area of the State has been classified according to thirteen different uses of land during 2014-15. The net area under cultivation during the year 2014-15 was 2042881 Ha. which occupies 52.57 % of the total area in the State. Out of 38,86,287 Ha of total geographical area, 20,42,881 Ha of land constituting 52.57% is cultivated atleast once with various crops during the year 2014-15 showing a slight increase of 0.39% in net area sown from the previous year.

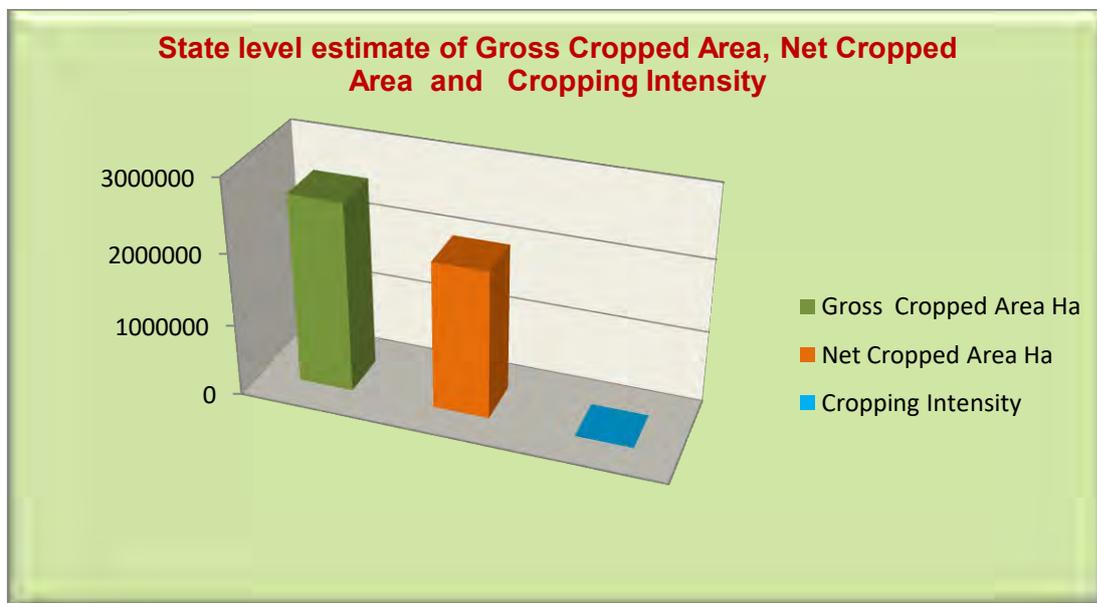


Table:5.1 State level estimate of Gross Cropped Area, Net Cropped Area and Cropping Intensity (2001-02 to 2014-15)

Sl. No.	Year	Gross Cropped Area Ha	Net Cropped Area Ha	Cropping Intensity
1.	2001-02	2992252	2190690	136.59
2.	2002-03	2970384	2188537	135.72
3.	2003-04	2954454	2189940	134.91
4.	2004-05	2994666	2154885	138.97
5.	2005-06	2982454	2132483	139.86
6.	2006-07	2913873	2101431	138.66
7.	2007-08	2758740	2089029	132.06
8.	2008-09	2694943	2088955	129.01
9.	2009-10	2668678	2078715	128.38
10.	2010-11	2647461	2071507	127.74
11.	2011-12	2661757	2040132	130.47
12.	2012-13	2591734	2048109	126.54
13.	2013-14	2616670	2050994	127.58
14.	2014-15	2624624	2042881	128.48

Source: Agricultural Statistics 2014-15, DES

Table:5.2 Classification of Area on the Basis of Land Utilisation 2014-15

(Area in Ha.)

Classification	Thiruvananthapuram	Kollam	Pathanamthitta	Alappuzha	Kottayam	Idukki	Ernakulam	Thrissur	Palakkad	Malappuram	Kozhikkodu	Wayanad	Kannur	Kasargodu	State
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Geographical Area	218781	248788	265277	141011	220442	436328	305826	302919	447584	355446	234641	212966	297112	199166	3886287
Forests	49861	81438	155214	0	8141	198413	70617	103619	136257	103417	41386	78787	48734	5625	1081509
Land put to an agricultural use	31887	27832	16647	23198	27739	13328	42491	37874	46010	50126	31039	11135	34452	25370	409128
Barren and Uncultivable land	206	140	162	9	1184	1606	325	151	1912	944	766	59	1896	3592	12952
Permanent pastures and Other Grazing Land	0	0	0	0	0	0	0	2	1	2	0	0	0	0	5
Land under Tree Miscellaneous Tree Crops	16	56	90	78	155	170	208	176	884	182	108	33	188	309	2653

Cultivable Waste	412	2537	1901	16421	6569	2359	12118	9063	23764	6157	2520	1030	7380	8445	100676
Fallow Land Other than Current Fallow	744	1715	2987	3190	2610	1256	7313	7699	15486	4835	1502	684	3177	1543	54741
Current Fallow	2869	4381	3575	3120	5722	1578	9013	7753	10819	6691	1897	2123	3721	2067	65329
Marshy Land	6	4	0	34	0	0	6	0	0	0	5	0	95	0	150
Still water	4342	6593	2698	12457	6360	10480	11090	6300	15340	6148	3933	3904	6472	4336	100453
Water logged Area	88	937	165	332	159	0	298	318	0	63	382	13	372	21	3148
Social Forestry	60	95	118	39	110	1140	105	147	379	198	34	59	73	105	2662
Net area sown	128290	123060	81720	82133	161693	205998	152242	129817	196732	176683	151069	115139	190552	147753	2042881
Area sown more than once	34458	28186	21624	21002	40730	66044	14219	44980	103890	64047	50925	56201	147753	4879	581743
Total Cropped Area	162748	151246	103344	103135	202423	272042	166461	174797	300622	240730	201994	171340	221110	152632	2624624

Source : Agricultural Statistics 2014-15, DES

Table:5.3 Net Area Irrigated Source wise 2014-15

Unit - Hectare

Sl. No.	District	Small stream (Thode/ Canal)		Pond		Well		Borewell/ Tubewell	Lift & Minor Irrigation	From River & Lake				Other Sources	Grand Total
		Govt	Private	Govt	Private	Govt	Private			Pump	Wheel	Other Methods	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Thiruvananthapuram	3810	177	483	9	0	2736	89	0	0	0	3	3	382	7689
2	Kollam	946	0	9	60	20	2783	47	2	0	0	0	0	624	4491
3	Pathanamthitta	2969	12	92	12	0	2218	2	0	0	0	0	0	4	5309
4	Alappuzha	5284	0	0	462	1	976	6125	0	5416	0	21697	27113	63	40024
5	Kottayam	0	0	0	173	0	1774	39	87	0	0	10245	10245	638	12956
6	Idukki	1317	84	10	16432	2	6613	2855	3	52	0	7552	7604	7175	42095
7	Ernakulam	8625	57	148	1611	149	6658	581	3647	894	0	311	1205	452	23133
8	Thrissur	15670	194	148	3475	18	33218	960	1076	464	0	4763	5227	2647	62633
9	Palakkad	41902	265	369	4632	41	14868	8585	288	9654	0	1921	11575	8402	90927
10	Malappuram	2726	156	250	4411	126	17981	1088	1505	1201	0	1377	2578	1936	32757
11	Kozhikkode	1105	69	3	380	1	2518	53	0	141	0	4	145	639	4913
12	Wayanad	0	0	4	27	1	269	0	203	116	0	0	116	14584	15204
13	Kannur	585	155	9	1615	1	8717	443	191	231	0	342	573	2655	14944
14	Kasargode	715	80	57	12214	57	31675	8806	80	2785	0	211	2996	527	57207
	STATE	85654	1249	1582	45513	417	133004	29673	7082	20954	0	48426	69380	40728	414282

Source : Agricultural Statistics 2014-15, DES

Table:5.4 Gross Area Under Irrigation (Crop wise) 2014-15

Sl. No.	District	Paddy				Vegetables	Coconut	Arecanut	Cloves	Nutmeg	Banana	Betel Leaves	Sugar cane	Other Crops	Total
		Autumn	Winter	Summer	Total										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Thiruvananthapuram	963	1064	66	2093	1312	2198	2	0	9	2329	15	0	2039	9997
2	Kollam	31	709	1	741	1201	443	14	0	38	857	23	0	520	3837
3	Pathanamthitta	31	467	2084	2582	999	898	24	12	495	1641	36	5	161	6853
4	Alappuzha	10269	4184	18643	33096	1519	6633	3	0	106	432	31	55	1231	43106
5	Kottayam	5033	2890	9346	17269	1603	48	2	108	1698	751	2	10	7	21498
6	Idukki	89	575	33	697	5637	635	83	52	1381	1357	0	1069	275	11186
7	Ernakulam	666	2923	390	3979	2210	10392	1066	5	6095	3890	5	0	2681	30323
8	Thrissur	39	13110	8051	21200	1172	41255	4398	7	6826	2267	3	0	3455	80583
9	Palakkad	4032	42596	2695	49323	3323	25489	3257	2	214	17213	4	372	10911	110108
10	Malappuram	0	4229	1940	6169	1764	20059	5395	5	265	5361	171	0	2032	41221
11	Kozhikkode	1	53	543	597	740	2755	335	0	72	1758	9	0	148	6414
12	Wayanad	0	8651	1039	9690	1085	49	58	0	1	7095	0	0	19	17997
13	Kannur	0	2217	11	2228	1281	12556	1692	0	82	2257	9	3	400	20508
14	Kasargod	0	740	296	1036	626	41804	17356	32	141	656	15	1	4349	66016
STATE		21154	84408	45138	150700	24472	165214	33685	223	17423	47864	323	1515	28228	469647

Source : Agricultural Statistics 2014-15, DES

Table:5.5 Area & Production of Important Crops in Kerala 2014-15

Sl. No.	Crops	Area (Ha)			Production (Tonnes)		
		2001-02	2014-15	% Variation	2001-02	2014-15	% Variation
1	Paddy!!	322368	198159	-39	703504	562092	-20
2	Tapioca	111189	75493	-32	2455880	2943919	20
3	Coconut*	905718	793856	-12	5479	5947	9
4	Pepper	203956	85431	-58	58240	40690	-30
5	Cashew	89718	45436	-49	65867	29715	-55
6	Rubber	475039	549955	16	580350	507700	-13
7	Groundnut	2437	480	-80	1812	692	-62
8	Sesamum	878	262	-70	284	89	-69
9	Cotton#	3760	170	-95	6069	279	-95
10	Pulses	8191	3601	-56	6281	3409	-46
11	Ginger(Dry)	10706	4800	-55	40181	22989	-43
12	Turmeric	3558	2470	-31	7895	6820	-14
13	Banana	50871	61936	22	345903	545431	58
14	Tobaco	71	13	-82	395	21	-95
15	Total Cereals	329875	198508	-40	708624	564294	-20
16	Arecanut*	93193	96686	4	84681	125925	49
17	Coffee	84795	85359	1	66690	67700	2
18	Tea	36899	30205	-18	66090	65174	-1

Source: Agricultural Statistics 2014-15, DES

!! Paddy
* Production in million nuts
Production in bales of 170 kg

Plantation Crops

Plantation crop refers to those crops which are cultivated on an extensive scale in contiguous area, owned and managed by an individual or a company.

