



COMPENDIUM OF ENVIRONMENT STATISTICS KERALA 2015-16



DEPARTMENT OF ECONOMICS
AND STATISTICS, KERALA



GOVERNMENT OF KERALA

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DEPARTMENT OF ECONOMICS & STATISTICS
GOVERNMENT OF KERALA – 695033

P R E F A C E

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.

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

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 concerned for their co-operation and assistance in providing the required data.

This publication is an effort of I & ES Wing in the Publication Division under the leadership of Sri. P.V. Babu, Addl. Director (General) comments and suggestions towards improving future reports would be greatly appreciated.

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



Thiruvananthapuram,
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V. RAMACHANDRAN
DIRECTOR

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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

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 UNSD's Frame work for the Development of Environment Statistics (FDES). 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. 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.

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. Human well-being depends upon the living and non-living elements of the environment and the goods and services they provide. Human 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. 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

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 affect 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 daily livelihood. Continuous exploitation of natural resources to satisfy the livelihood of the community degraded the environment to an extent 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.
- ❖ Chemical Effluents – Toxic effluents pose threat to the environment. Petroleum industries and chemical manufacturing industries create major waste products which are released directly into nearby streams without treatment, creating river pollution and

causing harm not only aquatic life but also man and animals who use the water for drinking and bathing.

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	Changes the climate 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 and agriculture 	<ul style="list-style-type: none"> ➤ Eutrophication ➤ Acidification ➤ Environment Contamination due to Radioactivity 	<ul style="list-style-type: none"> ➤ Climate Change ➤ Ozone Depletion

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

Pollutant is a substance that pollutes something, especially water or the atmosphere. It can enter the environment naturally, such as from volcanic eruptions, or through human activities, such

as burning coal and gasoline. Here, we are giving the list of Major Pollutant, their sources and their effects on humans and environment for general awareness.

Table: 1.4 Air Pollution Sources

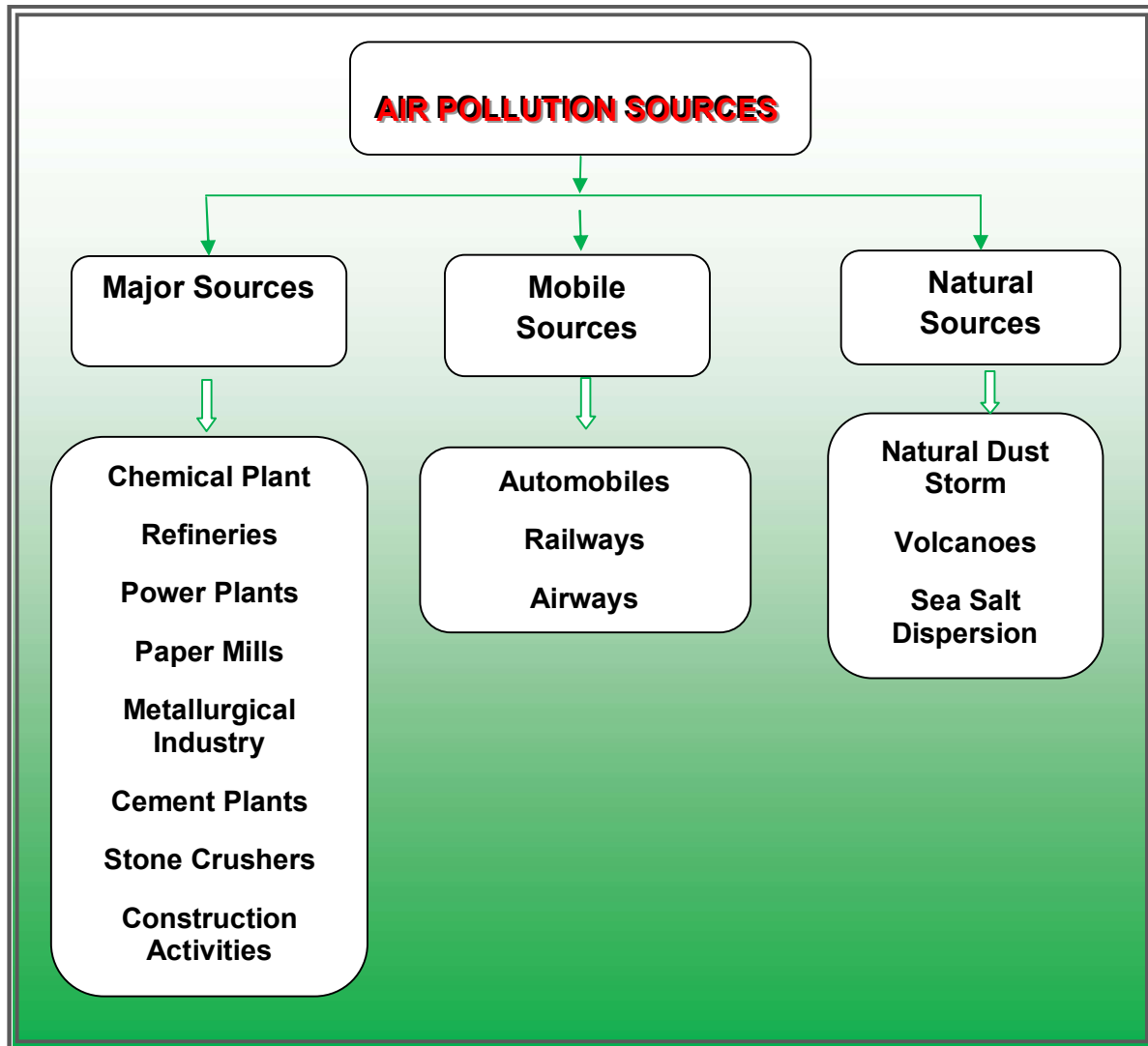


Table : 1.5 Water Born Disease and their Causative Factors

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 Echovirus, Coxsackie – virus</p> <p>Entamoeba histolytica</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>Trypanosoma through tsetse fly Plasmodium through Anopheles</p>
<p>5. Infection primarily due to defective sanitation</p> <p>Hookworm</p>	<p>Hook worm, Ascaris</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 impair 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 Environmental Statistics in Kerala

Introduction

The Development of Environmental Statistics is a flexible, multi-purpose conceptual and statistical framework that is comprehensive and integrative in nature. It points 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 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 formulation 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 coastal of 580 Km with an intricate system of backwaters along the coast. The tropical moist forest in 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 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 Conference of Central and State Statistical Organisation (COCSSO) meeting it was 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 5 reports have been released from this division and Environment Statistics 2015-16 is the Sixth 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.

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

Kerala State Pollution Control Board

Kerala State Pollution Control Board has been constituted on 12.9.1974 by the govt. of Kerala 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 is 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 assesseees.

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;
- Inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air therein and take steps for the prevention, control or abatement of air pollution in such areas
- 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 what ever 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, regarding;

- Co-operate in preparation of on-site emergency plans;
- Enforce directions and procedures on import of hazardous chemicals on information regarding import;
- 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.

The EIA notification

- Receive request for environment public hearing;
- Notify the details of public hearing;
- Assist District Collector for public hearing and to furnish report thereof to the Ministry of Environmental and Forests.

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 28008 sq.km 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(Mean Sea Level).
- 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.

National Centre for Earth Science Studies

National Centre for Earth Science Studies (NCESS) is the leading centres of excellence in the field of Earth System 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 are unique for the south-west coast of India.

Data generated under this programme found useful for various planning purposes at the State level and also to pursue systematic studies under various geo-environmental conditions. Data base has been generated under the broad resource categories of land, land use, water, forest, infrastructure, and population and allied activities. Water quality analysis also taken up for selected rivers and back waters for pollution monitoring and data base development. Land system and drainage pattern analyses are based on maps, images and direct field measurements. Earthquake monitoring and study of neo-tectonics are in hazard studies. Physical and social vulnerability analysis are taken up for hot spots in the Western Ghats and selected coastal stretch to develop management plans. Data on climatic parameters and greenhouse gases (GHG) will be acquired by installing field stations, one along coast and another at Munnar in Western Ghats region. Application of remote sensing will cover geological studies, corals and agricultural operations.

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 utilisation 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 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.

Department of Environment

Department of Environment Statistics 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.

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.

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

Biodiversity of Kerala

Biodiversity is the variety of life on earth. It includes the variability of species in terrestrial, aerial and aquatic habitats, the diversity of ecosystems and the diversity of genes they harbor. It is an essential component of the nature and it ensures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind. Indirectly, biodiversity serves the humans by providing the basic life supporting systems such as clean air, water and fertile soil. 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 biodiversity 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 biodiversity include:

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

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 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.

Plant Diversity in Kerala

Plant diversity is the biological basis for hotspot designation. To qualify as a hotspot, a region must support 1,500 endemic plant species, 0.5 percent of the global total. Existing primary vegetation is the basis for assessing human impact in a region; to qualify as a hotspot, a region must have lost more than 70 percent of its original habitat. Identification of hotspot would help pinpointing priority areas for conservation.

According to the classification of Norman Myres' there are 25 hotspots scattered in different parts of the world. Even though the 25 biodiversity hotspots together represent 1.4 percent of the earth's land area, they contain 44 percent of all plant species and 35 percent of all terrestrial vertebrate species in the world. Each of these hotspots is under severe pressure due to anthropogenic interventions and has already lost at least 70 percent of its original natural vegetation.

The Western Ghats region is one of the 25 biodiversity hotspots in the world. The Western Ghats 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: given in the table 3.1

Table: 3.1 Flora Statistics in Kerala

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

Endemic Species:

There are about 1272 species of endemic angiosperms out of 3800 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

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

Invasive alien species and biodiversity

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 mode 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. Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential. Alien species cause major environment and economic problems worldwide. 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.

Protected area of Kerala:

The Protected area 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

SI No.	Protected Areas	Area (sqKm)	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

Sl No.	Protected Areas	Area (sqKm)	District
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	Kurinjalma 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

Source: Kerala Biodiversity Board

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; Dipercarpus-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.

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 report 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.

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 Mean Sea Level. 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

SINo.	Plant Groups	World	India	Kerala	% in 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 Ghat's encompassing the forests of Kerala is one of the 34 Biodiversity hot spots in the World and Kerala has close to 90 % of its vertebrate fauna. Very high levels of species diversity and endemism provide importance to the faunal wealth of Kerala.

Table: 3.5 Faunal Wealth of Kerala

Sl.No	Group	No.of.Species
1	Mammals	145
2	Birds	486
3	Reptiles	164
4	Amphibians	85
5	Freshwater Fishes	196
6	Insects	4027
Total		5103

Source: Kerala Forest Department

According to one estimate, 285 species of Vertebrate are reported to be endemic to Western Ghats, which include 12 mammals, 16 birds, 89 reptiles, 87 amphibians, and 84 fresh water fishes. Among large mammals, no species is endemic to Kerala. However, birds such as White breasted laughing thrush, Wayanad laughing thrush, White bellied shortwing, Southern treepie, Rufous babbler are possible endemic birds which may slightly overlap state boundaries in the southern Western Ghats. High diversity area like West Malaysia has only about 10 endemic snakes, whereas the South West India has about 55. Among reptiles, Cochin forest cane turtle and Travancore tortoise are endemic to evergreen forests of southern Western Ghats. Arboreal agamid genera *Otocryptis* and *Salea* and the rare endemic genus of burrowing snake, *Xylophus* and others of the family *Uropeltidae* have been accorded high conservation value.

The monotypic agamid genus *Dravidogecko* is reported from Anamalais only. Thirty species of lizards are reported endemic to Western Ghats which include *Calotes rouxi*, *Cnemaspis sisparensis*, *C.wynadensis* and *Chalcides pentadactylus*. Out of 57 endemic snakes in the Western Ghats four species viz., *Boiga dightsni*, *Melanophidum bilineatum*, *Plectrurus aureus* and *Rhinophis fergusonianus* are endemic to Kerala and adjacent forests.