Table:5.6 Area, Production, Productivity of Plantation Crops 2014 -15

Area Ha.	2012-13		2013-14		2014-15
	Kerala	India	Kerala	India	Kerala
1	2	3	4	5	6
Tea #	30205	600000	30205	600000	30205
Coffee *	85359	400000	85359	400000	85359
Rubber ***	539565	700000	548225	700000	549955
Cardamom	41600	NA	39730	NA	39730
Production (MT)					
Tea #	62963	1000000	62937	1000000	65174
Coffee *	68175	300000	66645	300000	67700
Rubber ***	800050	900000	648220	900000	507700
Cardamom	10222	NA	14000	NA	16000
Productivity (Kg/Ha)					
Tea #	2085	1730	2084	1730	2158
Coffee *	799	766	781	766	793
Rubber ***	1481	1206	1182	1206	923
Cardamom	246	NA	352	NA	403

Source : Agricultural Statistics 2014-15

**Table:5.7 Chemical Fertilizers utilization Gross Cropped Area in Kerala
2002-03 to 2014-15**

Year	Nitrogen	Phosphorous	Pottash	Total		N:(P+K)%
				Kerala	India	
1	2	3	4	5	6	7
2002-03	29.18	13.53	26.19	68.90	86.00	73
2003-04	28.92	13.20	22.93	65.05	89.80	80
2004-05	29.87	14.14	24.2	68.21	98.34	78
2005-06	28.00	15.00	25.00	68.00	104.50	70
2006-07	31.00	16.00	43.00	89.00	113.26	53
2007-08	32.00	15.00	25.00	72.00	117.07	80
2008-09	38.00	19.00	32.00	89.00	NA	74
2009-10	39.00	20.00	32.00	91.00	NA	75
2010-11	40.00	24.00	33.00	97.00	NA	70
2011-12	44.00	22.00	32.00	98.00	NA	81
2012-13	47.00	24.00	35.00	106.00	NA	80
2013-14	53.00	27.00	45.00	125.00	NA	73
2014-15	40.00	16.00	24.00	80.00	NA	100

Source : Economic Review

Table:5.8 Soil Types in Kerala (District-Wise)

District	Type of Soil	Details of location
Thiruvananthapuram	<ul style="list-style-type: none"> Fairly rich brown loam of laterite Sandy loam Rich dark brown loam of granite origin 	<p>Middle part of the district</p> <p>Western coastal region</p> <p>Eastern hilly parts of the district</p>
Kollam	<ul style="list-style-type: none"> Sandy loam Laterite soil 	<p>Karunagappally and part of Kollam taluks</p> <p>Kottarakkara , Kunnathur and parts of Kollam and Pathanapuram taluks</p>
Pathanamthitta	<ul style="list-style-type: none"> Clay soil Laterite soil 	<p>Western and Eastern hilly regions</p> <p>Parts of Ranni and Kozhencheri taluks</p>
Alappuzha	<ul style="list-style-type: none"> Sandy loam Sandy soil Clay loam with much acidity Laterite soil 	<p>Karthikappally and parts of Mavelikkara taluks</p> <p>Cherthala & Ambalappuzha taluks Kuttanad</p> <p>Chengannur and parts of Mavelikkara taluks</p>
Kottayam	<ul style="list-style-type: none"> Laterite soil Alluvial soil 	<p>Parts of Changanacherry and Kottayam taluks and Kanjirappally and Meenachil taluks.</p> <p>Vaikom taluk and part of Changanacherry and Kottayam taluks</p>
Idukki	<ul style="list-style-type: none"> Laterite soil Alluvial soil 	<p>Peermade and Thodupuzha taluks</p> <p>Devicolam and Udumbanchola taluks</p>

Ernakulam	<ul style="list-style-type: none"> • Laterite soil • Sandy loam • Alluvial soil 	<p>Muvattupuzha, Kothamangalam and part of Aluva and Kunnathunad taluks</p> <p>Parur, Kochi and Kanayannur taluks</p> <p>Parts of Aluva and Kunnathunad taluks</p>
Thrissur	<ul style="list-style-type: none"> • Sandy loam • Laterite soil • Clayey soil • Alluvial soil 	<p>Part of Mukundapuram, Thrissur and Chavakkad taluks</p> <p>Eastern part of Thrissur and Western part of Thalappally taluks</p> <p>Back-water area of Chavakkad and Mukundapuram taluks</p> <p>Portions of Chavakkad taluk</p>
Palakkad	<ul style="list-style-type: none"> • Laterite soil • Black soil 	<p>Major part of the district</p> <p>North-Eastern part of Chittur taluk</p>
Malappuram	<ul style="list-style-type: none"> • Laterite soil • Sandy soil 	<p>Interior region of the district</p> <p>Along the costal belt of the district</p>
Kozhikode	<ul style="list-style-type: none"> • Laterite soil • Sandy soil 	<p>Major part of the district except coastal strip</p> <p>Coastal strip</p>
Wayanad	<ul style="list-style-type: none"> • Laterite soil • Loamy soil 	<p>Major part of the district</p> <p>Valleys in the middle portion of the district</p>
Kannur	<ul style="list-style-type: none"> • Laterite soil • Sandy soil 	<p>Major part of the district except coastal strip</p> <p>Coastal strip</p>
Kasaragod	<ul style="list-style-type: none"> • Laterite soil • Sandy soil 	<p>Major part of the district except coastal strip</p> <p>Coastal strip</p>

Source: Department of Agriculture

Mineral Based Industries in the State

Kerala State is endowed with a number of occurrences/deposits of minerals such as Heavy Mineral Sands (Ilmenite, Rutile, Zircon, Monazite, Sillimanite) ,Gold, Iron ore, Bauxite, Graphite, China Clay, Fire Clay, Tile and Brick Clay, Silica Sand, Lignite, Limestone, Limeshell, Dimension Stone (Granite), Gemstones, Magnesite, Steatite etc. However, mining activities on large scale are confined mainly to a few minerals - Heavy Mineral Sands, China Clay and to a lesser extent Limestone/Limeshell, Silica Sand and Granite. In fact, Heavy mineral sand and China Clay contribute more than 90% of the total value of mineral production in the State.

The State owns mineral deposits like placers, china clay (kaolin), limestone, limeshell, silica sand, bauxite, graphite, iron ore, granite etc. The major mineral based industries like Indian Rare Earths Ltd.; Kerala Minerals and Metals Ltd.; Malabar Cements; Travancore Cements Ltd.; Kundara Ceramics; English Indian Clays Ltd. (EICL); Excel Glass Industry; Kerala Clays and Ceramic Products Ltd. are some of the mineral based industries working in the State since several years. The resources of ornamental granites in the state are being exported to different countries.

Mining Lease in Kerala

There are 83 major mineral mines that are mined in the State. Also there are 3024 licensed minor mineral quarries in the state. Government gets revenue from minerals mainly by way of royalty. Revenue collected during the year 2012-13 is Rs.49.7 crore which is 12% higher than the previous year collection of Rs.44.3 crore. Total area covered by mining leases is 3314.52 ha.

Table:5.9 Production and Royalty of Minerals in Kerala- 2014-15

Sl. No.	Major Minerals	Production in Tonnes		Royalty (Rs.)	
		2012-13	2013-14	2012-13	2013-14
1.	China Clay	434121.88	904663	10853047	15379264
2.	Lime Stone	560828.95	455781	35332224	28714206
3.	Ilminite	128348.9	84247	26568222	25611098
4.	Silica Sand	88081.64	76890	12597104	12917482
5.	Limeshell	43470.97	37333	2738671	2351981
6.	Latrate	107683.96	190591	10445344	21917944
7.	Zircon	7919.35	3861	14832938	8340801
8.	Sillimanite	5161	8905	1424332	1896705
9.	Rutile	5236	2830	7707021	6632488
10.	Graphite	696	628	45240	36400
11.	Quatz	3488.37	1570	150000	67500
12.	Bauxite Ilmonite	483	49	584000	65574
	Minor Minerals				
		2012-13	2013-14	2012-13	2013-14
1	Granite(Building stone)	15227650.75	13973155	243642412	223570485
2	River sand	2629390.8	1893766	26293908	18937663
3	Ordinary sand	3187035.7	1914116	31870357	19141156
4	Laterite	2070631.5	2578368	33130104	412538889
5	Brick Clay	1515292.5	1243116	15152925	12431163
6	Lime shell	4804.66	7450	240233	469375
7	Granite(dimension stone (cubic mtrs)	1245.11	1219	4980445	4877084
8	Ordinary earth	880443	4827325	17608862	965464995

Source : Department of Mining & Geology

Individual Mineral Deposits Mineral Sand

The Heavy Mineral Sand deposits in Kerala contain an assemblage of Ilmenite, Rutile, Leucoxene, Monazite, Zircon and Sillimanite. The State possesses one of the world class deposits of mineral sands in the coastal tracts between Neendakara and Kayamkulam. This, commonly known as the Chavara deposit covers a total length of 22 km and a width of about 8 km in the northern side and 6 km in the southern side. The Chavara barrier beach portion contains concentration of heavy minerals above 60%. The Chavara deposit is estimated to contain 127 million tonnes of heavy minerals with ilmenite content of 80 million tonnes from the total reserve of raw sand of the order of 1400 million tonnes. In the northern portion beyond Kayamkulam Pozhi extending up to Thottappally in Alappuzha district, the total reserve of heavy minerals estimated to the order of 17 million tonnes with ilmenite content of 9 million tonnes from the raw sand of 242 million tonnes.

Chavara barrier beach with a width of 225 m is divided into 8 blocks numbered I to VIII for separating ilmenite for the manufacture of TiO₂. The blocks are apportioned between Kerala Minerals and Metals Ltd. (KMML), a State Government undertaking and Indian Rare Earths Ltd. (IRE), a Government of India enterprise under the Department of Atomic Energy. Apart from the Chavara heavy mineral deposits a number of heavy mineral placers have been delineated in different parts of the State.

Table:5.10 Heavy Mineral Deposits in Kerala

Sl. No.	Locality	Oxidised (million tonne)	% of Fe	Unoxidised (million tonne)	% of Fe	Total (million tonne)
1.	Eleyettimala	14.7	39.4	4.5	31.5	19.2
2.	Naduvallur	6.1	39.8	3.7	33.7	9.8
3.	Nanminda	4.3	41.2	-	-	4.3
4.	Cheruppa	3.2	35.5	7.5	31.7	10.7
5.	Alampara	9.0	35.6	26.2	35.2	35.2
6.	Korattimala	1.9	37.7	2.5	33.6	4.4

Bauxite

Bauxite occurs in close association with laterite all along the west coast of the State. Traces of bauxite are seen in almost all laterite cappings. But bauxite deposits of economic significance in south Kerala are a few and are located at Sooranad, Vadakkumuri, Chittavattom, and Adichanallur in Kollam district and Mangalapuram, Chilambil, Sasthavattom and Attipra areas of Thiruvananthapuram district. Geological Survey of India (GSI) and Mineral Exploration Corporation Ltd. (MECL) have conducted extensive studies of bauxite occurrence of Kasargod and Kannur districts in North Kerala during the period between 1968-'74 including geological mapping, pitting, drilling and sampling. Based on various investigations, the total bauxite reserves in the State are estimated at 12.5 million tonnes. The largest bauxite deposits are in Nileswaram with a reserve of 5.32 million tonnes.

China Clay

China Clay (Kaolin) consisting dominantly of kaolinite is one of the most sophisticated industrial minerals with a host of applications, viz., in ceramics, refractories, paper coating, filler for rubber, insecticides, cement, paint, textiles, fertilizers and others including abrasives, asbestos products, fibreglass, chemicals, cosmetics, pharmaceuticals, electrical ware, foundry and glass.

The Department of Mining and Geology through their past investigation campaigns in parts of Kerala, identified two major china clay zones viz., the southern china clay zone between Kundara and Thiruvananthapuram (Thiruvananthapuram and Kollam districts) and the northern china clay zone between Kannapuram Madayi - Cheruthazham in Kannur district to Nileswaram - Manjeshwaram in Kasargod district. Kerala china clay is one of the finest quality clay and is world class. In fact, Kaolin marketed by English Indian Clays Ltd. (EICL), Thiruvananthapuram claims to have similar or even better properties compared to imported clays. The paper coating grade china clay is produced by English Indian Clays Ltd., Thiruvananthapuram and Kerala Ceramics Ltd., Kundara. Ceramic grade high quality china clay is produced by Kerala Clays and Ceramic Products Ltd. (KCCP) from their mines at Kannapuram and Pazhayangadi, Kannur District and Pudukai, Kasargod District. Among the 25 working china clay mines in Kerala, 17 are in Thiruvananthapuram, 4 in Kollam, and 2 each in Kannur and in Kasargod districts, and these jointly produced 4,47,000 tonnes in 2000-'01 fiscal. Kerala has a prominent place in the refined clay map of the country, contributing about 58% of the national annual output. Being the largest producer of high grade processed china clay, the enormous export potential and relatively good infrastructure like ports, road and rail links, Kerala is yet to make a mark in the export of china clay.

Potential for China Clay Industries

The very large reserves of china clay, identified and proved by the Department, calls for new mining ventures and clay based industries. The Data Repository of the Department and Kerala Clay Data Book of Regional Research Laboratory, Thiruvananthapuram have adequate data and information on china clay in Kerala. Jointly these database provide most useful baseline data, like color, plasticity, tensile strength and particle size, to diverse users and industries.

Ball Clay

Ball clay is found to occur in certain areas in Kollam, Alappuzha, Ernakulam, Thrissur and Kannur districts. Though it does not conform to specification of ball clays, yet it is considered to be a good substitute. At present, there is no commercial production.

Fire Clay

The fire clay occurrences are in association with Tertiary sediments in the coastal land and the inferred reserve stands at 11.50 million tonnes. However, this resource is waiting to be exploited.

Tile and Brick Clay

The tile and brick clays are usually of low grade and red burning. The main requisites are that they should mould easily and burn hard at low temperature. There are about 400 tile factories and about 5000 brick kilns spread over the entire state to manufacture tile and bricks. The vast resources of alluvial clays in the paddy land and valley fill areas are used by this industry in the State. Clays available for the manufacture of tiles are mostly found in the districts of Thrissur, Kozhikode, Ernakulam, Kollam, Thiruvananthapuram, Kannur and Palakkad Districts. There are two main types of tile and brick clays in the State, lacustrine and floodplain. The former are confined to Kannur district. Clays are generally fine plastic to dull white to variegated colours and occur in the depressions in the laterite near Pattuvam, Alakode, Thaliparamambu etc. The flood plain deposits, which occur in the neighbourhood of rivers are found in a number of districts. Tile manufacturing units are concentrated in certain areas in the State mainly Feroke area of Kozhikode district, Amballur, Ollur of Thrissur district, Aluva of Ernakulam district, Chathannur of Kollam district and Amaravila of Thiruvananthapuram district.

Graphite

Graphite occurs in nature in the form of vein, dissemination (flaky) and amorphous variety. The first two types of occurrences are found in Kerala. The vein - type graphite mined earlier around Veli, Vellanad and Changa is confined only to the Thiruvananthapuram district. The flake type of graphite is extensive in occurrence in Thiruvananthapuram, Kollam, Kottayam, Idukki and Ernakulam districts which have been studied by Geological Survey of India and are quite akin to the celebrated flaky graphite mined in the Malagasy Republic. The graphite occurs as thin flakes distributed more or less evenly in the rock constituting on an average about 5% -10% of the bulk of the rock, although rich pockets are not uncommon. The studies in various laboratories in the country and abroad in respect of the bulk samples collected from the flaky graphite deposits of Vadakode, Nagapuzha (Muvattupuzha taluk, Ernakulam district) and Chirakkadavu (Kanjirappally taluk, Kottayam district) point to good beneficiation characteristics, a high recovery of fixed carbon (about 85%) and preservation of suitable flake size facilitating their use in key value added industrial application like crucible manufacture etc.

Table:5.11 Graphite Deposits in Kerala 2013-14

Sl. No.	Graphite	Nagapuzha	Vadakode	Chirakkadavu	Total
1.	Ore reserve (tonnes)	1059352	5050938	700000	6810920
2.	Grade (%c carbon)	7.3	5.0	3.0	-
3.	Recoverable graphite (tonnes)	43000	24000	16000	83800
4.	Concentrate grade (% carbon)	89	91	88	-
5.	Recovery	79	80	80	-

Silica Sand

The coastal tract between Alappuzha and Aroor in Alappuzha District contain extensive deposits of silica sand. The best deposits are confined to the narrow strip of land sandwiched on either side by Vembanad lake and stretching from Cherthala to Arookutti over a distance of about 35 km. Besides, there are also smaller deposits in other districts of Kerala. The sand deposit comprises of flat to gently dipping sandy stretches, generally about 5m above Mean Sea Level.

Vertical sequence

0-0.75 m below ground level	White sand mixed with soil
0.75-2.50 m below ground level	White sand
2.50-10.00 m below ground level	Brown sand

Reserves of Deposit Based on the recent appraisal carried out by the Department of Mining and Geology over the open area likely to be available for mining, the inferred reserve of silica sand in the villages are estimated as below:

Village	Approximate area in hectares	Reserve in million tones
Pallipuram	300	18.40
Thycattuserry	120	6.50
Panavally	50	3.50
Total	470	28.40

Quality of Sand

Investigation carried out at Regional Research Laboratory (RRL), Thiruvananthapuram have revealed that the silica sand of Pallipuram is superior compared to the sands of certain other countries (Mdina and Baraboo of USA and Germany) as raw material for silica refractory. Chemical analysis indicates that the sands are of high quality suitable for glass manufacturing. The brown sands occurring below the white sand in Varanad area have also shown that they are superior in quality to the white sand in the same area and are suitable for manufacture of glass. Varanad sand could be used for making high grade colourless glass such as crystal glass, table ware etc. The scope for beneficiation of the sand established its usefulness in optical and ophthalmic glass industry.

Lignite

Lignite, the only fuel mineral discovered recently in the State assumes special significance. Since no coal deposits have been identified and the landed cost of coal remains high, the possibility of substitution of coal and fire wood by lignite in the user industries would be worth pursuing. As per the recommendations of the task force on lignite constituted for Kerala, the

erstwhile Kerala Mineral Exploration & Development Project had carried out detailed investigation for lignite in Madai area, Kannur district.

Limestone

Crystalline Limestone

Kerala State is deficient in crystalline limestone and only a few bands of crystalline limestone in Palakkad and Idukki districts have been located in addition to the limestone deposit proved at Pandarathu, Walayar, Palakkad district. The Pandarathu limestone deposit (24 million tonnes) is now the captive mine producing limestone for M/s. Malabar Cements Ltd., the Portland cement plant in Kerala. A number of small bands have also been identified in other localities in Nattuvanki, Athurasram, Vannamadai, Thavalam in Palakkad district and in a few localities in Idukki district.

Kankar Limestone

Limestone of Kankar variety has been reported from Chittoor- Kozhinjampara area in Palakkad district. The economic significance of low-grade limestone has not been indicated by the studies conducted so far. The 16 km² area between Thavalam and near Anaiketty shows that kankar caps the amphibolite over 0.3 km².

Fossiliferous Limestone

Fossiliferous Limestone is known to occur in various parts of Kollam district such as Kallurkadavu, Mughathala, Kannanallur, Kottiyam, Mayyanad, Nedumgandam and Edava in Thiruvananthapuram district. The occurrence of shell limestone is in the form of discontinuous lenses intercalated with black carbonaceous clay in the Tertiary formations.

Lime Shell

The State is deficient in high-grade limestone. Consequently the requirement of lime for chemical industry is depended on the limeshell resources occurring in the backwaters/estuaries, river mouths and lagoons along the coastal tract. By far the largest reserves of lime shell are known to occur in Vembanad lake and adjoining portions comprising parts of Alappuzha, Ernakulam and Kottayam Districts. The Department of Mining and Geology by its detailed investigation in certain parts of Vembanad lake and adjoining areas have established a reserve of 3.29 million tonnes as shown the table:

Locality	Reserve in million tones
Vembanad Lake	2.50
Kualsekharamanagalam	0.18
Pallipuram	0.10
Vechoorpadam	0.26
Thannirmukkom	0.25

The lime shell resources next in importance to Vembanad lake are those in Kannur and Kasargod districts in North Kerala. The department had also investigated on the occurrence of limeshell in Thrissur, Malappuram and Kannur districts and the reserves indicated are as follows:

Sl. No.	District	Place	Reserve in million tones
1.	Thrissur	Naduvullikara, Vadanapalli, Chettuva, and Kappad	0.33
2.	Kannur	Payyannur, Cheruvathur, and Thrikkarippur	0.29
3.	Malappuram	Kanhiramukku	0.14

Magnesite

A total possible reserve of 0.037 million tonnes has been estimated in Mulli-Salayur areas, Attappadi in Palakkad District by the Department of Mining and Geology. In Salayur area, magnesite veins varying in thickness from 10 to 30 m were observed in pits. The average recovery of magnesite was assessed as 100 kg/m³ of magnesite - bearing rocks and samples on analysis were found to contain 43.05 to 46.73% MgO, 1.51 to 6.59% of SiO₂ and 0.29 to 0.59% of CaO.

Steatite / Talc

It is consumed in many manufacturing industries of paper, insecticide, textile, fertilizers, ceramics, rubber products, cement, asbestos etc. Several steatite occurrences have been identified in Thalassery Taluk of Kannur district. The total reserves estimated are of the order of 7.94 million tonnes.

Granite (Dimension Stone)

An important aspect of recent trend in architecture and construction is the increasing use of buildings and monuments. In this regard a number of rock types broadly grouped as "Granite" that exist in various parts of Kerala are utilised for this purpose. The major granite belt of Kerala can be classified by its geologic setting into three categories:

- ❖ Charnockite-Khondalite belt of Thiruvananthapuram, Kollam, Pathanamthitta and Kottayam districts (colour ranges from pale green with mottled red, bluish green with cordierite, deep dark green, greyish white).
- ❖ True intrusive or anatectic granites and associated migmatites of Proterozoic age from Idukki, Palakkad, Kannur, Kasargod and Wayanad districts (colour: Pink, light pink, Gray, yellowish white and bluish pink with wavy patterns).
- ❖ Dolerite-Gabbro dykes, Proterozoic intrusive hypabasal dyke swarms from Kottayam, Palakkad, Malappuram and Kozhikode districts (colour: dark greenish blue, black and dark gray with black spots).

In Kerala, the importance of exploration of granites has been recognised rather late although investigations have been initiated right from 1976. There has been a spurt in quarrying leases for granite dimension stone in the early nineties that resulted in creation of international market for green and white coloured granites of Kerala. Though Kerala has large resources of dimension stone granite in most of the districts amenable for being cut and polished, there are only 19 quarries producing 3589 cbm annually (2001-'02) which is low compared to the production of other southern States of Tamilnadu, Karnataka and Andhra Pradesh.

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large resources of dimension stone granite in most of the districts amenable for being cut and polished, there are only 19 quarries producing 3589 cbm annually (2001-'02) which is low compared to the production of other southern States of Tamilnadu, Karnataka and Andhra Pradesh. There are three different geological settings in which gemstones occur in Kerala viz.

- the pegmatites traversing the crystalline rocks
- in association with gravels in the river channels of the present day
- in the older gravels which are often consolidated and lateritised

These settings have fairly extensive geographical distribution in Thiruvananthapuram district, the localities of importance are Andoorkonam, Aruvikkara, Balaramapuram, Bonaccord Estate, Braemore Estate, Changa, Chullimanur, Madathara, Manickkal, Pirappancode, Venjaramoodu, Venganoor, Vembayam, Thonnakkal, Uzhamalakkal, Manvila, Mudakkal, Nedumangad, Vellanad, Nettani, Ooroottambalam, Pothencode and in Kollam, the main gem bearing localities are Adukkalamula, Podiattuvila, Kulathupuzha, and Talachira. Besides these localities several stretches of rivers like Kallar- Vamanapuram Ar, Karamana Ar, Neyyar in Thiruvananthapuram District and Kulathupuzha, Kallada rivers in Kollam district are also subjected to sporadic mining activities, though there is no legalized gem mining in the State.

Land Degradation

Land is degraded when it suffers a loss of intrinsic qualities, decline in its capabilities or loss in its productive capacity. Land degradation may be due to natural or human causes or it may be due to combination of both.

Land degradation is a global problem, largely related to agricultural use. The major causes include:

- Land clearance, such as deforestation
- Agricultural depletion of soil nutrients through poor farming practices
- Livestock including overgrazing
- Inappropriate Irrigation
- Urban sprawl and commercial development
- Land pollution including industrial waste
- Vehicle off-roading
- Quarrying of stone, sand, ore and minerals

Alkali or alkaline, soils are clay soils with high pH (> 9), a poor soil structure and a low infiltration capacity. Often they have a hard calcareous layer at 0.5 to 1 meter depth. Alkali soils owe their unfavourable physico-chemical properties mainly to the dominating presence of sodium carbonate which causes the soil to swell. Alkaline soils are difficult to take into agricultural production. Alkaline soils are difficult to take into agricultural production.

Soil is the non-renewable natural resource which supports life on earth. It is estimated that one-sixth of the world's soils have already been degraded by water and wind erosion. This has two important consequences: the reduced ability of society to produce sufficient food due to loss of quality and depth of soils; and resulted in off-site pollution associated with erosion. These include siltation of dams, pollution of water-courses by agricultural chemicals and damage to property by soil-laden runoff. On-site issues of declining soil quality tend to be spatially dispersed occurring on many different soil types whereas off-site pollution issues tend to be locally concentrated.

Soil erosion by rain and river that takes place in hilly areas causes landslides and floods, while cutting trees for firewood, agricultural implements and timber, grazing by a large number of livestock, over and above, the carrying capacity of grass lands, traditional agricultural practices, construction of roads, indiscriminate (limestone) quarrying and other activities, have all led to the opening of hill-faces to heavy soil erosion. Wind erosion causes expansion of deserts, dust, storms, whirlwinds and destruction of crops, while moving sand covers the land and makes it sterile. Excessive soil erosion with consequent high rate of sedimentation in the reservoirs and decreased fertility has become serious environmental problems with disastrous economic consequences.

Soil erosion results in huge loss of nutrients in suspension or solution, which are removed away from one place to another, thus causing depletion or enrichment of nutrients. Besides the loss of nutrients from the topsoil, there is also degradation through the creation of gullies and ravines, which makes the land unsuitable for agricultural production. Subsidence of the land in some areas and landslides in the hilly tracts are problems affecting highways, habitations and irrigation dams.

Natural Disaster

The State of Kerala is vulnerable to a multitude of hazards and is categorized as a multiple-hazard prone State. The State experiences various kinds of disasters of recurrent nature that results in loss of life, livelihood and property, and disruption of economic activity, besides

causing immense hardship to the affected population. Kerala has a long coast line of 590kms out of which, 322 Km is prone to severe sea erosion. The density of population is 819 persons per sq.km which is the second highest density in the country.

The mean maximum storm surge height in the state is 3.5m and minimum is 2.3m. If the storm surge is during high tide, the maximum surge height in the state will be 4.2m and minimum storm height will reach up to 3m, as observed by the Meteorological Department, Thiruvanthapuram. The coastal belt of Kerala is one of the most densely populated regions in the country, which adds to its vulnerability. The Western flank of the Western Ghats covering the eastern part of Kerala is identified as one of the major landslide prone areas of the country.