The southern Western Ghats have probably 40 species of endemic tree frogs. Among Amphibia, *Bufo* has five, *Microhylidae* one, *Ranidae* 14, *Rhacophoridae* four

and Gymnophiona, the caecilian, five. Of the endemic amphibian genera of the Western Ghats i.e., Nannobatrachus, Nyctibatrachus, Melahobatrachus and Uraeotyphlus, the notable species endemic to Kerala are Melanobatrachus indicus, Nannobatrachus anamallaiensis, Nyctibatrachus, Nyctibatrachus major, N. phygameus, Uraeotyphlus malabaricus and U. menoni. Among fish fauna, species like Lepidopygopsus typus, Hysilobarbus kurali, have been reported to be endemic to southern Western Ghats. In a recent survey of the stream fishes in the Kerala segment of Nilgiri Biosphere Reserve 58 species with 25 species endemic to Western Ghats were reported from the streams in Wayanad.

Table: 3.6 Fauna Endemic to Western Ghat's-Found in Kerala

Sl.No.	Group	Nos
1	Amphibians	61
2	Reptiles	57
3	Birds	16
Total		73

Source: Kerala Forest Department

Vertebrate Diversity of Kerala

Vertebrate Diversity of Kerala is represented by 1,847 species 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, amphibians with 151 species and mammals with 118 species.

Table: 3.7 Vertebrate Diversity of Kerala

Sl 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

Birds

There are at least 500 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.

Fishes

As of 2004, 288 freshwater fish species are listed for the Western Ghats, including 35 known from brackish or marine water. There is 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). The primary threats are from habitat loss, but also from overexploitation and introduced species.

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 173 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 151 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 among 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 Biodiversity 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 consists 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 indigenious 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

	<p>Scientific name: <i>Gonoproktopterusperiyarensis</i> 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.</p>
	<p>Scientific name: <i>Garrahughi Silas</i>, 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.</p>
	<p>Scientific name: <i>Tor khudree Sykes</i>. 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.</p>

	<p>Scientific name: <i>Vijayachelyssilvatica</i> (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.</p>
	<p>Scientific name: <i>Cheloniamydas</i> (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. <i>Cheloniamydas</i> is found throughout the Indian River Lagoon. As per IUCN, its status is endangered.</p>
	<p>Scientific name: <i>Varanusbengalensis</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>Rhacophoruslateralis</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>Bosgaurus</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>Platacanthomyslasiurus</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 DanaidEggfly. Loss and alteration of the habitiat, pollution, pesticide, fungicide and weedicide application, industrial pollution, etc. are the threats to the species. It is Included in the Wildlife Protection Act (1972) Schedule 1.</p>
	<p>Scientific name: <i>Lissemyspunctata</i> (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 habitiat, 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.</p>
	<p><i>Glyptopetalumgrandiflorum</i>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</p>

	<p><i>Humboldtia unijuga</i> Bedd. Family: Caesalpiniaceae 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</p>
	<p><i>Polyalthia shendurunii</i> 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</p>
	<p>Scientific name: <i>Ceropogia decaisneana</i> 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>
	<p>Scientific name: <i>Goniothalamus wynaadensis</i> (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>Ixora lawsonii</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>Miliosanilagirica</i>Bedd.</p> <p>Description: Shrubs in evergreen forests at higher altitudes</p> <p>Economic value : Not known</p> <p>Distribution: Southern Western Ghats</p> <p>Endemism: Endemic to Windward region of Nilgiri phytogeographical region of Southern Western Ghats</p> <p>Threat to the species: Habitat disturbances</p>
	<p>Scientific name : <i>Triasstocksii</i>Benth.</p> <p>Description: Epiphyte in evergreen and semi-evergreen forests</p> <p>Distribution: Southern Western Ghats</p> <p>Endemism: Endemic to Southern Western Ghats</p> <p>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: 3.8 Endangered Forest Species in Kerala

SI No.	Species	Family	Habit
1	Acampe congesta	Orchidaceae	Herbs
2	Bulbophyllum aureum	Orchidaceae	Herbs
3	Ipsea malabarica	Orchidaceae	Herbs
4	Paphiopedilum druryi	Orchidaceae	Herbs
5	Taeniophyllum scaberulum	Orchidaceae	Herbs
6	Vanilla wightiana	Orchidaceae	Herbs
7	Arisaema attenuatum	Araceae	Herbs
8	Arisaema auriculata	Araceae	Herbs
9	Arisaema peltatum	Araceae	Herbs
10	Calamus travancoricus	Arecaceae	Shrubs
11	Cynometra beddomei	Fabaceae	Trees
12	Cynometra travancorica	Fabaceae	Trees
13	Dalbergia beddomei	Fabaceae	Lianas
14	Dialium travancoricum	Fabaceae	Trees
15	Inga cynometroides	Fabaceae	Tree
16	Smithia venkobarrowii	Fabaceae	Shrubs
17	Tephrosia wynaadensis	Fabaceae	Herbs
18	Buchanania barberi	Anacardiaceae	Trees
19	Buchanania lanceolata	Anacardiaceae	Trees
20	Dysoxylum beddomei	Meliaceae	Trees
21	Dysoxylum ficiforme	Meliaceae	Trees
22	Eugenia argentea	Myrtaceae	Trees
23	Eugenia discifera	Myrtaceae	Trees
24	Hedyotis beddomei	Rubiaceae	Herbs
25	Hedyotis bourdillonii	Rubiaceae	Herbs
26	Hedyotis wynaadensis	Rubiaceae	Herbs
27	Adenosma malabaricum	Scrophulariaceae	Herbs
28	Anaphalis barnesii	Compositae	Herbs
29	Hydnocarpus macrocarpa	Flacourtiaceae	Trees
30	Atuna travancorica	Rosaceae	Trees
31	Bombax scopulorum	Bombacaceae	Trees
32	Syzygium bourdillonii	Myrtaceae	Trees
33	Syzygium palghatense	Myrtaceae	Trees

34	<i>Syzygium travancorcum</i>	Myrtaceae	Trees
35	<i>Impatiens aliciae</i>	Balsaminaceae	Herbs
36	<i>Impatiens anaimudica</i>	Balsaminaceae	Herbs
37	<i>Impatiens cochinica</i>	Balsaminaceae	Herbs
38	<i>Impatiens coelotropis</i>	Balsaminaceae	Herbs
39	<i>Impatiens concinna</i>	Balsaminaceae	Herbs
40	<i>Impatiens johnii</i>	Balsaminaceae	Herbs
41	<i>Impatiens leptura</i>	Balsaminaceae	Herbs
42	<i>Impatiens macrocarpa</i>	Balsaminaceae	Herbs
43	<i>Impatiens munnarensis</i>	Balsaminaceae	Herbs
44	<i>Impatiens pandata</i>	Balsaminaceae	Herbs
45	<i>Impatiens platyadena</i>	Balsaminaceae	Herbs
46	<i>Impatiens pallidiflora</i>	Balsaminaceae	Herbs
47	<i>Impatiens rivulicola</i>	Balsaminaceae	Herbs
48	<i>Impatiens verecunda</i>	Balsaminaceae	Herbs
49	<i>Nilgirianthus asper</i>	Acanthaceae	Shrubs
50	<i>Nilgirianthus barbatus</i>	Acanthaceae	Shrubs
51	<i>Nilgirianthus beddomei</i>	Acanthaceae	Shrubs
52	<i>Nilgirianthus ciliatus</i>	Acanthaceae	Shrubs
53	<i>Nilgirianthus decurrens</i>	Acanthaceae	Herbs
54	<i>Nilgirianthus foliosus</i>	Acanthaceae	Herbs
55	<i>Nilgirianthus lupulinus</i>	Acanthaceae	Herbs
56	<i>Nilgirianthus neilgherrensis</i>	Acanthaceae	Herbs
57	<i>Nilgirianthus perrottetianus</i>	Acanthaceae	Herbs
58	<i>Nilgirianthus punctatus</i>	Acanthaceae	Herbs
59	<i>Nilgirianthus urceolaris</i>	Acanthaceae	Herbs
60	<i>Ophiorrhiza barnesii</i>	Rubiaceae	Herbs
61	<i>Ophiorrhiza candata</i>	Rubiaceae	Herbs
62	<i>Ophiorrhiza incarnata</i>	Rubiaceae	Herbs
63	<i>Ophiorrhiza munnarensis</i>	Rubiaceae	Herbs
64	<i>Plectronia pergracilis</i>	Rubiaceae	Shrubs
65	<i>Isachne fischeri</i>	Gramineae	Herbs
66	<i>Isachne setosa</i>	Gramineae	Herbs
67	<i>Ixora johnsonii</i>	Rubiaceae	Herbs
68	<i>Jambosa bourdillonii</i>	Myrtaceae	Trees

69	Meteoromyrtus wynaadensis	Myrtaceae	Trees
70	Janakia arayalpathra	Periplocaceae	Herbs
71	Limnopoia meeboldii	Gramineae	Herbs
72	Litsea travancorica	Lauraceae	Trees
73	Loesnerinella bourdilonii	Celastraceae	Climber
74	Madhuca bourdillonii	Sapotaceae	Trees
75	Morinda reticulata	Rubiaceae	Climber
76	Ceropegia beddomei	Asclepiadaceae	Climbers
77	Cirrhopetalum avreum	Orchidaceae	Herbs
78	Clematis bourdillonii	Ranunculaceae	Climbers
79	Colubrinma travancorica	Rhamnaceae	Shrubs
80	Cyclea fissicalyx	Menispermaceae	Climbers
81	Didymocarpus macrostachya	Gesneriaceae	Herbs
82	Garcinia imberti	Guttiferae	Trees
83	Haplothismia exannulata	Burmanniaceae	Herbs
84	Hyalisma janthina	Triuridaceae	Herbs
85	Hydrobryum johnsonii	Podostemaceae	Herbs
86	Cinnamomum travancoricum	Lauraceae	Trees
87	Orophea uniflora	Annonaceae	Shrub
88	Phaenanthus malabaricus	Annonaceae	Trees
89	Polyalthia rufescens	Annonaceae	Trees
90	Sageraea grandiflora	Annonaceae	Trees
91	Vernonia anaimudica	Compositae	Herbs
92	Vernonia heynei	Compositae	Herbs
93	Vernonia multibracteata	Compositae	Herbs
94	Ochlandra beddomei	Bambusaceae	Trees
95	Ochreinauclea missionis	Rubiaceae	Trees
96	Oianthus beddomei	Asclepiadaceae	Twiners
97	Otonephelium stipulaceum	Sapindaceae	Trees
98	Palaquium bourdillonii	Sapotaceae	Trees
99	Phlebophyllum lawsonii	Acanthaceae	Shrubs
100	Pogostemon travancoricus	Labiatae	Herbs
101	Pterospermum reticulatum	Sterculiaceae	Trees
102	Schefflera bourdillonii	Araliaceae	Climbers
103	Silentvalleya nairii	Gramineae	Herbs

104	Sonerila nemakadensis	Melastomataceae	Herbs
105	Strobilanthes dupenii	Acanthaceae	Herbs
106	Toxicarpus palghatensis	Asclepiadaceae	Herbs
107	Poeciloneuron indicum	Bonnetiaceae	Trees
108	Poeciloneuron pauciflorum	Bonnetiaceae	Trees

Source: Kerala Forest Department

Table: 3.9 District Wise Forest Area (Area in sqKm)

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	Alappuzha	NIL			
5	Kottayam	2203	100.8450	0	100.8450
6	Idukki	5019	2679.072	34.6506	2713.7226
7	Ernakulam	2407	823.8302	0	823.8302
8	Thrissur	3032	1018.438	4.3137	1022.7517
9	Palakkadu	4480	860.2	667.1564	1527.3564
10	Malappuram	3550	325.3261	398.592	723.9181
11	Kozhikode	2344	47.3658	243.0856	290.4514
12	Wayanadu	2131	566.511	340.5337	907.0447
13	Kannur	2966	143.7275	97.8442	241.5716
14	Kasargod	1992	86.0221	33.7083	119.7304
TOTAL		38863	9471.6215	1837.7956	11309.4171 *