Floods: In Kerala, riverine flooding is a recurring event consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and flow capacity of streams and rivers. This causes a water course to overflow its banks onto flood plains; which by definition is a relatively flat land adjacent to a natural water course, composed primarily of unconsolidated depositional material derived from sediments transported by the related stream and subjected to periodic flooding. Reclamation and settlement in floodplain areas is a major cause of flood damage in Kerala. Defining the entire flood potential in a given area is a delicate task.

Landslides: In Kerala, landslides commonly occur in localised areas of the Western Ghats region where the slope is steep and the soil is over saturated as a result of prolonged rainfall. These events vary from events affecting a parcel of land to those larger ones with much causality. Only the larger ones with losses of lives have been highlighted and studied in detail. The smaller events also indicate landslide potential of an area. Case studies by CESS show that most of the events are of debris flow type triggered by excess rainfall and are influenced by terrain factors like slope, overburden thickness, landuse, relative relief, disposition of streams, landform at micro level etc. The area of the state is about 38863 sq.km of which 40% lies in the highland region forming the western slopes of Western Ghats. A considerable part of all districts of Kerala except the coastal district of Alleppey falls within this region. The western declivity of the Western Ghats is steep and usually terraced resembling ghat or landing stairs from which it derives the name. This region is characterized by rugged hills with steep slopes on which rests the soil and earth materials. Mass movements such as landslides are natural phenomenon that causes landscape changes, threat to life and destruction of property. The most common type of landslides in Kerala is debris flows.

Earthquakes: Kerala has experienced occasional mild tremors since historical times. None of them are reported to have caused casualties or major damages to built-up structures. A seismic hazard map with 10% probability of exceedance in 50 years assigns low-level hazard to regions falling in Kerala. However pockets of higher ground acceleration have been identified in central Kerala.

Tsunami:

The superimposition of tsunami waves with high tide was a factor that compounded the inundation resulted in higher intensity of damage. The worst affected part of the coast in terms of inundation, run-up and erosion was the 10 km segment of Azhikkal coast. Satellite imagery of this tract a day after the tsunami clearly shows highly turbid sediment-laden water. Many concrete houses, fishing boats canoes and automobiles of this area were uprooted and thrown to distances of 100 to 200 m. Even blocks of rocks (1m size) of the seawall were thrown ashore to 150m by the rushing tsunami waves

Coastal hazards: In Kerala, out of 14 districts, 9 districts are bordering the sea coast vulnerable to various disasters such as floods, cyclones, coastal erosion, landslides etc. These nine districts are namely, Kasargode, Kannur, Kozhikode, Malappuram, Thrissur, Ernakulam, Alappuzha, Kollam and Thiruvananthapuram. The state has 223 coastal villages which has the probability of being affected by cyclone. Natural causes of coastal erosion are due to the action of waves, winds, tides, near shore currents, storm surges and sealevel rise. Human activities such as the construction of harbours, jetties and groynes, river training works, mining and dredging can also lead to erosion of certain regions. Some of the coastal stretches in Kerala have shown long-term erosion with net loss of land. It is reported that about 480 km length of the coast is under the threat of erosion. The rocky coasts with pocket beaches have minimum level of erosion. In areas with laterite cliffs, under cutting of the softer clay layers lead to slumping with a net landward migration of the shoreline. In the sandy areas some of the segments show long term erosion while others with either accretion or stable condition.

Lightning: On an average about 70 people in the state die due to lightning. There are numerous overlaps of dots in the plot. It can be seen that there is a relative void in incidents in an area west of the Palakkad. More specifically the region west of Palakkad namely the region near Thrisur has less incidence. This is because the mountain range has a gap in Palakkad and so the absence of mountain results in less Cb formation and lightning incidence. The two figures indicate that the mid land of Kerala has more lightning.

Table:5.12 Kerala's Major Natural Disasters 2014-15

SI. No.	Item	Flood	Drought	Fire
1	Period of occurrence	2014-15	2014-15	2014-15
2	Total number of districts in the State	14	14	14
3	Number and names of districts affected	14 Districts Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha, Idukki, Ernakulam, Kottayam, Ernakulam, Thrissur, Palakkad, Kannur, Malappuram, Kozhikkode, Wayanad, Kasaragod	06 Districts Thiruvananthapuram, Kollam, Pathanamthitta, Idukki, Ernakulam, Palakkad	NIL
4	Number of villages affected	1420	247	0
5	Population affected (in lakh)	29	10	0
6	Total land area affected (in lakh ha)	3146	01	0
7.1	Cropped area affected	0	01	0
7.1.1	Total cropped area affected (in lakh ha.)	3489	118	0
7.1.2	Estimated loss to crops (Rs.in lakh)	7912	211	0
7.1.3	Area where crop damage was more than 50%	282	184	0
7.2	Percentage of cropped area held by SMF	170	91	0
7.2.1	In State, as a whole	100	90	0
7.2.2	In the affected districts	Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha, Kottayam, Idukki, Ernakulam, Thrissur, Palakkad, Malappuram, Kozhikkode, Kannur, Wayanad, Kasaragod.	Thiruvananthapuram, Kollam, Pathanamthitta, Idukki, Ernakulam, Palakkad	0
8	Houses damaged	38292	0	0

Source : Kerala's Major Natural Disasters 2014-15

CHAPTER - VI

WATER

Water is essential for life. The amount of drinking water required varies. It depends on physical activity, age, health issues, and environmental conditions. It is estimated that on an average, an American drinks about one litre of water a day with 95% of them drinking less than three litres per day. For those who work in a hot climate, up to 16 liters a day may be required. Typically in developed countries tap water meets drinking water quality standards, even though only a small proportion is actually consumed or used in food preparation. Other typical uses include washing, toilets, and irrigation. Greywater may also be used for toilets or irrigation. Its use for irrigation however may be associated with risks. Water may also be unacceptable due to levels of toxins or suspended solids. Reduction of waterborne diseases and development of safe water resources is a major public health global in developing countries. Bottled water is sold for public consumption in most parts of the world.

Water quality management in India is accomplished under the provision of water (Prevention to control of pollution) Act 1974. Main objective of the act is to prevent the pollution of water by Industrial, agricultural and household waste water that can contaminate our water source. The water quality informations are being used to manage the quality of water from the source of pollution. The unstream water stations of rivers are having good water quality compared to the downstream stations.

Water is used for drinking & other domestic purposes in most communities are obtained from Natural Sources such as rivers, streams, lakes, ponds & springs of artificial sources such as wells and bore wells. Most times these water supplies are likely to be polluted with waste. Micro organisms in these natural sources are numerous in both number and diversity. Water plays a very important role in human health. To determining the health of individuals and the whole communities, the quality of water supplied is more important. The human body contains from 55% to 78% water, depending on body size. To function properly, the body requires between one and seven liters of water per day to avoid dehydration the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is

not clear how much water intake is needed by healthy people, though most specialists agree that approximately 2 liters (6 to 7 glasses) of water daily is the minimum to maintain proper hydration. Medical literature favors a lower consumption, typically 1 liter of water for an average male, excluding extra requirements due to fluid loss from exercise or warm weather.

**Table:6.1 Primary water quality criteria for bathing water
(Water used for organized outdoor bathing)**

Criteria	Rationale
Faecal Coliform : 500 (desirable) MPN /100ml: 2500 (maximum permissible)	To ensure low sewage contamination, faecal coliform and faecal streptococci are considered as they reflect the bacterial pathogenicity.
Faecal Streptococci: 100 (desirable) MPN/100ml : 500 (maximum permissible)	The desirable and permissible limits are suggested to allow for fluctuation in environment conditions such as seasonal changes, changes in flow conditions, and so on.
pH: between 6.5 and 8.5	The range provides protection of the skin and delicate organs like eyes, nose, ears, and so on, which are directly exposed outdoor bathing.
Dissolved oxygen : 5 mg/l or more	The minimum dissolved oxygen concentration of 5 mg/l ensures reasonable freedom from oxygen consuming organic pollution immediately U/s which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediments.
Biochemical oxygen Demand : 3 mg/l or less 3 days at 27 C	The biochemical oxygen demand of 3 mg/l or less of the water ensures reasonable freedom from oxygen demanding pollutants and prevent production of obnoxious gases.

Source: Kerala State Pollution Control Board

Table:6.2 Water Quality Criteria (CPCB) 2014-15

Designated-Best-Use	Use Class	Criteria
Drinking water source without conventional treatment but after disinfection	A	Total Coliforms MPN/100ml shall be 50 or less. pH: 6.5. and 8.5 DO : 6mg/l or more BOD: 2 mg/l or less.
Outdoor bathing (Organised)	B	Total Coliforms MPN/100ml shall be 500 or less pH : 6.5 and 8.5 DO : 5 mg/l or more BOD: 3mg/l or less.
Drinking water source after conventional Treatment and disinfection.	C	Total Coliforms MPN/100 ml shall be 5000 or less pH : 6.5 to 8.5 DO : 4mg/l or more BOD: 3mg/l or less.
Propagation or Wild Life and Fisheries	D	pH: 6.5 to 8.5 DO: 4mg/l or more, Free Ammonia (as N) 1.2 mg/l or less.
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH: 6.0 to 8.5 Electrical conductivity at 25 ^o C micro mhos/cm Max 2250 Sodium Absorption Ratio Max: 26 Boron Max 2mg/l
	Below E	Not Meeting A, B, C, D & E Criteria

Source: Kerala State Pollution Control Board

Table:6.3 Storage levels in Reservoirs

Cubic Meter				
Sl. No.	Item	2013	2014	2015
1	Storage of water on the beginning of the monsoon year	280.59	415.16	527.83
2	Storage of water at the end of the monsoon year	1261.14	1258.73	1165.01
3	Increase in storage	980.49	843.54	637.18
Average for 10 Years				
4	Storage of water on the beginning of the monsoon year	395.63	360.50	450.27
5	Storage of water at the end of the monsoon year	1186.48	1087.27	1156.16
6	Increase in storage	790.85	726.77	705.89

Source: Economic Review 2015

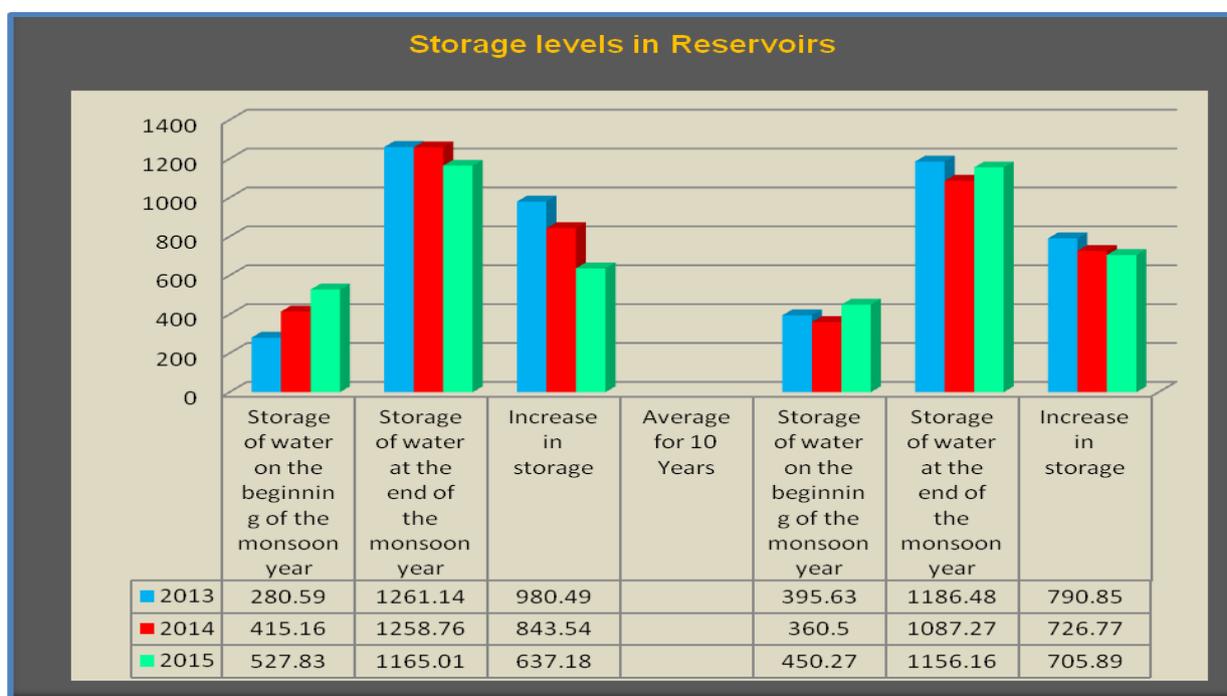


Table:6.4 Name of Reservoirs 2014-15

Sl. No.	Name of Reservoir	District	Area (Ha)
1	Neyyar	Thiruvananthapuram	1500
2	Peppara	Thiruvananthapuram	582
3	Aruvikkara	Thiruvananthapuram	258
4	Thenmala Dam (Kallada)	Kollam	2590
5	Pamba	Pathanamthitta	570
6	Kakki	Pathanamthitta	1800
7	Maniyar	Pathanamthitta	110
8	Gani & Kallar Dam	Pathanamthitta	25
9	Ponmudi	Idukki	260
10	Idukki Arch Dam	Idukki	6160
11	Anayirankal Dam	Idukki	433
12	Gundala	Idukki	230
13	Mattupetty Dam	Idukki	324
14	Sengulam Dam	Idukki	33
15	Neriyamangalam	Idukki	413
16	Periyar Lake	Idukki	2890
17	Edamalayar Dam	Idukki	350
18	Kallarkutty Dam	Idukki	58
19	Munnar Headworkers Dam	Idukki	250
20	Kallar Division Dam	Idukki	220
21	Lower Periyar Dam	Idukki	150
22	Erattayar Dam	Idukki	200
23	Malankara Dam	Idukki	120
24	Mullaperiyar Dam	Idukki	400

25	Kulamavu Dam	Idukki	6160
26	Cheruthoni Dam	Idukki	--
27	Bhoothathankettu	Ernakulam	608
28	Peechi	Thrissur	1200
29	Vazhani	Thrissur	255
30	Sholayar	Thrissur	870
31	Peringalkuthu	Thrissur	280
32	Chimmini- Dam	Thrissur	1000
33	Poomala	Thrissur	75
34	Pathazhakunnu Dam	Thrissur	14
35	Asuram Kundu Dam	Thrissur	12
36	Malampuzha	Palakkad	2313
37	Mangalam	Palakkad	393
38	Meenkara	Palakkad	259
39	Chulliyar	Palakkad	159
40	Pothundi	Palakkad	363
41	Walayar	Palakkad	289
42	Parambikulam	Palakkad	2092
43	Thunakkadavu	Palakkad	283
44	Lakkidi	Palakkad	25
45	Kanjirappuzha	Palakkad	512
46	Cheramangalam	Palakkad	200
47	Tharampilli	Palakkad	244
48	Kuttiyadi	Kozhikkode	1052
49	Kakkayam	Kozhikkode	1070
50	Peruvannamuzhi	Kozhikkode	1050
51	Banasurasagar	Wayanad	1277
52	Korapuzha	Wayanad	1660
53	Pazhassi	Kannur	648
	Total		44289

Source: Fisheries Department, website

Table:6.5 Biological Water Quality Criteria (Bwqc) 2014-15

Sl. No.	Taxonomic groups	Range of Saprobic Score (BMWP)	Range of Diversity Score	Water quality characteristics	Water quality class	Indicator colour
1	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Diptera	7 and more	0.2-1	Clean	A	Blue
2	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Planaria, Odonata, Diptera	6-7	0.5-1	Slight pollution	B	Light Blue
3	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Odonata, Crustacea, Mollusca, Polychaeta, Coleoptera, Diptera, Hirundinea, Oligochaeta	3-6	0.3-0.9	Moderate Pollution	C	Green
4	Hemiptera, Mollusca, Coleoptera, Diptera, Oligochaeta	2-5	0.4 & less	Heavy Pollution	D	Orange
5	Diptera, Oligochaeta, No Animal	0-2	0-0.2	Severe Pollution	E	Red

Source: Kerala Pollution Control Board

Table:6.6 Navigable Waterways in Kerala 2014-15

Sl. No.	Name of the River	Length of the River	Navigable Length
1	Achenkoil	128	32
2	Anjarakandy	48	27.2
3	Ayroor	17	1
4	Bharatha Puzha	209	40
5	Chalakudy	130	16
6	Chaliyar	169	68.4
7	Chandragiri	105	12.8
8	Chittari	25	NA
9	Ithikkara	56	16
10	Kadalundi	130	43.2
11	Kallada	121	40
12	Kallayi	22	9.6
13	Mamom	27	1
14	Karamana	68	NA
15	Kariangode	64	24
16	Karuvannur	48	24
17	Kavvayi	31	9.6
18	Keecheri	51	NA
19	Korapuzha	40	24.8
20	Kuppam	82	24
21	Kuttiyadi	74	9.6
22	Mahe	54	24
23	Manimala	90	54.4
24	Manjeswar	16	3.2

25	Meenachil	78	41.6
26	Mogral	34	NA
27	Muvattupuzha	121	25.6
28	Neyyar	56	NA
29	Nileswar	46	NA
30	Pallichal	42	3
31	Pamba	176	73.6
32	Periyar	244	72
33	Peruvamba	51	16
34	Puzhakkal	29	NA
35	Ramapuram	19	5.4
36	Shiriyā	67	4.8
37	Thalasseri	28	21.6
38	Tirur	48	9.6
39	Uppala	50	3.2
40	Valapattanam	110	44.8
41	Vamanapuram	88	11.2

Source: Fisheries Department

Table:6.7 District Wise Brackish Water Area in Kerala 2014-15

Sl. No	Name of District	Area (Ha)
1	Thiruvananthapuram	1424
2	Kollam	8604
3	Pathanamthitta	Nil
4	Alappuzha	15223
5	Kottayam	4327
6	Idukki	Nil
7	Ernakulam	16213
8	Thrissur	4272
9	Palakkadu	Nil
10	Malappuram	1796
11	Kozhikkode	4162
12	Wayanadu	Nil
13	Kannur	5944
14	Kasaragod	3248
TOTAL		65213

Source: Fisheries Department

Table:6.8 Fresh Water Lakes in Kerala 2014-15

Sl.No	Name of Lake	District	Area (Ha)
1	Vallayani Lake	Thiruvananthapuram	250
2	Sasthamkotta Lake	Kollam	440
3	Eravikulam Lake	Idukki	3
4	Devikulam Lake	Idukki	10
5	Elephant pond	Idukki	6
6	Periyar Lake	Idukki	605
7	Mankodi Lake	Thrissur	205
8	Muriyadu Lake	Thrissur	94
9	Pookote Lake	Wayanadu	7
	TOTAL		1620

Source: Fisheries Department

Table:6.9 District wise Distribution of Coast Line of Kerala 2014-15

Sl.No	District	Coast Line Length (in KM)	Percentage to Total
1	Thiruvananthapuram	78	13.22
2	Kollam	37	6.27
3	Alappuzha	82	13.90
4	Ernakulam	46	7.80
5	Thrissur	54	9.15
6	Malappuram	70	11.87
7	Kozhikkode	71	12.03
8	Kannur	82	13.90
9	Kasargod	70	11.86
	Total	590	100.00

Source: Fisheries Department

Table:6.10 Backwaters in Kerala 2014-15

SI.No.	Name of District	SI. No.	Name of Backwaters	Area (Ha)
1	Thiruvananthapuram	1	Poovar Kayal	30.93
		2	Poonthura Kayal	97.59
		3	Veli Kayal	22.48
		4	Kadinamkulam Kayal	346.88
		5	Anchuthengu Kayal	521.75
		6	Edava-Nadayara Kayal	157.65
		TOTAL		
2	Kollam	1	Paravoor Kayal	662.46
		2	Ashtamudi Kayal	6424.15
		3	Kayamkulam Kayal	140.58
		TOTAL		
3	Pathanamthitta	Nil		
4	Alappuzha	1	Kayamkulam	1511.75
		2	Poomeen Kayal	3.37
		3	Vadakkal Kayal	1.46
		4	Chethi Kayal	4.11
		5	Arthungal Kayal	5.96
		6	Pozhichal Kayal	20.41
		7	Vettakkalchal Kayal	27.1
		8	Vembanattu Kayal	10661.23
		TOTAL		
5	Kottayam	1	Vembanattu Kayal	2926.77
		TOTAL		
6	Idukki	Nil		
7	Ernakulam	1	Vembanattu Kayal	2257.59
		2	Kochi Kayal	7503.80
		TOTAL		
8	Thrissur	1	Azhikode Kayal	82.02
		2	Kodungalloor Kayal	613.81
		3	Chettuva Kayal	713.87
		4	Pattikkara Kayal	-
		5	Manakkady Kayal	-
TOTAL			1409.70	

9	Palakkad	NIL		
10	Malappuram	1	Puthupponnani	150.83
		2	Ponnani Kayal	757.19
		3	Poorapuzha	62.98
		4	Kadalundi Kayal	323.56
		TOTAL		
11	Kozhikode	1	Kadalundi Kayal	83.85
		2	Bey pore Kayal	783.74
		3	Kallai Kayal	160.13
		4	Korapuzha	1038.08
		5	Payyolipuzha	26.70
		6	Kottapuzha	584.12
		7	Newmahepuzha	88.28
		TOTAL		
12	Wayanad	NIL		
13	Kannur	1	Mahe	91.89
		2	Dharmadam Kayal	359.06
		3	Valapattanam	3077.64
		4	Palakkode	598.25
		5	Cheruvathur	30.58
		TOTAL		
14	Kasaragode	1	Cheruvathur	1123.12
		2	Nileswaram	824.69
		3	Chittari Kayal	89.33
		4	Bekal Kayal	43.37
		5	Kappil Pozhi	2.22
		6	Neembil Kayal	22.47
		7	Chandragiri	575.81
		8	Mogral Puthur	89.74
		9	Kumbala	221.54
		10	Suvamagiri	6.22
		11	Manjeswaram	158.41
		12	Thalappady	17.12
		TOTAL		
GRAND TOTAL				46128.94

Source: Fisheries Department

Table:6.11 List of 44 major Rivers of Kerala 2014-15

Sl. No.	Name of River	Length of River (km)	Area in Km ²
1	Achancovil	128	1340.4
2	Anjarakandi	48	423.763
3	Ayiroor	17	124.288
4	Bharathapuzha	209	3852.04
5	Chalakuudi	130	1118.32
6	Chaliyar	169	2539.82
7	Chandragiri	105	615.353
8	Chittari	25	101.319
9	Ithikkara	56	659.716
10	Kadalundi	130	1264.01
11	Kallada	121	1615.56
12	Kallai	22	87.5233
13	Kanjiramukku	29	353.741
14	Karamana	68	689.593
15	Karingote	64	442.019
16	Karuvannur	48	956.945
17	Kavvayi	31	164.758
18	Keecheri	51	769.787
19	Korapuzha	46	657.596
20	Kuppam	82	440.06
21	Kuttiyadi	74	665.83
22	Mahe	54	421.045
23	Mamom	27	57.1075
24	Manimala	90	1063.16
25	Manjeswar	16	49.8757
26	Meenachil	78	1208.11

27	Mogral	34	119.997
28	Muvattupuzha	121	2675.08
29	Neyyar	56	499.996
30	Nileswaram	46	204.38
31	Pallikkal Thode	42	326.64
32	Pampa	176	2082.8
33	Periyar	244	5029.03
34	Peruvamba	51	298.148
35	Ramapuram	19	57.5121
36	Shiriya	67	367.386
37	Thalassery	28	157.591
38	Tirur	48	203.144
39	Uppala	50	99.7847
40	Valapattanam	110	1341.27
41	Vamanapuram	88	766.9
42	Bhavani	135	603.266
43	Kabani	240	1934.5
44	Pambar	31	381.576
Total		3054	38831

Source: Irrigation.kerala.gov.in

Table:6.12 Fish Production in Kerala during last Five Years

(Lakh tones)

Year	Kerala			All India		
	Marine	Inland	Total	Marine	Inland	Total
2010-11	5.60	1.21	6.81	32.50	49.81	82.31
2011-12	5.53	1.40	6.93	33.72	52.94	86.66
2012-13	5.31	1.49	6.80	33.21	57.19	90.40
2013-14	5.22	1.86	7.08	34.43	61.36	95.79
2014-15	5.24	2.02	7.26	34.91	65.77	100.69

Source: Economic Review 2015

Table:6.13 Minimum and Maximum Observed values of water quality parameters at PWD sites and River Stations: 2015

Sl. No.	Name of River	Name of Site	Quality Parameters												Class
			pH			Dissolved Oxygen			B.O.D			Coliform bacteria			
			Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	
1.	Neyyar	Aruvippuram (Perumkadavila Village)	6.6	6.1	6.35	7	6	6.44	1	0.4	0.67	670	200	351.75	E
		Amaravila (Neyyatinkara)	6.7	6.5	6.58	6.9	5.8	6.32	1.6	0.5	1.18	900	700	800.00	B
2.	Mamom	Mamom Bridge (Attingal Village)	6.9	6.6	6.75	6.6	5.7	6.1	1.8	0.8	1.26	1500	1400	1431.33	C
3.	Ayroor	Ayoor Bridge (Ayroor Village)	8.1	5.6	6.35	6.2	4.8	5.5	1.6	0.8	1.17	2700	2200	2485.33	E
4.	Karamana	Aruvikkara	6.9	6.2	6.56	7.3	6.4	6.96	1	0.1	0.3	300	230	281.44	E
		Moonnattumukku (Thiruvallom village)	7.5	6.5	6.95	1.8	1.3	1.56	4.1	2.8	3.27	44000	35000	37127.77	E
5.	Ithikkara	Ayroor Bridge	7.8	7	7.49	7.8	6	6.76	2	1.2	1.34	1220	330	692.50	C
		Ithikkara Bridge	7.8	7.1	7.33	7.1	5.3	6.11	2.4	1.2	1.65	840	200	597.78	E
6.	Vamanapuram	Vamanapuram Village	6.9	6.3	6.51	6.9	5.6	6.17	2	1.5	1.75	1800	1200	1532.00	E
	Pallickal	Nellimughal	7.6	7.1	7.38	7.1	5.7	6.53	2	0.8	1.24	700	150	433.33	C
7.	Achenkovil	Kallarakkadavu	7.9	7	7.47	7.8	5.8	6.81	1.6	1.2	1.46	1120	140	675.55	C
		Chennithala	7.9	6.7	7.44	6.9	6	6.37	1.6	1.2	1.37	1400	400	735.55	C