Source : Forest Statistics 2016

** 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.*

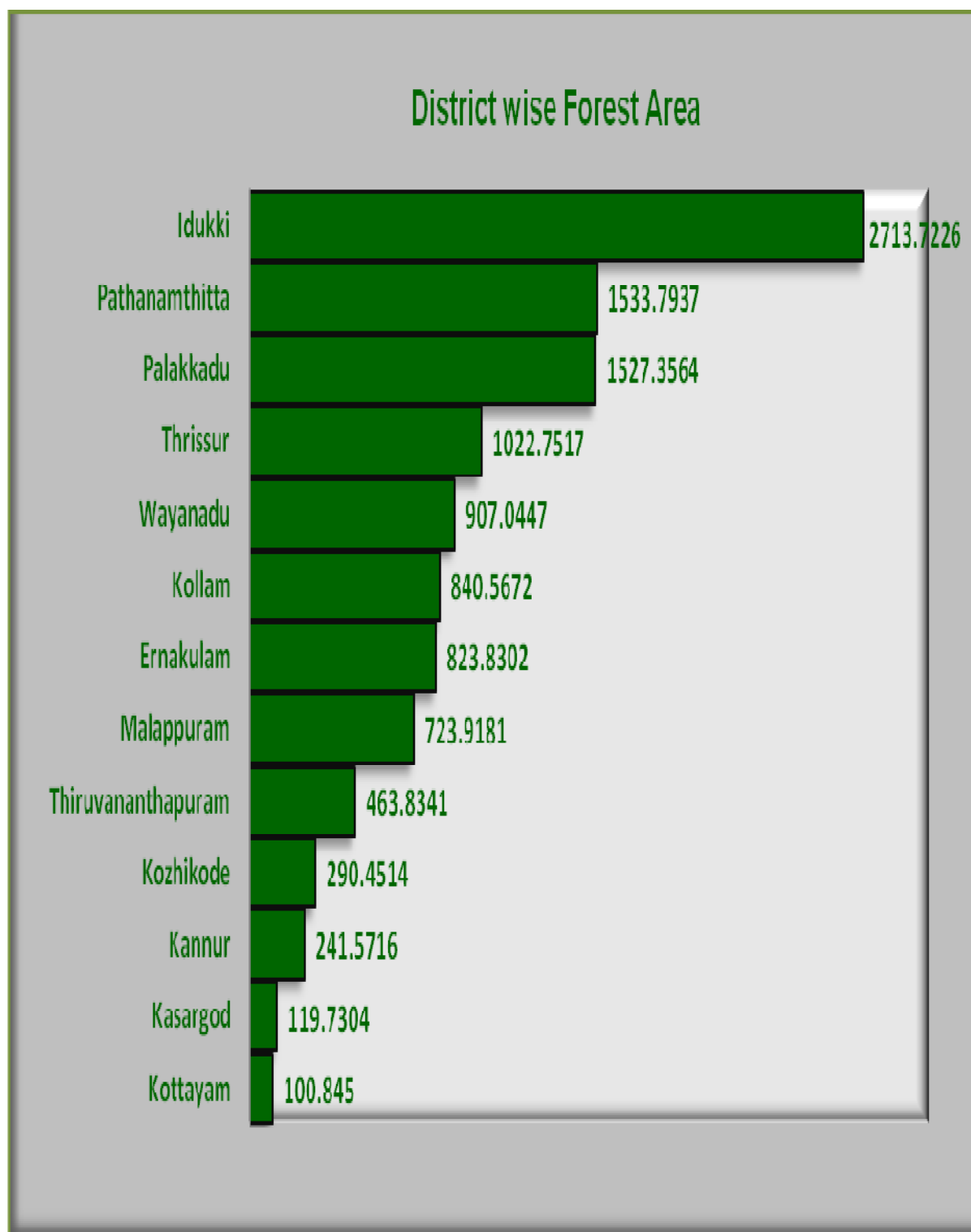


Table: 3.10 Division wise area of Forest 2015-16
Area in sqKm

SI 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
Agastyanam 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	

Source: Forest Statistics 2016

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

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 is 391.3636 Km², Montane Sub-tropical Temperate shoals is 386.4210 Km², Plantations are 1549.5033 Km², Grass lands covers 501.0865 and others are 987.6757 Km². The classification of Total Forest Area is given in the chart.

Table: 3.11 Classifications of Forest Types 2015-16

Sl No.	Type of Forest	Area (SqKm)	% 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	1549.5033	13.70
6	Grass Lands	501.0865	4.43
7	Others	987.6757	8.73
	Total	11309.4754	100

Source: Forest Statistics 2016

Table: 3.12 Classification of Forest Area according to utilisation

SlNo.	Mode of Utilisation	2015	2016
		Area (Km ²)	
1	Dense Forest / Degraded Forest	8754.2168	8852.8761
2	Plantations	1567.4374	1549.5033
3	Area under Lease	604.4537	523.7198
4	Forest Land diverted under FCA	383.3675	383.3762
	Total	11309.4754	11309.4754

Source: Forest Statistics

Table: 3.13 District wise Ecologically Fragile Land (EFL) Area

Sl. No.	District	2015	2016
		Area (ha)	
1	Thiruvananthapuram	885.26	723.5817
2	Kollam	273.72	273.7233
3	Idukki	1411.82	1398.0533
4	Thrissur	80.04	76.4046
5	Palakkad	5270.69	4874.3636
6	Malappuram	1285.09	1153.2027
7	Kozhikode	1544.99	1544.0400
8	Wayanad	3004.86	2957.8486
9	Kannur	491.26	488.1291
10	Kasaragode	662.90	663.1677
	TOTAL	14910.63	14152.5146

Source: Forest Statistics

Table: 3.14 District wise Forest cover 2015-16 (area in SqKm)

SINo	District	Geographic Area	2015 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 2016

Table: 3.15 Division wise Area of Plantation (species wise) 2015-16

SI No.	Division	Hardwood	Softwood	Others	Bamboo, Cane and Reeds	Mangroves	Total
1	Thiruvananthapuram	4347.712	367.676	2114.567	0	0.000	6829.955
2	Thenmala	1804.910	971.946	3213.090	9.740	0.000	5999.686
3	Punalur	3223.710	394.680	1039.380	129.220	0.000	4786.990
4	Achenkovil	2943.730	0	1278.847	0	0.000	4222.577
5	Ranni	3966.450	0	2354.470	541.470	0.000	6862.390
6	Konni	8509.634	32.480	1181.716	912.900	0.000	10636.730
7	Kottayam	4185.401	252.940	1304.867	371.381	0.000	6114.589
8	Munnar	790.524	3563.410	1305.580	587.860	0.000	6247.374
9	Kothamangalam	4761.715	304.040	1233.897	266.860	0.000	6566.512
10	Marayoor	0	799.620	17.200	0	0.000	816.820
11	Mankulam	39.250	101.000	211.130	211.560	0.000	562.940
12	Malayattoor	5211.354	31.098	2678.628	86.700	0.000	8007.780
13	Vazhachal	3933.870	489.510	2881.780	363.940	0.000	7669.100
14	Chalakkudy	4622.590	107.800	1031.850	38.600	0.000	5800.840
15	Thrissur	4437.690	40.000	2033.010	0	0.000	6510.700
16	TS Perumbavoor	64.490	0	0	0	0.000	64.490
17	Nenmara	1631.930	146.540	1468.720	90.040	0.000	3337.230
18	Palakkad	1927.610	108.820	1390.410	173.430	0.000	3600.270
19	Mannarkkad	598.750	143.920	599.760	50.000	0.000	1392.430
20	Nilambur (South)	4659.978	0	539.680	177.500	0.000	5377.158
21	Nilambur (North)	4155.359	41.580	1267.660	1311.484	0.000	6776.083
22	Kozhikkode	339.860	1048.812	981.390	83.100	5.000	2458.162
23	Wayanad (South)	2693.650	1003.400	1478.680	171.000	0.000	5346.730
24	Wayanad (North)	712.450	263.930	2981.470	1281.600	0.000	5239.450
25	Kannur	703.442	0	3950.204	102.100	251.979	5007.725
26	Kasaragod	1208.012	0	1835.383	467.212	116.210	3626.817
27	Thiruvananthapuram Wildlife	63.080	93.760	1248.381	1126.468	0.000	2531.689
28	Peechi Wildlife	457.427	0	1141.887	132.250	0.000	1731.564
29	Parambikulam Wildlife	8747.466	0	0	0	0.000	8747.466

SI No.	Division	Hardwood	Softwood	Others	Bamboo, Cane and Reeds	Mangroves	Total
30	Silent Valley Wildlife	437.300	57.890	94.000	0	0.000	589.190
31	Wayanad Wildlife	7486.802	429.670	2987.899	0	0.000	10904.371
32	Aaralam Wildlife	291.300	0	30.000	0	0.000	321.300
33	NSC, Kalady	162.217	0	77.500	23.500	0.000	263.217
	Total	89119.663	10794.522	45953.036	8709.915	373.189	154950.325

Source : Forest Statistics 2016

Table: 3.16 Species wise distribution of Plantation Area

SI No.	Species	2015	2016
		Area (Ha.)	
1	Teak	76734.962	77440.840
2	Teak & Soft wood	14482.874	13537.283
3	Accacia Mangium	3589.465	3048.425
4	Accacia auriculiformis	5752.314	6482.983
5	Eucalyptus	6566.155	7136.528
6	Cane	1908.872	2946.692
7	Bamboo	5057.442	5347.263
8	Rosewood	55.130	45.130
9	Mahagani	360.556	478.356
10	Sandalwood	73.840	73.840
11	Other Hardwood	264.130	502.810
12	Reeds	515.352	415.960
13	Cinnamon	0.000	0.000
14	Pepper	70.000	100.000
15	Medicinal Plants	2027.111	2025.200
16	Gravelia Robusta	576.728	490.368
17	Pine	552.800	608.976
18	Albezzia	120.330	120.330
19	Anjili	393.340	585.039
20	Kambakam	185.240	462.240
21	Elavu	600.980	600.980
22	Rubber	86.370	44.370
23	Balsa	36.040	21.040
24	Wattle	2187.610	1285.620

25	Matti	497.310	486.310
26	Cashew	4849.459	4694.819
27	Agave	41.640	41.640
28	Alnus	74.350	74.350
29	Sesbania	21.070	21.070
30	Casuarina	138.870	52.630
31	Silver Oak	108.530	134.530
32	Mangroves	373.189	373.189
33	Fruit bearing	366.543	315.543
34	Miscellaneous	28075.141	24955.971
	TOTAL	156743.742	154950.325

Source: Forest Statistics

Table: 3.17 Out turn of Major Forest Produces

SI No.	Category	Unit	Quantity
1	Industrial wood	M ³	31185.936
2	Plywood	M ³	651.974
3	Match wood	M ³	596.002
4	Bobbin wood	M ³	35.337
5	Packing case wood	M ³	296.124
6	Pulpwood	MT	26824.588
7	Miscellaneous		
	a) Timber	M ³	8008.516
	b) Fire wood / Billets	MT	5831.270
	c) Sandal wood	Kg	68644.600
	d) Teak Poles	MT	9354.813
	e) Other Poles	MT	459.600

Source : Forest Statistics 2016

Table: 3.18 Procurement of Minor Forest Produces

SI No.	Name	Quantity (kg)
1	Ayurvedic Herbs	732560.10
2	Spices	4745.00
3	Fibre	8361.00
4	Grass other than fodder	127693.00
5	Incensive Plants	10437.70
6	Honey	56176.90
7	Bee's Wax	272.40
8	Vegitable Oil Seeds	4415.00
	TOTAL	944661.10

Source : Forest Statistics 2016

Biosphere Reserves in Kerala

The 17 Biosphere Reserves in India, which protect larger areas of nature and often include one or more 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 Sqkm in the State of Tamil Nadu (2537.6 Sqkm), Karnataka (1527.4 Sqkm) and Kerala (1455.4 Sqkm). 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 Sqkm out of which 1828 Sqkm is in Kerala and 1672 Sqkm 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:

This biosphere reserve straddles the border of Kollam and Thiruvananthapuram districts in Kerala and Tirunelveli and Kanyakumari district 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 now covers 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

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: 3.19 Biosphere Reserves in Kerala

Sl No	Name of reserve	Area (Sq.Km)	Forest area 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

Wildlife Conservation

According to Forest Statistics 2016, 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: 3.20 List of Wildlife Sanctuaries, National Parks, Community Reserve and Biosphere Reserves

SlNo.	Name	District	Area (Sqkm)	Year of Formation
Wildlife Sanctuaries				
1	Periyar WLS (Tiger Reserve), Idukki	Idukki	925.000	1950(1978)
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(2009)
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.	Kozhikode	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
Total			3211.7372	
Community Reserve				
1	Kadalundi – Vallikunnu Community Reserve	Kozhikode & Malappuram	1.500	2007
Biosphere Reserve				
1	Agasthyamala Biosphere Reserve	Thiruvananthapuram & Kollam	1828.00	2001
2	Nilgiri Biosphere Reserve	Palakkad	1455.40	1986

Source: Forest Statistics 2016

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: 3.21 District Wise Mangrove Cover in Sqkm

SlNo.	District	Mangrove Cover			
		Very dense	Moderate dense	Open forest	Total
1	Ernakulam	0	1	1	2
2	Kannur	0	4	2	6
3	Kasaragode	0	0	1	1
TOTAL		0	5	4	9

Source : Forest Statistics 2015-16

Table: 3.22 District wise Fish Production in Kerala 2015-16 (in tones)

Sl No	District	Inland	Marine	Total
1	Thiruvananthapuram	5562	63518	69080
2	Kollam	19757	108686	128443
3	Pathanamthitta	3525	0	3525
4	Alappuzha	34930	44388	79318
5	Kottayam	12308	0	12308
6	Idukki	3536	0	3536
7	Ernakulam	38951	80394	119345
8	Thrissur	26781	21057	47838
9	Palakkadu	22064	0	22064
10	Malappuram	6831	59920	66751
11	Kozhikode	6124	93443	99567
12	Wayanadu	2274	0	2274
13	Kannur	4786	23254	28040
14	Kasaragode	23333	22085	45418
	Total	210762	516745	727507

Source: Fisheries Hand Book

Chapter - IV

Atmosphere

Vehicles and industries are mainly responsible for the deterioration of air quality in the state. Both create noise and emit air pollutants. Impact of vehicular emission and noise is widespread while that due to industrial emission is limited to areas around the industries. Advanced manufacturing techniques have considerably reduced both noise and emission and automobiles. Cleaner production process have emerged which reduce emissions from some industries. But the benefits are being offset by the rapid increase in the numbers of vehicles as well as industries. This growth is pronounced in urban areas. Air quality is therefore under increased stress around urban areas.

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, and global circulation patterns can transport some types of pollution rapidly around the world. In this unit, discover the basic chemistry of atmospheric pollution and learn which human activities have the greatest impacts on air quality. Until a decade ago pollution was not a matter of concern for our State. Increasing use of fossil fuel in the transportation 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 due to increased use of fuels and personal transport. Improper collection and disposal of garbage is causing the waste to rot before it is removed. Scientific disposal facilities are inadequate even in the major cities. Garbage is mostly burned in the open causing air pollution. Vehicular movements and unrestrained use of loud speakers are mainly responsible for the noise 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 part decade by Pollution control Board 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.

Kerala's industrial growth has been very lower when compared to rest of India. The number of industries, which can be categorized as Large or Medium, is about 640. Most of these units are in the private sector and a majority of them are located at Kochi. There are about 2.5 lakh SSI units, which are dispersed in the different districts of the state. Kerala state pollution control board brought nearly 600 large/medium scale industries and about 2500 SSI units under the consent regime of Air (Prevention and Control of Pollution) Act. Majority of the smaller units, comprise of stone crusher. The 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.

Table: 4.1 Air Pollution Monitoring Cities in Kerala 2015-16

City	Particulate Matter upto 10 Micrometer (PM 10)	Particulate Matter upto 2.5 Micro metre (PM 2.5)
Pathanamthitta	23	10
Kollam	39	17
Alappuzha	46	20
Thiruvananthapuram	52	23
Kottayam	55	24
Kozhikkode	57	25
Kochi	64	28
Thrissur	73	32

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 – 78.09% by volume
- ✓ Oxygen – 20.95%
- ✓ Argon – 0.93%
- ✓ Carbon dioxide – 0.04%

Green House Gas Emission in Kerala

Kerala has a fragile and closed ecosystem. In Kerala the emission rate of Carbon dioxide 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, 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 Carbon dioxide 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. Total assumption of all petroleum products during 2003-04 in Kerala was 3.87589 tonnes.

Ozone Depletion

Ozone depletion occurs when chlorofluorocarbons (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 reduces 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.

Hydrochlorofluorocarbons (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.

Wind

The winds over the State are seasonal only in the region of Palghat Gap where winds are predominantly from the east in the period from November to March and from west in the rest of the year. In other parts of the state, flow of wind is mainly governed by differential heating of land and water mass together with mountain winds. Winds have westerly component during the day and easterly components during the night through out the year. In general winds are quite strong during afternoons when the thermal circulation is best developed and weak during night.

Humidity:

As the State stretches from north to south with the Arabian Sea in its west, relative humidity is high in general 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:

Day temperatures are more or less uniform over the plains throughout the year except during monsoon months when these temperatures drop down by about 3 to 5°C.

Both day and night temperatures are lower over the plateau and at high level stations than over the plain. Day temperatures of coastal places are less than those of interior places. March is hottest month with a mean maximum temperature of about 33°C. Mean maximum temperature is minimum in the month of July when the State receives plenty of rainfall and the sky is heavily clouded. It is 28.5°C for the State as a whole in July, varying from about 28°C in the north to about 29°C in the south. Inland stations experience higher maximum temperatures than the coastal stations. From May onwards both the maximum and minimum temperatures start falling, latter very rapidly while the former slowly.

Rainfall

The total annual rainfall in the State varies from 360 cm. over the extreme northern parts to about 180 cm. in the southern parts. The southwest monsoon (June-October) is the principal rainy season when the State receives about 70% of its annual rainfall. Monsoon rainfall as percentage of annual rainfall decreases from north to south and varies from 83 % in northern district Kasaragode to 50% southern district Thiruvananthapuram. Northeast monsoon rainfall as percentage of annual rainfall increases from north to south and varies from 9% in north district Kasaragode to 27% in south most district Thiruvananthapuram. The rainfall amount in the State decreases towards the south with decrease of height of Western Ghats. The southern district Thiruvananthapuram, where Western Ghats are nearest to the sea coast and its average height is also least in the State receives minimum amount of 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 23% of annual rainfall monthly distribution of normal and actual rainfall of Kerala state for last ten years.

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 2015-16

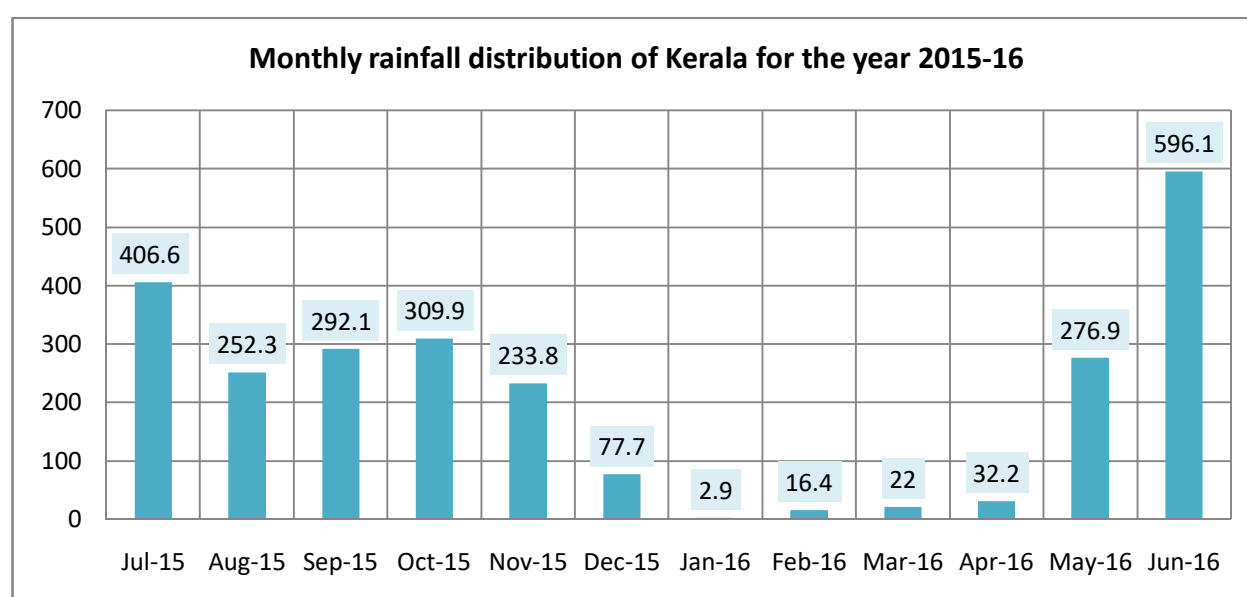
SI No.	Districts	2015						2016						2015-16		
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Actual	Normal	Departure %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Thiruvananthapuram	60.6	71.4	307.1	367.0	275.8	152.3	3.2	3.7	19	57.9	429.1	395.0	2142.1	1803.2	18.8
2	Kollam	185.0	141.1	247.6	386.0	307.6	68.6	1.0	50.3	54.6	64.8	384.4	508.5	2399.5	2491.7	-3.7
3	Pathanamthitta	186.1	269.1	347.8	546.4	336.0	74.6	0.5	4.6	70	114.2	427.4	459.4	2836.1	2958.4	-4.1
4	Alappuzha	235.7	188.4	238.4	375.9	189.7	120.4	5.9	52.1	43.5	24.6	296.0	524.0	2294.6	2841.2	-19.2
5	Kottayam	306.8	293.1	374.1	402.9	203.0	116.2	11.5	43.3	72.5	55.8	318.7	630.6	2828.5	2930.5	-3.5
6	Idukki	436.3	270.7	343.8	253.6	248.1	125.2	5.1	5.1	26.1	37.9	458.6	586.3	2796.8	3302.5	-15.3
7	Ernakulam	367.2	241.2	393.5	355.0	470.5	175.7	0.4	91.4	3.4	43.4	322.8	624.6	3089.1	3029.9	2.0
8	Thrissur	463.2	277.5	314.3	274.4	187.3	91.6	10.8	4.0	6.2	37.2	257.5	588.4	2512.4	3063.1	-18.0
9	Palakkad	281.8	219.2	193.3	140.9	180.4	42.8	0.2	0.0	4.2	4.1	169.2	461.5	1697.6	2280.2	-25.6
10	Malappuram	411.5	264.0	266.8	291.0	232.0	35.4	0.0	1.8	2.3	4.1	154.5	585.2	2248.6	2837.5	-20.8
11	Kozhikode	780.5	256.9	290.1	351.4	199.3	8.0	0.0	0.0	29.9	5.7	260.1	916.4	3098.3	3335.1	-7.1
12	Wayanad	304.3	226.1	232.5	154.1	113.4	33.4	3.3	0.0	12.6	19.8	112.8	411.2	1623.5	3253.1	-50.1
13	Kannur	803.0	352.9	317.2	330.8	167.0	28.6	0.0	0.0	0.8	1.0	138.4	801.8	2941.5	3319.1	-11.4
14	Kasargod	846.5	432.7	198.2	296.0	92.1	19.1	2.9	0.5	0.0	0.1	138.3	945.5	2971.9	3621.6	-17.9
	State (Average)	406.6	252.3	292.1	309.9	233.8	77.7	2.9	16.4	22.0	32.2	276.9	596.1	2518.8	2921.4	-13.8