8.		Thumpamon	7.9	6.9	7.3	7.2	5.8	6.41	2	1.2	1.46	1300	400	697.77	C
		Pandalom	7.9	7	7.2	7.2	5.9	6.59	1.6	1.2	1.38	700	400	497.78	C
	Kallada	Perumthottamkadav	7.9	7.2	7.58	7.9	6	7.05	2	1.2	1.5	900	540	663.33	C
9.	Pamba	Pamba (Parumala) Down	7.2	6.3	6.76	8.6	4	6.05	4.92	0.3	1.38	54000	640	13055.83	E
		Chenganoor ncpality	7.1	5.8	6.55	7.4	4.6	5.69	1.5	0.7	1.13	1740	450	974.16	E
		Thakazhi Panchayath	6.8	5.95	6.33	6.3	2.2	4.44	1.9	1	1.33	2450	560	1201.66	E
10.	Meenachil	Kidangoor Panchayath	7.4	6.5	7.02	7.7	6.6	7.15	1.4	0.4	0.71	5400	1400	2472.72	D
11.	Manimala	Thondara (Kuttoor Panchayath)	7.5	6.3	6.95	7.7	5.3	6.52	4.2	0.6	1.8	460	0	252.5	E
		Kallooppara Panchayath	7.9	6.4	7.13	7.9	4.8	6.42	2.8	0.2	1.48	520	0	241.91	C
12.	Periyar	Eloor (Kadungallore Panchayath)	7.29	6.5	6.94	6.5	2.6	4.63	3.3	0.9	1.97	1020	25	179.45	E
		Kalady Panchayath	7.37	6.6	7.09	8	4.8	6.97	2.1	0.3	1.2	920	17	203.41	C
		KWA Muncipality Aluva	7.36	6.5	6.96	7.3	0.2	5.62	4	0.1	1.74	520	12	125.25	E
		Pathalam (Kadungallore Panchayath)	7.2	6.4	6.86	6.5	3.6	5.51	3.3	0.5	1.8	540	21	153.66	E
		Kalamassery Muncipality	7.15	6.3	6.85	6.7	4.2	5.37	4.2	1.4	2.82	760	34	177.16	E

13.		Purapallikadavu (Chengamanadu Panchayath)	7.55	6.3	7	7.4	5.39	6.49	2.3	0.2	1.21	700	20	165.16	E
		Muppathadam (Kadungallore Panchayath)	7.3	6.6	7.02	7.3	5.4	6.26	2	0.4	1.15	920	27	185.66	C
14.	Moovattupuzha	Vettikkattumukku (Mevallore Panchayath)	7.3	6.64	7.08	7.6	6.4	6.91	1.1	0.2	0.66	4600	1100	1962.5	C
15.	Chalaky puzha	Pullickakadavu (Kadakutty Panchayath)	7.7	6.5	7.08	11.7	6.4	7.48	2.3	0.4	1.36	700	300	551.66	C
16.	Karuvanoor	Karuvanoor Bridge (Porathissery Village)	7.9	6.8	7.29	8.4	5.4	6.58	5.9	0.5	2.1	750	250	435	D
17.	Puzhakal	Puzhakkal Bridge (Adat Panchayath)	7.5	6.5	6.95	7.3	2.2	4.77	2.5	0.6	1.5	630	280	476.25	E
18.	Keecheri	Vadakkancherry (Eranelur Village)	7.6	6.5	6.94	8.7	5.2	6.41	5.3	0.2	1.72	1600	350	515.71	E
19.	Bharathapuzha	Kuttippuram Panchayath	8.3	6.5	7.64	7.7	6.3	6.98	1.2	0.5	0.83	450	100	277.5	B
		Pattambi Panchayath	8.3	6.8	7.7	7.6	5.8	6.71	4	0.3	1.308	840	300	525.33	D
20.	Kadalundi	Thirurangadi Village	0	6.3	6.87	7	5.2	6.4	0	0.7	2.44	0	20	70.63	E
		Hajiyarppally (Panakad Village)	7.2	6.5	6.77	7.9	5.3	7.02	2.6	0.8	1.64	192	16	66.54	B
21.	Tirur	Thalakkadathur (Cheriyamundam Village)	7.1	6.34	6.8	7	3.4	4.87	4.5	0.7	1.94	220	16	69.33	E

22.	Chaliyar	Koolimadu (Chathamangalam Panchayath)	7.9	6.9	7.44	7.6	6.3	6.93	1.5	0.5	0.78	2000	100	670.83	C
		Nilambur	8.1	6.9	7.26	7.9	5.4	6.93	1.2	0.2	0.56	2200	21	283.87	C
		Chungapally (Perumana Panchayath)	8.1	6.8	7.41	7.6	6.3	6.93	1.5	0.5	0.78	2000	100	670.83	C
23.	Kabani	Muthankara (Mananthavadi Panchayath)	7.5	6.6	6.78	7.6	5	6.56	1	0.2	0.509	126	33	78.9	B
24.	Bhavani	Elaichivazhi (Agali Panchayath)	8.5	6.7	7.87	7.5	6.7	6.96	1.2	0.4	0.85	430	40	171	B
25.	Kuttiyadipuzha	Estatemukku (Chakkittappara Panchayath)	7.3	6.5	6.81	7.7	7	7.37	1.8	0	0.6	540	48	274.54	C
26.	Mahe	Valayam (Valayam Panchayath)	7.5	6.5	7.05	7.8	4.6	6.48	0.9	0	0.55	1700	70	526.72	C
27.	Kallai Puzha	Kallai Bridge (Kozhikode Corporation)	8.1	7.1	7.51	5.4	2.3	3.88	5.2	0.5	1.49	216000	350	36033.64	E
28.	Korapuzha	Kanayankode	8.3	7.2	7.64	6.7	4.3	5.41	1.3	0.6	0.65	8500	300	2170	E
29.	Kuppam	Taliparamba (Taliparamba Village)	7.1	6.5	6.8	7.5	3.6	5.46	2.5	0.2	1.37	1100	94	282.72	E
		Rayoram (Alakkode Village)	7.6	6.7	7.09	8.3	5	7.13	2.6	0.2	1.07	540	180	298.91	C
30.	Thalassery	Pathipalam (Patyam)	7	6.2	6.53	8	3.3	6.01	2.3	0.1	1.3	920	68	349.27	E
31.	Ancharakkandy	Ancharakkandy Village	6.9	6	6.65	8.6	5.3	6.78	2.2	0.4	1.24	920	160	417.45	E

		Meruvamba (Vengad Village)	7.3	6.3	6.75	7.7	5.8	6.77	2.5	0.3	1.42	920	220	332.72	E
32.	Ramapuram	Ramapuram Bridge (Cheruthazham Village)	7.5	6	6.72	8.3	1.5	5.61	2.5	0.1	1.44	920	80	285.09	E
33.	Kavai	Kuttiyolpalam (Peralam Village)	7.2	6.1	6.5	7.8	4.3	5.85	1.5	0.1	0.85	600	94	321.27	E
34.	Valapattanam	Parassanikkadavu	7.4	6.1	7.0	7.7	4.6	6.6	2.1	0.2	1.0	404	60	218.9	E
35.	Neeleswaram	Hosdurg (Neeleswaram Village)	8.7	6.1	7.04	8.1	5	6.31	3	0.3	1.41	1800	80	957.27	E
		Nambiarckal (Hosdurg Village)	7.5	6.1	6.75	7.7	5.3	6.69	3.3	0.9	1.59	1100	94	601.27	E
36.	Karingode	Kakkadavu (Cheemeni Village)	8	6.5	7.2	8.4	7.1	7.79	1.9	0.1	0.85	1400	430	772.72	C
37.	Chandragiri Puzha	Padiayathadka	8.1	5.9	6.95	8.4	6.7	7.47	1.7	0.1	1.01	1400	50	730	C
38.	Mogral	Mogral Bridge (Mogral Village)	7.8	6.1	6.95	7.7	4.1	5.53	2.9	0.3	1.49	2400	320	1116.36	E
39.	Shriya	Angadimogaru Village	7.2	6.5	6.85	8.9	7.4	7.94	2.7	0.3	1.03	2200	170	907.78	C
40.	Uppala	Uppala Bridge (Uppala Village)	7.8	6.2	7.13	8.4	5	6.6	2.7	0.2	1.7	2500	110	923.63	E
41.	Manjeswaram	Bajrakkara Bridge (Vorcadu Village)	7.9	6.1	7.04	8.7	6.5	7.67	2.1	0.2	1.07	1800	100	784.28	E
42.	Peruvamba	Chandrapura (Kadanapally Village)	7.1	6	6.48	7.7	3	6.16	1.5	0.2	0.7	550	94	249.27	E

Source: State Pollution Control Board

Coast Line of Kerala

Kerala (38,863 km²; 1.18% of India's landmass) is situated between the Arabian Sea to the west and the Western Ghats to the east. Kerala's coast runs about 590 km in length, while the state itself varies between 35–120 km in width. Kerala is a coastal state bordered on the west by Arabian Sea. The Exclusive Economic Zone (EEZ) extends up to 200 nautical miles far beyond the continental shelf, which covers an area of 218536 Sq.Km. provide opportunities in traditional fishing in inshore waters from ages. Thus fisheries form one of the most important sectors of Kerala's economy.

Table:6.14 District-wise Distribution of Coast Line of Kerala

Sl. No.	District	Coast line length (in km)	Percentage of Total
1	Thiruvananthapuram	78	13.22
2	Kollam	37	6.27
3	Alappuzha	82	13.90
4	Ernakulam	46	7.80
5	Thrissur	54	9.15
6	Malappuram	70	11.87
7	Kozhikode	71	12.03
8	Kannur	82	13.90
9	Kasaragod	70	11.86
	TOTAL	590	100.00

Source: Fisheries Department

Groundwater

Groundwater is a part of water cycle. The awareness among the public about the importance of the groundwater has increased during the recent years. The need for groundwater being felt by all sectors because of the shortage of surface water sources to mitigate the growing needs of the society. Recently the problems of decline in water table, contamination of groundwater, seawater intrusion etc are being reported at many places. The shortage of rainfall in recent years and the increased utilisation of ground water caused concern among the public that water may become scarce commodity in future. In order to assess the real situation of groundwater conditions, it is very essential to monitor the groundwater level and water quality over time and space. Central Ground Water Board is monitoring water level and quality through a network of Ground Water Monitoring Wells distributed throughout the State. The monitoring started from the year 1969 for nine monitoring wells and the numbers of monitoring wells were increased during the subsequent years and became 224 by the year 1979 and the number became 460 by the year 1988.

Thick zones of weathered crystallines are seen along midland region. The depth to water level in the weathered crystallines in the midland area ranges from 3 to 16 mbgl. The midland area sustains medium capacity dug wells for irrigation. Along the hill ranges, the crystalline rocks are covered by thin weathered zone. Mostly dug wells that can cater to domestic needs are feasible along topographic lows. Bore wells tapping deeper fractured aquifer are feasible along potential fractures in the midland and hill ranges. Potential fractures are seen down to 240 mbgl and the most productive zone lies between 60 and 175 mbgl and the discharge of bore wells range between 36,000 and 1,25,000 lph.

Laterites are the most widely distributed lithological unit in the State and the thickness of the formation varies from a few meters to about 30m. The depth to water level in the formation ranges from less than a meter to 25 mbgl. Laterite forms potential aquifers along valleys and can sustain medium duty irrigation wells with the yields in the range of 0.5 - 6 m³ per day.

The alluvium forms potential aquifer along the coastal plains and ground water occurs under phreatic and semi-confined conditions in this aquifer. The thickness of this formation varies from few meters to above 100 m and the depth to water level ranges from less than a meter to 6 mbgl. Filter point wells are feasible wherever the saturated thickness exceeds 5 m.