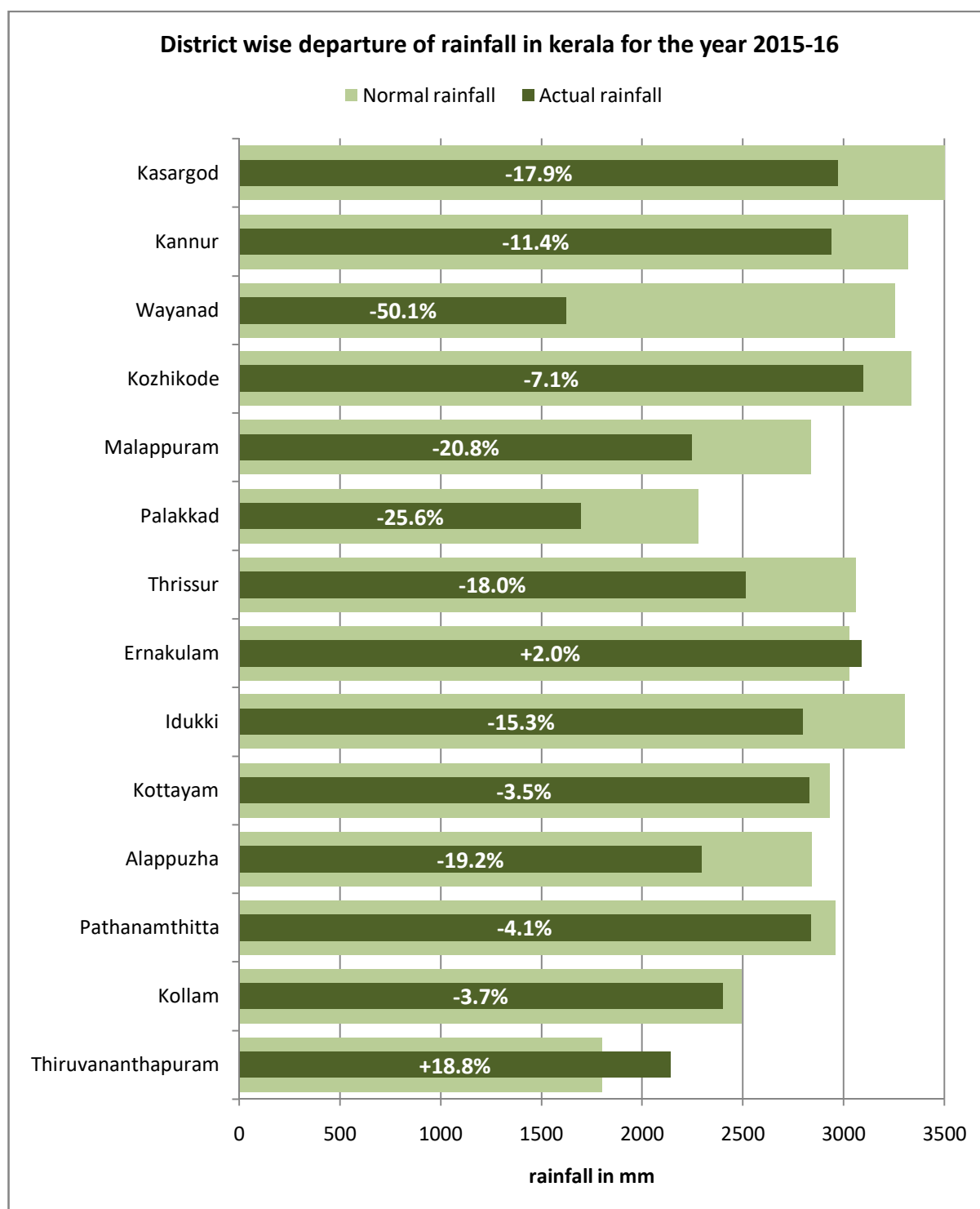
Source : Agriculture Statistics 2015-16, DES

Table: 4.3 District wise Annual Average Rainfall 2015-16 (in mm)

Sl No.	Name of District	Normal Rainfall (mm)	Actual Rainfall (mm)	% Departure
1	2	3	4	5
1	Thiruvananthapuram	2142.1	1803.2	18.8
2	Kollam	2399.5	2491.7	-3.7
3	Pathanamthitta	2836.1	2958.4	-4.1
4	Alappuzha	2294.6	2841.2	-19.2
5	Kottayam	2828.5	2930.5	-3.5
6	Idukki	2796.8	3302.5	-15.3
7	Ernakulam	3089.1	3029.9	2.0
8	Thrissur	2512.4	3063.1	-18.0
9	Palakkad	1697.6	2280.2	-25.6
10	Malappuram	2248.6	2837.5	-20.8
11	Kozhikode	3098.3	3335.1	-7.1
12	Wayanad	1623.5	3253.1	-50.1
13	Kannur	2941.5	3319.1	-11.4
14	Kasargod	2971.9	3621.6	-17.9
	STATE AVERAGE	2518.8	2921.4	-13.8

Source: Agricultural Statistics, DES





Geographical Details

The State is located in the tropical region of Indian Peninsula and extends to an area of about 38863 Sqkm, which accounts for about 1.2% of the total geographical area of the country. The State is bordered by Tamil Nadu State on its South and part of the East, Karnataka State on the North and part of the East, the Lakshadweep Sea on the West and

the Indian Ocean along the South. The State has a total coastline of about 590 km and from sea level it rises to about 2694 m above msl.

Because of the location of the State along the windward side of the Western Ghats, it receives an average yearly rainfall of about 3000 mm, and the precipitations in the South-West and North-East Monsoon period may go even up to 5000 mm, especially in the higher altitudes of Wayanad and Idukki plateaus. The average temperature of the state at low and medium elevations ranging between 0-700 m is about 23°C. Between 700 - 1400 m above msl, the temperature fluctuates between 16 and 23°C and in high altitude areas along the crests of the Western Ghats, it is about 15°C during the coldest months. Above 1400 m elevation, the average temperature is even less ranging from 13.5 to 16°C, and it is in this zone that the shola forests, with similarities in species representation with the temperate Himalayan forests are distributed in the State.

Physiographically, the terrain has three natural regions namely, lowlands, midland and highland. A physiographic classification, identified mainly in terms of broad geomorphic surfaces and altitudinal characteristics, is also used in the parlance of geographers (CESS, 1984). It has five physiographic zones, namely, high ranges with elevation above 600 m, foothill zone between 300 to 600 m, upland regions between 100 - 300 m, midland between 20 - 100 m and coastal areas and low land below an altitude of 20 m.

Kerala has 44 perennial rivers, of which three are east flowing and the remaining 41 are emptied into the Lakshadweep Sea, along the western side of the State. Rivers are generally swift flowing having very steep gradients in their higher reaches. Absence of delta formation is characteristic of Kerala rivers. The general drainage pattern of these rivers is dendritic, although at places trellis, sub-parallel and radial occur. The segments of river courses are nearly straight, indicating structural control, coinciding with the prominent lineament directions (NW-SE and NE-SW). As per national norm (Rao, 1979), there are no major rivers in Kerala. The four medium rivers, namely Chaliyar, Bharathapuzha, Periyar and Pamba have a total drainage area of only 8250 Sqkm with length 169 km, 209 km, 244 km and 176 km respectively. The length of rest of the rivers varies from 16 km to 130 km, with an average length of 62 km and total drainage area of 19,485 Sqkm. The river flow is modulated by about 30 reservoirs, mostly located in highlands (KSLUB, 2002; CWRDM, 1995). There are two fresh water lakes in the State namely the Pookot and Sasthamkottah.

The State is also having a total of 46.13 Sqkm of estuaries and backwaters. The important backwaters are Vembanad and Ashtamudi lakes.

Ten broad groups of soils based on morphological features and physico-chemical properties have been identified in Kerala .They are Red soil, Laterite soil, Coastal Alluvium soil, Riverine alluvium soil, Onattukara alluvium soil, Brown Hydromorphic soil, Hydromorphic Saline soil, Acid Saline soil, Black soil and Forest soil.

The major forest types represented in the State include the dry deciduous, moist deciduous, semievergreen, evergreen and shola forests. Almost 78 percent of the total land area of the State is under agriculture and dwelling, and the remaining 22 percent of the land is under forests and forest plantations. Quite obviously, the pristine status of nature is better protected only in a limited area, and that too in the higher altitudes, whereas, most of the remaining area of the State is subjected to degradation and transformations of various types.

Rain fall Details

Annual average rainfall data for the period 1.4.15 to 31.3.2016 is given below.

Period	Actual (mm)	Normal (mm)	Departure %
1.4.2015 to 31.3.16	2518.8	2921.4	-13.8

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).

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 (NAMQP) 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

Annual Average mg/m ³							
SlNo.	District	So ₂	Air quality	NO ₂	Air quality	PM10	Air quality
1	2	3	4	5	6	7	8
1	Kochi	3	L	13	L	38	M
2	Kozhikkodu	2	L	8	L	46	M
3	Thrisur	2	L	14	L	33	M
4	Malappuram	2	L	5	L	30	L
5	Thiruvananthapuram	10	L	23	M	58	M
6	Kollam	4	L	20	L	53	M

SO₂ Sulphur Dioxide, NO₂ 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 2016 - Annual Average

Sl No.	District	Monitoring Location	Sulphur Dioxide µg/m ³ (50 µg/m ³ , max)	Nitrogen Dioxide µg/m ³ (40 µg/m ³ , max)	Respirable Suspended Particulates Matter µg/m ³ (60 µg/m ³ , max)	Category
1	2	3	4	5	6	7
1	Thiruvananthapuram	Filatex, Veli	17.60	24.04	53	Industrial
		SMV School, Over Bridge	7.79	26.42	53	Sensitive
		Cosmopolitan Hospital, Murinjapalam	7.30	25.84	53	Sensitive
		Pettah Station	7.36	24.99	51	Residential
2	Kollam	Kadappakada Station	4.04	7.46	45	Residential & Others
		KMML, Chavara	4.07	7.59	46	Industrial

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	2	3	4	5	6	7
3	Pathanamthitta	Makkankunnu	2.00	14.88	26	Residential & Others
4	Alappuzha	DC Mills, Pathirappally	2.00	4.50	43	Industrial
		Thodankulangara	2.00	4.50	43	Industrial
5	Kottayam	Nagambadam	4.13	15.60	50	Residential & Others
		Vadavathur	4.60	17.51	58	Industrial
6	Idukki	Thodupuzha	2.00	4.50	35	Residential & Others
7	Ernakulam	Eloor Methanam	2.00	37.45	49	Residential
		Eloor TCC	2.00	38.24	54	Industrial
		South Overbridge	2.23	12.27	57	Residential & Others
		Vyttila	2.30	19.23	52	Residential Rural & Others
		Irumpanam	2.28	13.14	33	Industrial
		Kalamassery	2.18	11.01	57	Industrial
		M.G.Road	2.21	11.77	47	Residential & Others
		Perumbavoor	2.16	15.35	61	Residential & Others
8	Thrissur	Poomkunnam	2.01	5.45	55	Residential & Others
9	Palakkadu	Kanjikkode	2.00	8.56	41	Industrial
10	Malappuram	Kakkancherry	2.00	16.57	37	Industrial
11	Kozhikode	Kozhikode City	2.00	17.87	51	Residential & Others
		Nallalam	2.00	17.76	50	Industrial
12	Wayanadu	Sulthan Batheri	2.00	4.57	40	Sensitive
13	Kannur	Kannur	2.00	4.53	56	Residential Rural & Others

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	2	3	4	5	6	7
		Mangattuparambu	2.00	4.53	40	Residential Rural & Others
14	Kasaragod	Kasargod	2.00	5.13	39	Residential Rural & Others
		Kanhangadu	2.14	5.83	44	Residential Rural & Others

Source: Kerala State Pollution Control Board Directory 2016

Table: 4.6 Ambient Air Quality Standards in Respect of Noise

Sl.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: Central Pollution Control Board

dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

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 Major Indicators showing operational efficiency of KSRTC

Sl. No.	Items	Year	
		2014-15	2015-16
1	2	3	4
1	Fleet Strength (Nos) (as on March 31 st)	5629	5682
2	Gross Revenue Earnings (Rs. in Crores)	1923.82	2165.16
3	Gross Revenue Expenditure (Rs.in Crores)	2541.1	2778.3
4	Gross operating loss (Rs. in Crores)	617.28	613.14
5	No. schedules operated as on 31 st March	4602	4522
6	Average earnings per vehicle on road per day (Rs)	10928	11191
7	Average earnings per km. of Buses operated (paise)	3268	3309
8	Average Earnings per Passenger (paise)	1636	1741
9	Average route length (Kms)	63.78	60.76
10	Average Kms. By a bus per day	329.16	332.54
11	Average number of buses held daily (Nos)	5691	5636
12	Passengers carried (Lakhs)	11059.43	10437.78

Source: Economic Review 2016

Table : 4.9 Registered motor vehicles in districts of Kerala 2015-16

Sl. No.	Name of District	Three Wheelers	Two Wheelers	Car, Jeeps and Taxis	Buses	Goods Vehicles	Others	Total
1	2	3	4	5	6	7	8	9
1	Thiruvananthapuram	4791	66703	22456	1272	1569	1187	97978
2	Kollam	1739	52262	14647	294	1304	658	70904
3	Pathanamthitta	881	22847	9646	200	757	394	34725
4	Alappuzha	917	39031	11201	293	1207	443	53092
5	Kottayam	1036	29318	13684	510	1341	752	46641
6	Idukki	942	12854	4154	215	617	235	19017
7	Ernakulam	1982	75574	27559	811	2849	1444	110219
8	Thrissur	1429	60701	18073	557	1756	881	83397
9	Palakkad	1117	46620	10694	338	1197	590	60556
10	Malappuram	2586	63442	19366	429	2123	1145	89091
11	Kozhikode	2356	66703	16796	400	1824	881	88960
12	Wayanad	776	11169	3009	65	522	250	15791
13	Kannur	1782	40838	15565	473	1716	944	61318
14	Kasaragode	1030	18607	8842	130	528	497	29634
Total		23364	606669	195692	5987	19310	10301	861323

Source: Motor Vehicle Department

Table : 4.10 VALID REGISTERED MOTOR VEHICLES DURING 2015-16

Sl No.	District	Goods vehicles		Buses		Four Wheelers		Three Wheelers	Two Wheelers	Tractors / Trailers		Others	Total
		Four Wheelers & above	Three wheelers including tempos	Stage Carriages	Contract carriages/ Omni buses	Cars	Taxis	Auto rickshaws	Scooter/Motor cycles	Tractors / Tillers	Trailers		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Thiruvananthapuram	1112	457	886	386	21578	878	4791	66703	37	-	1150	97978
2	Kollam	983	321	31	263	14089	558	1739	52262	14	-	644	70904
3	Pathanamthitta	530	227	12	188	9223	423	881	22847	7	1	386	34725
4	Alappuzha	904	303	19	274	10247	954	917	39031	18	1	424	53092
5	Kottayam	1082	259	99	411	13054	630	1036	29318	11	1	740	46641
6	Idukki	487	130	57	158	3944	210	942	12854	3	-	232	19017
7	Ernakulam	2362	487	97	714	25365	2194	1982	75574	35	1	1408	110219
8	Thrissur	1320	436	105	452	16774	1299	1429	60701	36	2	843	83397
9	Palakkad	875	322	88	250	10007	687	1117	46620	57	-	533	60556
10	Malappuram	1448	675	96	333	18827	539	2586	63442	40	1	1104	89091
11	Kozhikkode	1188	636	138	262	16013	783	2356	66703	11	1	869	88960
12	Wayanad	350	172	17	48	2807	202	776	11169	13	6	231	15791
13	Kannur	1288	428	190	283	14582	983	1782	40838	13	-	931	61318
14	Kasargod	432	96	24	106	8415	427	1030	18607	11	2	484	29634
	Total	14361	4949	1859	4128	184925	10767	23364	606669	306	16	9979	861323
	<i>Source: Motor Vehicle Department</i>												

Table : 4.11 DETAILS OF REGISTERED TRANSPORT VEHICLES 2011-12 - 2015-16

Sl No.	Vehicles	2011-12	2012-13	2013-14	2014-15	2015-16	
1	2	3	4	5	6	7	8
1	Goods vehicles	Four Wheelers & above	23463	27508	21099	14141	14361
2		Three wheelers including tempos	10132	9485	7818	5787	4949
3	Buses	Stage Carriages	886	1227	933	935	1859
4		Contract carriages/ Omni buses	4231	4573	4582	3653	4128
5	Four Wheelers	Cars	175032	174301	189394	175519	184925
6		Taxis	8351	12344	17356	11128	10767
7	Three Wheelers	Auto rickshaws	68772	64998	37018	27951	23364
8	Two Wheelers	Scooter/Motor cycles	529338	654194	637546	634221	606669
9	Tractors / Trailers	Tractors	556	590	471	280	306
10		Tillers	1	-	1	-	-
11		Trailers	52	68	28	16	16
12	Others		20063	16481	12472	8588	9979
Total			840877	965769	928718	882219	861323

Source: Motor Vehicle Department

Table: 4.12 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

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
3	FACT Ltd., Udyogamandal, 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

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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
4	FACT Ltd., Petrochemical Division, Udyogamandal P.O., Eloor, Ernakulam	CU	Petrochemical	1990	River Periyar	200 m	River Periyar	Discharge directly into river	Yes	5040	BOD pH SS COD O & G Free NH3 Amm.NH3 TKN Nitrate Phenolic Compounds	151.2 8.5 151.2 1260 50.4 25.2 252 504 100.8 5.04	OPRS
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	Kuzhikandomthode	1750 m	River Periyar	Through Kuzhikandomthode	No	1024	pH SS TDS O & G SO2 Chlorine	9 102.4 2150.4 10.24 1024 1024	OPRNS RNS

Compendium of Environment Statistics 2015-16

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
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, Muppathadam 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, Edayar, Muppathadam P.O., Ernakulam	PU	Tannery	2004	River Periyar	150 m	River Periyar	Discharge directly into river	Yes	1010	BOD pH SS Hex. Chr. Sulphide O & G	3.03 9 10.1 0.0101 0.0101 1.01	OPRNS

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	
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	0.391	OPRNS	
11	Hindustan Organic Cemicals Ltd., Ambalamugal, Ernakulam	CU	Petrochemical	1988	Chithrapuzha	>100m	Chithrapuzha River	Discharge directly into Chithrapuzha	Yes		BOD	412.8	9.6	OPRS
12	Cochi Refinery, Ambalamugal, Ernakulam	CU	Oil Refinery	1966	Chithrapuzha	>100m	Chithrapuzha River	Discharge directly into Chithrapuzha	Yes		BOD	2421.03	20.43	OPRS
13	Gramox Paper and Boards, Puthuppady, Muvattupuzha, Ernakulam	PU	Pulp & Paper	1995		>100m	Kothamangalam River		Yes		BOD	123.5	23.92	OPRS

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	
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	15725	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.

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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	
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		Perumbithode	0.25km	Chalakydy 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	Narakampilly River	500m	Kalpathy River, tributary of Bharathapuzha	5km		400	BOD	345.6	10.4	
19	United Spirits Limited, Former McDowell & Co. Ltd) Cherthala, Alapuzha	PU	Distillery		Vembanadu Lake	Banks of the lake	Vembanadu lake	Banks of lake	No	270	BOD	3132	4.1	OPRNS

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	
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 print Ltd., Newsprint Nagar, Kottayam.	CU	Pulp & Paper	1983	Muvattupuzha River	2km	Muvattupuzha River	2km	Yes	38384	BOD	10133	1152	OPRS
22	MRFLtd., Vadavathoor, Kottayam.	PU	Rubber Industry	1959	Meenanthara River	2km	Meenanthara River	2km	Yes	200	BOD	155	6	OPRS
23	Canara Paper Mills Pvt. Ltd., Chethipuzha, Changanachery, Kottayam.	PU	Craft Paper	1985	Chethipuzha Canal	50m	Vembanat Kayal	8km	Yes	5	1.8	0.645		OPRS
24	Kollam Dairy, Thevally, Kollam.	CP	Milk Processing	1986	Ashtamudy lake	0.01km					BOD	180	23.5	OPRS

Source: Kerala State Pollution Control Board

SINo	District	2014-15		2015-16	
		*MNRE scheme	State scheme	MNRE scheme	State scheme
1	2	3	4	5	6
1	Thiruvananthapuram	13	103	49	383
2	Kollam	7	187	42	376
3	Pathanamthitta	22	219	16	229
4	Alappuzha	20	301	12	343
5	Kottayam	126	326	48	785
6	Idukki	255	270	237	338
7	Eranakulam	123	248	109	579
8	Thrissur	147	167	121	346
9	Palakkad	59	89	44	117
10	Malappuram	23	188	25	165
11	Kozhikode	64	89	87	536
12	Wayanad	93	67	66	131
13	Kannur	47	144	47	119
14	Kasargod	41	61	22	45
	Total	1040	2459	925	4492

Source : Anert, *Ministry of New and Renewable Energy

SINo.	Source of Energy	Installed Capacity (MW)				
		2011-12	2012-13	2013-14	2014-15	2015-16
1	2	3	4	5	6	7
1	Hydel: KSEBL	2008.80	2007.40	2008.60	2024.15	2046.15
2	Thermal : KSEBL	234.60	234.60	234.60	159.96	159.96
3	Wind : KSEBL	2.03	2.03	2.03	2.03	2.025
4	Solar : KSEBL	-	-	-	-	1.156
5	Solar other than KSEBL (Solar connected to Grid other than KSEBL)	-	-	-	-	13.00
6	NTPC	359.60	359.60	359.60	359.60	359.60
7	Thermal IPP	198.93	198.93	198.93	198.93	198.90
8	Hydel Captive	33.00	33.00	33.00	33.00	33.00
9	Hydel IPP	10.00	10.00	22.11	25.16	25.16
10	Wind IPP	32.85	32.85	32.85	32.85	41.25
	Total	2879.81	2878.41	2891.72	2835.68	2880.20

Source : Economic Review 2016

Table : 4.15 Total installed capacity 2011-12 to 2015-16

SINo.	Sector	Installed Capacity (MW)				
		2011-12	2012-13	2013-14	2014-15	2015-16
1	2	3	4	5	6	7
1	State Sector	2245.43	2244.03	2245.23	2186.14	2222.29
2	Central Sector	359.60	359.60	359.60	359.60	359.60
3	Private Sector	274.78	274.78	286.89	289.94	298.31
Total		2879.81	2878.41	2891.72	2835.68	2880.20

Source: Economic Review 2016

Table: 4.16 transmission infrastructures 2015 - 2016

SINo.	Item	Target	Achievement	Unit	Percentage of Achievement
1	2	3	4	5	6
1	220KV Substations	1	0	Nos.	0%
2	110KV Substations	12	8	Nos.	67%
3	66KV Substations	4	3	Nos.	75%
4	33KV substations	13	3	Nos.	23.08%

Source: Economic Review 2016

Table : 4.17 details of power availability 2011-12 to 2015-16

Sl.No	Particulars	Internal Generation(MU)				
		2011-12	2012-13	2013-14	2014-15	2015-16
1	2	3	4	5	6	7
1	Hydel Generation	8058.01	4848.8	7995.43	7134.00	6639
2	KSEBL-Thermal Generation	290.70	532.7	220.87	207.70	150.63
3	Wind	2.03	1.763	1.8	1.06	1.38
4	Solar	0	0	0	0	0.81
5	Solar other than KSEBL	0	0	0	0	5.92
6	Total Internal Generation	8350.75	5389.6	8218.10	7342.88	6791.9
7	Less: Auxiliary Consumption	60.84	55.35	55.07	55.97	52.6
8	Net Generation	8289.91	5334.3	8163.03	7286.91	6739.3
9	Power Purchase (CGSs, IPPs, Traders)	11263.21	14909	14070.4	14996.4	16448
10	External PGCIL line losses	413.21	364.96	293.69	357.98	550.6
11	Energy Available for sale within the State	19139.90	19878	21939.8	21925.8	22944
12	Energy Requirement	18938.81	19877	20525.2	21914.2	22584
13	Surplus /Deficit	201.09	0.97	1414.6	11.64	360.92