Table:6.15 Ground Water Resources of Kerala 2014-15

Sl. No.	District	Total Annual Ground Water Recharge (Ha.m)	Provision for Natural Discharge(Ha.m)	Net annual Ground Water availability (Ha.m)	Existing Gross Ground Water for Irrigation (Ha.m)	Existing Gross Ground Water for domestic and industrial water supply (Ha.m)	Existing Gross Ground Water for All uses(Ha.m)	Provision for domestic and industrial requirement supply upto 2025 (Ha.m)	Net annual Ground Water availability for future irrigation Devt. (Ha.m)	Stage of Ground Water Devt. (%)
1	Thiruvananthapuram	355.96	27.24	328.71	39.85	133.16	173.01	146.99	141.87	53
2	Kollam	467.55	45.35	422.21	40.15	119.33	159.48	130.16	251.90	38
3	Pathanamthitta	278.81	24.69	254.11	34.63	60.04	94.67	63.04	156.44	37
4	Alappuzha	486.46	33.56	452.90	29.92	100.40	130.32	103.72	319.27	29
5	Kottayam	491.82	46.12	445.70	34.91	92.14	127.05	107.04	303.75	29
6	Idukki	218.38	21.84	196.55	28.74	54.96	83.70	59.85	107.96	43
7	Ernakulam	644.99	61.73	583.27	103.08	139.31	242.39	152.96	327.22	42
8	Thrissur	755.05	73.52	681.53	221.68	137.20	358.88	152.16	307.69	53
9	Palakkad	858.14	74.31	783.83	354.94	131.51	486.46	141.97	288.94	62
10	Malappuram	545.31	49.76	495.55	81.66	202.35	284.01	243.92	169.97	57
11	Kozhikkode	379.04	34.42	344.62	52.00	140.24	192.24	157.93	134.69	56
12	Wayanad	306.75	30.67	276.07	6.52	43.19	49.71	48.16	221.39	18
13	Kannur	532.31	52.19	480.13	109.43	109.39	218.83	119.32	251.37	46
14	Kasargod	365.44	36.54	328.89	167.05	67.75	234.79	77.98	83.87	71
	Total	6686.01	611.94	6074.07	1304.56	1530.97	2835.54	1705.20	3066.33	47.00

Source : Economic Review 2015

Table:6.16 Physical Achievements under Ground Water Development Schemes

Sl. No	Items	Unit	2012-13	2013-14	2014-15
1	2	3	4	5	6
1	Detailed hydrological survey (Site selection)	No.	8500	10134	9382
2	Sitting and providing technical assistance for open wells	No.	966	904	553
3	Sitting and construction of different types of drilled wells	No.	7534	9230	8829
4	Creating of additional irrigation facilities	ha.	241		
5	Training of personnel	No.	57	29	16
6	Water Sample analysis	No.	1961	4400	2876

Source : Economic Review 2015

The total number of GMMWs as on 31.3.2015 is 1638. Out of these, 1369 are dug wells tapping phreatic aquifers and 269 are borewells /tubewells tapping deeper aquifers of confined / semi-confined nature. These GMMWs are spread over all the physiographic divisions of the State. About 62% of the GMMWs fall in the midland region, 18% in coastal plains, 15% in highlands and 5% in Plateau region. Among the GMMWs tapping phreatic aquifer, 65% are tapping laterite, 17% tapping weathered and fractured crystallines, 15% tapping coastal alluvium and 3% tapping riverine alluvium. The data of these GMMWs were analysed to understand the depth to water level scenario in the State, annual fluctuation in the water levels due to the monsoon recharge, long term trend in water levels and the nature of the quality of ground water and the salient features are brought out in this report.

Table:6.17 Ground Water Monitoring Wells in Kerala 2014-15

Sl. No.	Districts	No. of GMMW			Density (Sq.Km)/ GMMW
		Dug Wells	Piezometers	Total	
1	Thiruvananthapuram	116	22	138	16
2	Kollam	109	20	129	19
3	Pathanamthitta	80	14	94	28
4	Alappuzha	81	22	103	14
5	Kottayam	99	8	107	21
6	Idukki	69	8	77	58
7	Ernakulam	115	18	133	22
8	Thrissur	120	21	141	22
9	Palakkadu	112	44	156	29
10	Malappuram	115	22	137	26
11	Kozhikode	79	20	99	24
12	Wayanadu	75	9	84	25
13	Kannur	95	16	111	27
14	Kasargod	104	25	129	15
TOTAL		1369	269	1638	24

Source: Dynamic Ground Water Resources of Kerala, Year Book, 2014-15

CHAPTER - VII

HUMAN SETTLEMENT

Human Settlement is defined as a settlement; locality or populated place is a community in which people live. A settlement is traditionally included its constructed facilities such as roads, ponds, parks, wells and irrigation facilities for cultivation. Human settlement can broadly be divided into two types- rural and urban settlement.

In Kerala the density of population is 819 during 2001 census and 860 in 2011 census. It shows that the density of population has increased at last decades. The population of Kerala has increased from 31841374 in 2001 census to 33406061 in 2011 census increased at **4.91%**.

Rural and Urban Settlement

In rural areas the most of the people engaged in agriculture sector. But in urban areas have dominated in secondary and tertiary sector. In rural area, mainly there consists of agricultural land in vast area. All over Kerala it is like a large number of small and medium town distributed in the village back ground. A rural development tends to have small population density.

Urban Settlement

An urban settlement is concentrated settlement that constitutes or is part of an urban area. It engages in predominantly in secondary and tertiary activities such as food processing and banking. Urban settlement has a large population size and high population density.

In Kerala their exist a high pace of urbanisation with Malappuram district having the largest increase in the urban content with in a decade 2001-2011 followed by Kozhikode. The population density of Urban agglomerates in Kerala is less when compared to other states. The analysis of population growth rate indicates that Kerala is likely to achieve zero population growth in 25 to 30 years. The low population growth rate with high level of urbanisation will increase the scarcity of labour in agriculture & related activities. The maximum population density has been achieved in urban areas in the present human settlement pattern in Kerala. Most of the people migrated in Urban area is due to avail employment opportunities likely industrial works, IT field and other related activities.

The rural population in Kerala is 17471135 in which the male population is 84080547 and the female population is 9063081. But in 15934926 urban population, male population is 7619358, female population is 8315568, 52.29% population rural area, 47.70% population in urban area.

Population Census

A population census is the total process of collecting, compiling, evaluating analysis and publishing or otherwise disseminating, demographic, economic and social data pertaining at a specified time, to all persons in a country or in a well delimited part of a country. Census is the largest single source of a variety of statistical information on different characteristics of the people of Kerala.

As per population census 2011 the total population of Kerala is 33406061 of which male and female are 16027412 and 17378649 respectively. The most populated district in Kerala is Malappuram in which 4112920 followed by Thiruvananthapuram is 3301427. As per the projected figure of population in 2014 Kerala is 33941670 of which male is 16284385 and female is 17657285.

Age is one of the most important characteristics of population composition. Almost all population characteristics vary significantly with age. Age statistics is an important component of population analysis. The age groups 0-14 and above 65+ are economically inactive persons. They are dependent only 10.77% of population is dependent but 68.13% of population are working class they are economically active persons.

Water Supply

Kerala water authority is an autonomous authority established for the development and regulation of water supply and waste water collection and disposal. Kerala Water Authority is the largest entity in the field of water supply and implemented thousands of small, medium and large urban and rural piped water supply schemes. The interaction between water and human health are indeed complex. Access to safe drinking water is a recognised Universal human need. Kerala Water Authority came into existence on 1st April 1984. Government of Kerala thousand of water supply schemes were implemented under the Panchayat System as well. The State also gets rain from the North-East monsoon during October to December and the South west monsoon during May to June. In early period the rural household for domestic water supply depends are traditional ground water system and rarely use piped water supply system and early used pipe water system.

With the high density of population, Industrialisation and rapid urbanisation on the one hand and the impact of climate change the availability of different user groups on the other climate condition of the earth has been changing over the few year. This will affect the weather condition of Kerala.

Ground Water

Ground water is one among the nations most important natural resources. Groundwater has been the main stay for meeting the domestic needs of more than 80 % of rural and 50% of urban population. The ground water level receding drastically during the summer months and drying up of wells are common features of the ground water levels in many parts of Kerala. The availability of the ground water level between the post and one monsoon levels varies widely. Kerala water authority is a autonomous authority established for the development and regulation of water supply and waste water collection and disposal. The National Water policy of the Govt. of India states that the non conventional method for utilisation of water such a through artificial recharge of ground water and traditional water conservation practices like rain water harvesting need to be practised to increase the utilisable water resources. In the past we used to depend more on surface water sources like rivers ponds and streams. But with depletion of water bodies due to extremes summer and other factors the peoples shifted our focus to ground water.

Jalanidhi Project

Jalanidhi is a project of Kerala Rural Water Supply Authority (KRWSA) which is aided by World Bank. The World Bank aided Jalanidhi scheme for rural water supply. It aims to assist Govt of Kerala in improving the quality of rural water supply and delivery of environmental sanitation services to achieve sustainability of investment. The KRWSA was launched as a nodal agency to facilitate the implementation of rural water supply systems. Jalanidhi – I Project completed during the year 2000-08 with the cost of Rs.381.50 crores had completed 3705 water supply schemes covering 112 Grama panchayaths. Consequent to the successful implementation of Jalanidhi-I, Govt of Kerala has decided to implement Jalanidhi -2 with world bank support Jalanidhi projects covers 112 Grama Panchayaths from all districts of Kerala.

Jalanidhi I & II water supply connection provided in domestic and non domestic purposes, 195928 and 175 connection respectively.

Dug wells are unlined boreholes and used for maximum height of free water over intake length. Piezometers are line bore holes used for measuring pressure of free water at intake depth. On the analysis of data related to ground water, the total number of dug wells is 428 but piezometers are 426. Kasargode has highest dug well at rate of 9%, but piezometers has highest in Thiruvananthapuram at rate of 10%.

KWA implement many schemes related to drinking water in the state. Schemes are divided into 2 streams namely urban water supply and rural water supply. Rural water supply schemes included multi Panchayath and single Panchayath. In rural water supply schemes ,single panchayath has 1067 connections . It is comparatively higher than multi Panchayath schemes and urban water supply schemes.

Infant mortality rates

Infant mortality refers to death of young children, typically those less than one year of age. It is measured by the IMR, which is the number of death of children under one year of age per 1000 live birth. Out of 3445 infants death registered only 33.09% infant death occurred during 2013, it was declined to 7.22 again it was declined 6.45% in 2014, the male IMR rate is 6.94 and female IMR rate is 5.93, comparatively the IMR is high in male. Kozhikode has highest infant death 15.22% followed by Thiruvananthapuram at 11.11%.

Table:7.1 Population of Kerala

Sl. No.	Districts	Census 2011			
		Male	Female	Population	Sex Ratio
1.	Thiruvananthapuram	1581678	1719749	3301427	1088
2.	Kollam	1246968	1388407	2635375	1113
3.	Pathanamthitta	561716	635696	1197412	1129
4.	Alappuzha	1013142	1114647	2127789	1100
5.	Kottayam	968289	1006262	1974551	1040
6.	Idukki	552808	556166	1108974	1006
7.	Ernakulam	1619557	1662831	3282388	1028
8.	Thrissur	1480763	1640437	3121200	1109
9.	Palakkad	1359478	1450456	2809934	1067
10.	Malappuram	1960328	2152592	4112920	1096
11.	Kozhikode	1470942	1615351	3086293	1097
12.	Wayanad	401684	415736	817420	1035
13.	Kannur	1181446	1341557	2523003	1133
14.	Kasaragod	628613	678762	1307375	1079
	Kerala	16027412	17378649	33406061	1084

Source: Census 2011

Table: 7.2 District wise Sex-Ratio from 1901-2011

Sl. No.	Districts	Sex-ratio (Number of Females per 1000 Males)											
		1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	2011
1	Thiruvananthapuram	996	990	981	1003	1017	1010	1005	1008	1030	1036	1060	1087
2	Kollam	987	988	989	1006	1013	997	996	1000	1022	1035	1069	1113
3	Pathanamthitta	986	987	949	975	986	996	1011	1019	1056	1062	1094	1132
4	Alappuzha	986	987	986	997	1003	1022	1026	1025	1043	1051	1079	1100
5	Kottayam	965	969	947	966	966	987	988	991	1001	1003	1025	1039
6	Idukki	839	842	850	834	875	909	914	937	963	975	993	1006
7	Ernakulam	985	990	969	994	994	1008	999	988	997	1000	1019	1027
8	Thrissur	1004	1009	1051	1075	1082	1105	1093	1081	1100	1085	1092	1108
9	Palakkad	1042	1057	1069	1079	1079	1085	1077	1056	1056	1061	1066	1067
10	Malappuram	1017	1020	1037	1059	1062	1055	1057	1041	1052	1053	1066	1098
11	Kozhikode	1009	1022	1038	1032	1044	1019	1007	1004	1020	1027	1057	1098
12	Wayanad	805	815	786	804	835	838	903	922	949	966	995	1035
13	Kannur	1060	1079	1121	1106	1110	1074	1048	1033	1040	1049	1090	1136
14	Kasaragod	1060	1053	1050	1040	1039	1046	1026	998	1020	1026	1047	1080
	Total	1004	1008	1011	1022	1027	1028	1022	1016	1032	1036	1058	1084