Source : Economic Review 2016

Table: 4.18 Pattern of Power Consumption and Revenue Collected during 2015-16

SINo.	Category Voltage	No. of consumers	% of consumers to total	Consumption (MU)	Consumption as % of total	Revenue collected (lakh)	Revenue as % of total
1	2	3	4	5	6	7	8
1.	Domestic Paying group	9124747	78.20	9943.5	51.45	374410.00	35.84
b	Non paying group						
2	Commercial including general	1923402	16.48	2735.36	14.15	244850.00	23.44
3	Industrial LT	136693	1.17	1103.23	5.71	74663.00	7.15
4	HT and EHT	5005	0.04	4106.00	21.25	281690.00	26.97
5	Public lighting	4281	0.04	366.62	1.90	15636.00	1.50
6	Railway Traction	9	0	212.83	1.10	12086.00	1.16
7	Agricultural Pumping	473882	4.06	279.48	1.45	6562.00	0.63
8	Licenses (Bulk supply)	12	0.00	578.08	2.99	34704.00	3.32
	Total	11668031	100.00	19325.10	100	1044601.00	100.00

Source: Economic Review 2016
High Tension

LT: Low Tension, HT: High Tension, EHT: Extra High Tension

Table : 4.19 Generating Capacity, Maximum Demand and Load Factor

SlNo	Year	Installed Capacity	Energy input to system excl.aux.cons. & ext.losses (Gen+Purchases- Export) (MU)	Maximum demand (MW)	Load factor (%)
1	2	3	4	5	6
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
25	2015-16	2880.18	22727.34	3860.00	67.21

Source: Power system, Kerala State Electricity Board

Table: 4.20 Ddetail of Indian standards for maximum permissible limits for Industrial effluent discharges in India

SI 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 2016

Table: 4.21 Average Gaseous composition of Dry air in the Troposphere in India

SI No.	Gas	Percent by volume (%)	Parts per million (ppm)
1	2	3	4
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- 0.3 (variable)

Source: Compendium of Environment Statistics 2016 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: 4.22 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 (NO2)	Increased risk of viral infections
	Lung irritation (including pulmonary fibrosis and emphyseal)
	Higher respiratory illness rates
	Airway resistance
	Chest tightness and discomfort
	Eye burning
	Head ache
Ozone (O3)	Respiratory system damage(lung damage from free radicals)
	Reduces mental activity
	Damage to cell lining(especially in nasal passage)
	Reduces effectiveness of the immune system
	Headache

Pollutant	Health Effects
	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

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 (Kerala State Land Utilisation Board (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

Total geographical area of the State has been classified according to thirteen different uses of land. Out of 3886287 ha. of total geographical area, 2023073 ha. of land constituting 52.06% is cultivated atleast once with various crops during the year 2015-16, showing slight decrease of 0.97% in net area sown from previous year. The total cropped area comes 2627577 ha. during the above period.

Table: 5.1 State level estimate of Gross Cropped Area, Net Cropped Area and Cropping Intensity (2001-02 to 2015-16)

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
15	2015-16	2627577	2023073	129.88

Source: Agricultural Statistics 2015-16

Table: 5.2 Classification of Area on the Basis of Land Utilisation 2015-16

(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 non agricultural use	33161	28314	17666	25114	28449	13714	42941	38313	49021	51203	31763	12649	36727	25611	434646
Barren and Uncultivable land	243	178	181	8	1166	1515	314	254	2459	968	582	78	1566	3588	13100
Permanent pastures and Other Grazing Land	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land under Tree Miscellaneous Tree Crops	18	46	100	94	131	156	244	187	892	178	108	40	211	258	2663
Cultivable Waste	438	2673	1694	13694	7273	2145	12402	9734	23641	6110	2832	952	7105	8806	99499
Fallow Land Other than Current Fallow	1072	1691	3165	2494	2518	1201	7907	6024	16087	5332	1676	763	3168	2160	55258

Compendium of Environment Statistics 2015-16

Classification	Thiruvananthapuram	Kollam	Pathanamthitta	Alappuzha	Kottayam	Idukki	Eranakulam	Thrissur	Palakkad	Malappuram	Kozhikkodu	Wayanad	Kannur	Kasargodu	State
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Current Fallow	2912	3255	4053	3183	4765	1884	10814	8081	12237	7589	2000	2257	4376	2597	70003
Marshy Land	6	4	0	1	0	0	6	0	0	0	5	0	95	0	117
Still water	4342	6593	2698	12457	6360	10480	11090	6300	15333	6148	3933	4047	6472	4336	100589
Water logged Area	88	938	165	337	159	0	297	318	0	62	382	19	372	22	3159
Social Forestry	60	95	118	39	112	1140	105	147	380	202	34	61	73	105	2671
Net area sown	126580	123563	80223	83590	161368	205680	149089	129942	191277	174237	149940	113313	188213	146058	2023073
Area sown more than once	36268	25754	23348	17908	42382	64807	16447	44333	102163	67348	50902	66175	37229	9440	604504
Total Cropped Area	162848	149317	103571	101498	203750	270487	165536	174275	293440	241585	200842	179488	225442	155498	2627577

Source: Agricultural Statistics 2015-16, DES

Table : 5.3 NET AREA IRRIGATED - DISTRICT WISE & SOURCE WISE 2015-16

(area in Ha)

SI No	District	Small stream (Canal / Thode)		Pond		Well		Bore well/ Tube well	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	3833	0	588	21	1	3254	111	0	0	0	0	0	439	8247
2	Kollam	1368	27	15	49	31	2853	33	0	0	0	4	4	1674	6054
3	Pathanamthitta	2751	0	34	0	0	2343	4	113	0	0	7	7	1	5253
4	Alappuzha	6237	1	0	462	0	819	7728	0	5567	0	19255	24822	335	40404
5	Kottayam	15	13	0	276	0	1952	18	107	0	0	12204	12204	10	14595
6	Idukki	1214	11	54	16605	0	8341	4150	0	68	0	1982	2050	9096	41521
7	Ernakulam	7340	6	309	1693	5	6965	465	3130	568	0	1027	1595	357	21865
8	Thrissur	19023	5	224	3567	70	37937	1716	991	561	0	4709	5270	2530	71333
9	Palakkad	42443	25	140	5729	7	13063	8741	514	7801	0	548	8349	8242	87253
10	Malappuram	2443	378	157	4332	69	16019	1362	1290	1072	0	1726	2798	1356	30204
11	Kozhikode	989	8	0	513	1	2363	56	0	216	0	3	219	522	4671
12	Wayanad	0	0	18	52	0	73	0	103	136	0	0	136	12123	12505
13	Kannur	631	281	22	1415	17	9223	438	34	221	0	652	873	2281	15215
14	Kasargode	530	19	43	12141	15	28108	10269	15	3021	0	102	3123	450	54713
Total		88817	774	1604	46855	216	133313	35091	6297	19231	0	42219	61450	39416	413833
Source : Agricultural Statistics 2015-16, DES															

Table: 5.4 Gross Area under Irrigation (Crop wise) 2015-16

(Area in Ha.)

Sl No.	District	Paddy				Vegetables	Coconut	Areca nut	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	1074	903	142	2119	3325	2742	6	0	19	2669	18		1891	12789
2	Kollam	258	917	6	1181	6260	443	12	1	34	1591	24		659	10205
3	Pathanamthitta	28	419	2087	2534	1172	718	14	11	521	1513	39		121	6643
4	Alappuzha	9493	1576	19810	30879	2599	7537	13	0	129	472	36	40	1336	43041
5	Kottayam	3573	4251	8360	16184	1903	61	2	107	1863	881	7		152	21160
6	Idukki	81	759	46	886	5713	767	105	70	1384	1260	0	765	193	11143
7	Ernakulam	569	4048	656	5273	2399	10020	1106	2	6597	4113	4		3038	32552
8	Thrissur	83	13688	8869	22640	1671	40437	4224	9	6759	2164	3		3594	81501
9	Palakkad	4360	40912	3839	49111	4679	24807	3285	2	288	14420	2	338	9096	106028
10	Malappuram	9	3839	2158	6006	4171	19117	5455	2	248	6177	158		1988	43322
11	Kozhikkode	3	68	410	481	1249	2606	325	5	217	1828	9		255	6975
12	Wayanad	0	8587	617	9204	1244	85	20	0	0	6718	2		20	17293
13	Kannur	0	2681	7	2688	2225	12538	1632	0	209	2312	13		767	22384
14	Kasargod	0	1042	288	1330	696	43772	17928	28	158	636	18		4046	68612
STATE		19531	83690	47295	150516	39306	165650	34127	237	18426	46754	333	1143	27156	483648

Source: Agricultural Statistics 2015-16, DES

Table: 5.5 Area under Dry Land Paddy 2015-16

Sl No.	District	Dry land Paddy Area in Ha.			
		Autum	Winter	Aummer	Total
1	2	3	4	5	6
1	Thiruvananthapuram	0.33	0.27	0	0.6
2	Kollam	37.53	3.08	0	40.61
3	Pathanamthitta	0	0.93	0	0.93
4	Alappuzha	453.41	0.2	5260.06	5713.67
5	Kottayam	0	0	0	0
6	Idukki	0.023	4.29	0.02	4.33
7	Ernakulam	2.76	2.02	2.02	6.8
8	Thrissur	8.53	0.79	0	9.32
9	Palakkad	66.84	1.15	17.41	85.4
10	Malappuram	8.22	0.1	0	8.32
11	Kozhikkode	6.21	1.54	0	7.75
12	Wayanad	0	0	0.53	0.53
13	Kannur	31.41	3.48	0	34.89
14	Kasargod	17.12	0	0.4	17.52
STATE		632.38	17.85	5280.44	5930.67

Source: Agricultural Statistics 2015-16, DES

Table: 5.6 Area & Production of Important Crops in Kerala 2015-16

Sl No.	Crops	Area(Ha)			Production(Tonnes)		
		2001-02	2015-16	% Variation	2001-02	2015-16	% Variation
1	Paddy!!	322368	196870	-39	703504	549275	-22
2	Tapioca	111189	69405	-38	2455880	2662610	8
3	Coconut*	905718	790223	-13	5479	5873	7
4	Pepper	203956	85948	-58	58240	42132	-28
5	Cashew	89718	43090	-52	65867	24733	-62
6	Rubber	475039	550840	16	580350	438630	-24
7	Groundnut	2437	449	-82	1812	619	-66
8	Sesame	878	187	-79	284	47.703	-83
9	Cotton#	3760	109	-97	6069	196	-97
10	Pulses	8191	3764	-54	6281	4265	-32
11	Ginger(Dry)	10706	4986	-53	40181	22044	-45
12	Turmeric	3558	2603	-27	7895	7112	-10
13	Banana	50871	59835	18	345903	5636155	55
14	Tobaco	71	9	-87	395	15	-96
15	Total Cereals	329875	197189	-40	708624	549570	-22
16	Arecanut*	93193	99126	6	84681	132453	56
17	Coffee	84795	84987	0	66690	69230	4
18	Tea	36899	30205	-18	66090	57898	-12

Source: Agricultural Statistics 2015-16, DES

!! Production in Rice

* 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. Plantation crops constitute a large group of crops. The major plantation crops include coconut, arecanut, oil palm, cashew, tea, coffee and rubber; the minor plantation crops include cocoa.