Source: Census of India

Table:7.3 Density of Population (per Sq.Km) by residence : 2001-2011

Sl. No.	Districts	Density of Population (Per Sq .Km) - 2001	Density of Population (Per Sq .Km) - 2011
1	Thiruvananthapuram	1476	1508
2	Kollam	1038	1061
3	Pathanamthitta	468	452
4	Alappuzha	1492	1504
5	Kottayam	885	895
6	Idukki	259	255
7	Ernakulam	1012	1072
8	Thrissur	981	1031
9	Palakkad	584	627
10	Malappuram	1021	1157
11	Kozhikode	1228	1316
12	Wayanad	366	384
13	Kannur	812	852
14	Kasaragod	604	657
	Total	819	860

Table : 7.4 District wise Population in 5 yr age group - 2011 Census (General Category)

Sl. No.	Districts	All ages			0-4			5-9		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Thiruvananthapuram	3301427	1581678	1719749	216891	110287	106604	227143	115487	111656
2	Kollam	2635375	1246968	1388407	178550	90349	88201	192036	97758	94278
3	Pathanamthitta	1197412	561716	635696	67294	34022	33272	76061	38863	37198
4	Alappuzha	2127789	1013142	1114647	134233	68661	65572	146499	75050	71449
5	Kottayam	1974551	968289	1006262	120699	61477	59222	137235	69895	67340
6	Idukki	1108974	552808	556166	73798	37443	36355	81682	41740	39942
7	Ernakulam	3282388	1619557	1662831	214713	109407	105306	226293	115494	110799
8	Thrissur	3121200	1480763	1640437	213202	109165	104037	213202	109165	104037
9	Palakkad	2809934	1359478	1450456	214550	108923	105627	219514	111856	107658
10	Malappuram	4112920	1960328	2152592	410106	208636	201470	407354	207693	199661
11	Kozhikode	3086293	1470942	1615351	236427	119951	116476	247158	125979	121179
12	Wayanad	817420	401684	415736	65082	33062	32020	69746	35656	34090
13	Kannur	2523003	1181446	1341557	196829	99755	97074	196829	99755	97074
14	Kasaragod	1307375	628613	678762	110718	56396	54322	110107	56329	53778
	Total	33406061	16027412	17378649	2453092	1247534	1205558	2555112	1303190	1251922

Source: Census of India

Table : 7.5 District wise population in 5 yr age group - 2011 Census(General Category)

Sl. No.	Districts	10-14			15-19			20-24		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Thiruvananthapuram	263246	134006	129240	255313	128688	126625	266969	128374	138595
2	Kollam	212437	108388	104049	194497	98395	96102	199854	95208	104646
3	Pathanamthitta	89315	45295	44020	84509	43388	41121	82770	41860	40910
4	Alappuzha	165547	84279	81268	147508	75552	71956	146758	72479	74279
5	Kottayam	155915	79113	76802	138696	72099	66597	129329	68170	61159
6	Idukki	91858	46763	45095	79704	40943	38761	81667	41758	39909
7	Ernakulam	252209	128742	123467	229573	118577	110996	235855	121109	114746
8	Thrissur	250700	127773	122927	239833	121875	117958	239355	116293	123062
9	Palakkad	244128	123988	120140	228471	115748	112723	246144	119819	126325
10	Malappuram	424031	216411	207620	393009	198452	194557	406877	194357	212520
11	Kozhikode	266107	136111	129996	245547	125167	120380	246515	116838	129677
12	Wayanad	77418	39481	37937	63919	32424	31495	66417	31936	34481
13	Kannur	207988	106226	101762	195500	99226	96274	199663	94983	104680
14	Kasaragod	121871	62341	59530	114473	57765	56708	117636	55642	61994
	Total	2822770	1438917	1383853	2610552	1328299	1282253	2665809	1298826	1366983

Source: Census of India

Table: 7.6 District wise population in 5 yr age group - 2011 Census (General Category)

Sl. No.	Districts	25-29			30-34			35-39		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Thiruvananthapuram	258879	120193	138686	245395	114711	130684	257169	117565	139604
2	Kollam	199985	89590	110395	195866	88041	107825	210925	93671	117254
3	Pathanamthitta	79258	36071	43187	78280	34401	43879	87475	37466	50009
4	Alappuzha	150967	69517	81450	153465	70438	83027	168866	75029	93837
5	Kottayam	129779	63724	66055	132945	63546	69399	152837	71558	81279
6	Idukki	85747	43333	42414	83361	41198	42163	94420	45273	49147
7	Ernakulam	238325	116775	121550	239287	116713	122574	262692	124545	138147
8	Thrissur	226434	103198	123236	217204	97933	119271	242166	106832	135334
9	Palakkad	242415	116092	126323	211243	100653	110590	217268	99958	117310
10	Malappuram	364628	164498	200130	300552	132859	167693	281541	121166	160375
11	Kozhikode	245890	109469	136421	234874	104571	130303	242221	106829	135392
12	Wayanad	70224	33366	36858	65644	31334	34310	67856	32250	35606
13	Kannur	197603	86704	110899	195261	85303	109958	194385	84138	110247
14	Kasaragod	113958	51448	62510	102124	46516	55608	99852	45539	54313
	Total	2604092	1203978	1400114	2455501	1128217	1327284	2579673	1161819	1417854

Source: Census of India

Table:7.7 District wise population in 5 yr age group - 2011 Census (General Category)

Sl. No.	Districts	40-44			45-49			50-54		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Thiruvananthapuram	241071	110566	130505	245603	114946	130657	202305	96880	105425
2	Kollam	194318	87448	106870	194136	89847	104289	159033	75188	83845
3	Pathanamthitta	88083	38251	49832	92323	41026	51297	79426	36511	42915
4	Alappuzha	163706	74902	88804	162485	75544	86941	134926	63861	71065
5	Kottayam	156328	75162	81166	154192	74632	79560	132330	65223	67107
6	Idukki	88118	43562	44556	86264	42405	43859	72116	36153	35963
7	Ernakulam	266293	130357	135936	256448	126876	129572	215067	107761	107306
8	Thrissur	239311	110044	129267	233160	109457	123703	194664	92929	101735
9	Palakkad	188881	89633	99248	185219	89055	96164	145372	71048	74324
10	Malappuram	241469	106628	134841	217799	98035	119764	172496	82690	89806
11	Kozhikode	222484	102379	120105	210002	98203	111799	170780	82899	87881
12	Wayanad	57693	28496	29197	55397	27117	28280	42987	21742	21245
13	Kannur	179536	80011	99525	172802	78840	93962	142427	66823	75604
14	Kasaragod	85207	39985	45222	82700	39615	43085	64216	31483	32733
	Total	2412498	1117424	1295074	2348530	1105598	1242932	1928145	931191	996954

Source: Census of India

Table:7.8 District wise Population in 5 yr age group - 2011 Census (General Category)

Sl. No.	Districts	55-59			60-64			65-69		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Thiruvananthapuram	188288	92084	96204	147631	70801	76830	108793	51008	57785
2	Kollam	151920	74390	77530	117038	56968	60070	85527	39780	45747
3	Pathanamthitta	78078	37255	40823	64733	31189	33544	48508	22448	26060
4	Alappuzha	128419	62876	65543	107060	51767	55293	73923	34042	39881
5	Kottayam	120629	60260	60369	97534	47795	49739	70803	33301	37502
6	Idukki	60796	31521	29275	42600	21778	20822	30790	14248	16542
7	Ernakulam	192149	97746	94403	149443	73548	75895	103428	48357	55071
8	Thrissur	168923	82900	86023	142384	67432	74952	99052	44405	54647
9	Palakkad	130083	63772	66311	113415	53287	60128	81894	37059	44835
10	Malappuram	148036	73341	74695	124191	60432	63759	87856	39659	48197
11	Kozhikode	154449	77249	77200	127863	63245	64618	86813	39360	47453
12	Wayanad	36277	18451	17826	28307	14181	14126	19045	8801	10244
13	Kannur	129416	62516	66900	108136	51107	57029	73238	32424	40814
14	Kasaragod	54945	27166	27779	44336	21606	22730	32464	14340	18124
	Total	1742408	861527	880881	1414671	685136	729535	1002134	459232	542902

Source: Census of India

Table : 7.9 District wise population in 5 yr age group - 2011 Census (General Category)

Sl. No.	State/ Districts	70-74			75-79			80+			Age not specified		
		Total	M	F	Total	M	F	Total	M	F	Total	M	F
	Kerala	733372	326562	406810	501367	208317	293050	541849	204348	337501	34486	17297	17189
1.	Kasaragod	22162	9802	12360	14054	5958	8096	14798	5745	9053	1754	937	817
2.	Kannur	55799	24181	31618	38295	15248	23047	40770	14743	26027	5761	2935	2826
3.	Wayanad	12686	5737	6949	8542	3524	5018	9482	3741	5741	698	385	313
4.	Kozhikode	60549	27251	33298	41629	17021	24608	44026	16860	27166	2959	1560	1399
5.	Malappuram	57916	25771	32145	36779	15070	21709	35037	13043	21994	3243	1587	1656
6.	Palakkad	59901	26530	33371	39364	16215	23149	38937	14287	24650	3135	1555	1580
7.	Thrissur	77623	32997	44626	53997	21454	32543	55539	19501	36038	2963	1468	1495
8.	Ernakulam	79552	35457	44095	55915	23493	32422	62456	23351	39105	2690	1249	1441
9.	Idukki	22129	10163	11966	15168	6518	8650	17872	7510	10362	884	499	385
10.	Kottayam	54951	25011	29940	40020	17062	22958	48781	19500	29281	1548	761	787
11.	Alappuzha	56333	24960	31373	39785	16557	23228	45145	16581	28564	2164	1047	1117
12.	Pathanamthitta	37326	17014	20312	28439	12294	16145	34377	13761	20616	1157	601	556
13.	Kollam	61775	27341	34434	40849	17021	23828	44823	16696	28127	1806	889	917
14.	Thiruvananthapuram	74670	34347	40323	48531	20882	27649	49806	19029	30777	3724	1824	1900

'F' - Femal, 'M' - Male

Table :7. 10 Age Wise, Sex Wise Population 2011 & Mid Year 2014

age group	2011 census Population			Mid year population 2014		
	Male	Female	Total	Male	Female	Total
0-4	1247534	1205558	2453092	1267536	1224888	2492424
5 to 9	1303190	1251922	2555112	1324085	1271993	2596078
10 to14	1438917	1383853	2822770	1461988	1406040	2868028
15 to19	1328299	1282253	2610552	1349595	1302813	2652408
20 to 24	1298826	1366983	2665809	1319650	1388901	2708551
25 to 29	1203978	1400114	2604092	1223282	1422562	2645844
30 to 34	1128217	1327284	2455501	1146307	1348564	2494871
35 to 39	1161819	1417854	2579673	1180447	1440587	2621034
40 to44	1117424	1295074	2412498	1135340	1315838	2451178
45 to 49	1105598	1242932	2348530	1123325	1262859	2386184
50 to 54	931191	996954	1928145	946121	1012939	1959060
55 to 59	861527	880881	1742408	875340	895004	1770344
60 to 64	685136	729535	1414671	696121	741232	1437353
65 to 69	459232	542902	1002134	466595	551606	1018201
70 to 74	326562	406810	733372	331797	413333	745130
75 to 79	208317	293050	501367	211657	297748	509405
Above 80	204348	337501	541849	207624	342913	550537
age not stated	17297	17189	34486	17575	17465	35040
TOTAL	16027412	17378649	33406061	16284385	17657285	33941670

Table:7.11 District wise Distribution of Fishermen Population in Kerala 2014-15 (Estimated)

Sl.No.	District	Marine				Inland				Marine & Inland (Total)
		Male	Female	Children	Total	Male	Female	Children	Total	
1	2	3	4	5	6	7	8	9	10	11
1	Thiruvananthapuram	62857	55527	49370	167754	445	517	443	1405	169159
2	Kollam	39498	33393	19609	92500	13435	12649	8102	34186	126686
3	Pathanamthitta	0	0	0	0	927	805	375	2107	2107
4	Alappuzha	50472	46127	31177	127776	24879	23832	12871	61582	189358
5	Kottayam	0	0	0	0	9770	9274	5753	24797	24797
6	Idukki	0	0	0	0	266	267	169	702	702
7	Ernakulam	28559	26756	16804	72119	23605	23098	16752	63455	135574
8	Thrissur	21539	21706	12412	55657	7887	7219	4563	19669	75326
9	Palakkadu	0	0	0	0	860	848	868	2576	2576
10	Malappuram	34942	28418	26005	89365	1800	1568	847	4215	93580
11	Kozhikode	38607	33610	25770	97987	4147	4374	3397	11918	109905
12	Wayanadu	0	0	0	0	76	81	77	234	234
13	Kannur	13997	12718	10912	37627	2409	2548	1365	6322	43949
14	Kasargod	17246	16082	9787	43115	413	390	180	983	44098
	TOTAL	307717	274337	201846	783900	90919	87470	55762	234151	1018051

Source: Economic Review 2015



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