Table: 5.7 Areas, Production, Productivity of Plantation Crops (2013-14 to 2015-16)

	2013-14	2014-15	2015-16
1	2	3	4
Area (Ha.)			
Tea #	30205	30205	30205
Coffee *	85359	85359	84987
Rubber \$	548225	549955	550840
Cardamom@	39730	39730	39730
Production (MT)			
Tea #	62938	65174	57898
Coffee *	66645	67700	69230
Rubber \$	648220	507700	438630
Cardamom@	14000	16000	19500
Productivity (Kg. / Ha.)			
Tea #	2084	2158	1917
Coffee *	781	793	815
Rubber \$	1182	923	796
Cardamom@	352	403	491

Source: Economic Review 2016

*Coffee Board

#Tea Board

\$Rubber Board

@SpicesBrand

Table: 5.8 Consumption of Fertilizers /Ha. of Gross Cropped Area 2002-03 to 2015-16

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
2015-16	50.00	19.00	31.00	80.00	NA	100

Source: Economic Review 2016

Table: 5.9 Soil Types (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</p> <p>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>

District	Type of Soil	Details of location
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.

Growth of Mining Sector in the State

The contribution of Mining and Quarrying sector to Gross State Domestic Product (GSDP) at constant prices is estimated at 5,07,958 lakh during 2015-16, thus registering an increase of 6.21 percent compared to previous year. The share of the sector in Gross State Domestic Product (GSDP) at constant prices stood at 1.20 percent during 2015-16. Mining and quarrying sector in the State registered negative growth during 2012-13 and witnessed a high positive growth of 50.13 per cent during 2013-14 and declined to 39.13 percent in 2014-15 and 6.21per cent in 2015-16. There are 87 major mineral mines that are operational in the State as on March 31, 2016. During 2015-16, 77 mining leases for major minerals, 501 quarrying leases for minor minerals, 2,670 quarry permits in minor minerals and 1,549 dealers' license were granted. In 2015-16 there were 188 registered working metal crusher units in Kerala and two prospecting licenses were also granted for minor minerals.

The total area covered under mining leases as during 2015-16 was 1,139.75 hectares, of which Mineral Sand accounts for 558.37 hectares, Limestone 245.69 hectares, Lime

shell/seashell 99.4 hectares, Iron Ore 86.06 hectares and China Clay 72.95 hectares. Area covered by Graphite was 1.25 hectares and there was no area reported for Bauxite is zero.

Production and Royalty of Minerals 2015-16

During 2015-16, 408.01 lakh tonnes of major and minor minerals were produced in Kerala. Among major minerals, Bauxite/laterite tops the list with 16.90 lakh tonnes followed by Limestone (6.26 lakhs ton) and China clay (5.86 lakh ton). Among minor minerals highest production is from Graphite Building Stone (298.75 lakh ton) followed by Ordinary Earth (55.08 lakhs ton) and Ordinary Sand (13.31 lakhs ton)

During 2015-16 an amount of 119.51 crore received as royalty from minerals, of which 28.00 crore was from major minerals and 91.51 crore from minor minerals. During 2015-16 highest royalty among major minerals was from bauxite/laterite (16.22 crore) followed by lime stone (5.01 crore), china clay (2.34 crore), silica sand (1.59 crore) and ilmenite (1.15 crore). Among minor minerals granite building stone stands first by contributing 71.70 crore as royalty followed by ordinary earth (11.01crore) and ordinary sand (5.32 crore) during 2015-16.

Table: 5.10 Productions and Royalty of Minerals – 2015-16

SlNo.	Major Minerals	Royalty (Rs. Lakh)	Production (Tons)
1	2	3	4
Major Minerals			
1	China Clay	234.39	585965
2	Ilminite	115.08	54798
3	Rutile	38.75	2636
4	Zircon	84.42	6267
5	Sillimianite	16.07	7205
6	Silica Sand	159.21	70447
7	Limeshell / Sea shell	27.29	34118
8	Lime stone	501.16	626451
9	Bauxite / Laterite	1622.56	1690170
10	Graphite	0.41	630
11	Leucoxene	0.61	56
12	Monozite	0	0
Subtotal		2799.95	3078743

SlNo.	Major Minerals	Royalty (Rs. Lakh)	Production (Tons)
1	2	3	4
Minor Minerals			
1	Granite(Building stone)	7170.08	29875337
2	Granite(dimension stone	51.36	1284
3	Laterite	161.14	671411
4	Lime / Sea shell	2.25	3000
5	Brick Clay	104.10	260249
6	Ordinary sand	532.45	1331120
7	River Sand	28.43	71076
8	Ordinary earth	1101.68	5508414
Subtotal		9151.49	37721891
Grand Total		11951.44	40800634

Source: Mining and 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: 5.11 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

Source: Mining and Geology

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 Nileswarm - 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 out put. 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 databases 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: 5.12 Graphite Deposits in Kerala 2015-16

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. The reserves estimated tentatively are of the order of 250 million tonnes.

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. Detailed exploration carried out by the Mining & Geology department in Nileswaram Ankakalari-Palayi-Chathamath area in Kasargod district has identified lignite seams at a depth of 18 m. and the aerge cumulative thickness is about 4 m. The reserves estimated tentatively arof the order of 250 million tones in Kadankottumala, near Cheruvathur 0.55 million in Kayyur-Klayicode area

□

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 below:

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. 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.
- Exercise use of fertilizers and pesticides
- Livestock including overgrazing.
- Inappropriate Irrigation.
- Soil erosion
- 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, 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 are having 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 per year. 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.

Chapter - VI

Water

Water management is an interdisciplinary field concerned with the management of water resources ensuring the clean potable water to the people who need it while balancing the needs of industry and the environment. 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. Water is essential for life. Varies on different aspects 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.

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 determe the health of individuals and the whole communities, the quality of water supplied is more important.

Kerala receives abundant rainfall from the monsoon period from June to August and from October to November. The rest of the year experience mostly dry weather. The best and the most reliable method which can be used for Kerala is the construction of storage reservoirs for impounding water during the monsoon and utilizing the water in the reservoir for critical periods for the crops when there is insufficiency. Hence, major and medium projects were taken up and a major portion of the cultivable land could be made ayacut under these projects. First significant attempt to supply water on controlled basis was through a Lift Irrigation scheme constructed in 1942. The scheme consisting of lifting water from Periyar River by electric pumping and feeding through channels for paddy cultivation. Malampuzha Irrigation Project in Palakkad district is the 1st large-scale irrigation system in Kerala. The project consists of a dam constructed across the river Malampuzha, a tributary of Bharathapuzha and a net work of canal system to irrigate an area of 21245 ha. The dam is straight gravity type masonry structure with an earthen saddle, completed in 1966. Malampuzha Reservoir provides drinking water to Palakkad Municipality and 6 adjacent panchayaths.

Bacteriological monitoring is based on knowledge of the sanitary condition of water supply which is based on the detection of Colifom bacteria in the specific indicator of human faecal condamination, Escherichacol (E.coli) The term indicator organisms refers to micro organ isms whose presence in water shows that the water is polluted with faecal method from human or other warm blooded animals. Coliform bacteria are a group of becteria found in the intestinal trait of human and other animals. There is rod-shaped micro organism. Coliform will not likely cause illness. However the presence of coliform in drinking indicates the presence of disease-cause of organisms Eschericha-coli, Enterobacteria, aeigens, Salmonella and Klebasialla re some examples of this group. Coliform bacteria do not occur naturally in ground water. However it can live within biofilm formed by naturally occurring ground water micro organisms. The main causes of contamination are:

1. Missing/defective well cap seals around wires/pipes
2. Coracles of holes in the well casing
3. Many older wells were not sealed with grout when constructed.
4. Well flooding

5. Close proximity of a well to septic tanks, drain fields sewers, drains and surface water
6. Cross connection with waste water plumping.

Total Coliform, faecal coliform, and EColi are the indicators of drinking water quality. Total Coliform bacteria are found in the environment (Soil or vegetables) are usually harmless. Faecal Coliform bacteria are subgroup of the Total Coliform group. They are found in intestine and faces of warm-blooded animal. E-Coli is sub group of the faecal coli form group. They are also found in the intestines of people and warm blooded animals. Most E-coli are harmless but some strains may cause serious illness.

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

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. 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.
Faecal Streptococci: 100 (desirable) MPN/100ml : 500 (maximum permissible)	
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) 2015-16

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 ⁰ 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

SI No.	Item	Cubic Meter		
		2014	2015	2016
1	Storage of water on the beginning of the monsoon year	415.16	527.83	483.35
2	Storage of water at the end of the monsoon year	1316.46	901.15	690.35
3	Increase in storage	901.26	373.32	201.65
Average for 10 Years				
4	Storage of water on the beginning of the monsoon year	360.50	450.27	442.05
5	Storage of water at the end of the monsoon year	1087.27	1156.16	1094.95
6	Increase in storage	726.77	705.89	652.90

Source: Economic Review 2016

Table: 6.4 Name of Reservoirs 2015-16

SI 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

Sl No.	Name of Reservoir	District	Area(Ha)
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

SI No.	Name of Reservoir	District	Area(Ha)
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: ENVIS Centre, Kerala

Table: 6.5 Biological Water Quality Criteria (Bwqc) 2015-16

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, Animal	No	0-2	0-0.2	Severe Pollution	E	Red

Source: Cental Pollution Control Board

Table: 6.6 Navigable Waterways in Kerala 2015-16

Sl.No.	Name of the River	Length of the River	Navigable Length
1	Achenkoil	128	32
2	Anjarakandy	48	27.2
3	Ayroom	17	1
4	Bharatha Puzha	209	40
5	Chalakydy	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

Sl.No.	Name of the River	Length of the River	Navigable Length
30	Pallikal	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 Hand Book, Rivers of Kerala

Table: 6.7 District Wise Brackish Water Area in Kerala 2015-16

Sl. No	Name of District	Area in (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 Hand Book

Table: 6.8 Fresh Water Lakes in Kerala 2015-16

Sl.No	Name of Lake	District	Area in (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 Hand Book

Table: 6.9 Backwaters in Kerala 2015-16

Sl.No.	Name of District	Sl. No.	Name of Backwaters	Area in (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		

Sl.No.	Name of District	Sl. No.	Name of Backwaters	Area in (Ha)
5	Kottayam	1	Vembanattu Kayal	2926.77
		TOTAL		2926.77
6	Idukki	Nil		
7	Ernakulam	1	Vembanattu Kayal	2257.59
		2	Kochi Kayal	7503.80
		TOTAL		9761.69
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		1294.56
11	Kozhikode	1	Kadalundi Kayal	83.85
		2	Beypore 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		2764.90
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		4157.42
14	Kasaragode	1	Cheruvathur	1123.12

Sl.No.	Name of District	Sl. No.	Name of Backwaters	Area in (Ha)
		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		3174.04
GRAND TOTAL				46128.94

Source: Fisheries Hand Book

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 complexone and access to safe drinking water is recognised as an Universal human need. Kerala Water Authority came into existence on 1st April 1984. Government of Kerala implemented thousand of water supply schemes under the rural system as well as water system. 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 depends on traditional ground water systems and rarely piped water supply system. With the high density of population, industrialisation rapid urbanisation and the impact of climate change with effect the availability of water in the natural resources. Ground water has an important role in meeting the water requirement of agriculture, industrial and deomestic sectors in Kerala. About 85% of drinking water supplies and 60% of irrigation requirements are dependent on ground water resources.

Table: 6.10 District wise Population covered by Water Supply Schemes of KWA 2015-16

SINo	District	Rural		Urban		Total	
		Rural population covered	% of total population	Urban population covered	% of Urban population	Total population covered	% of total population
1	2	3	4	5	6	7	8
1	Thiruvananthapuram	1017000	66.48	1360000	76.77	2377000	72.00
2	Kollam	1089231	75.21	459269	38.69	1548500	58.76
3	Pathanamthitta	510597	47.91	74427	56.55	585024	48.86
4	Alappuzha	590530	60.28	780440	67.97	1370970	64.43
5	Kottayam	1079301	76.59	278740	49.3	1358041	68.78
9	Idukki	304653	28.82	33010	63.43	337663	30.45
7	Ernakulam	743512	70.94	1931808	86.46	2675320	81.51
8	Thrissur	655538	63.97	1508400	71.95	2163938	69.33
9	Palakkad	953800	44.71	543800	80.35	1497600	53.29
10	Malappuram	718155	31.28	312945	17.22	1031100	25.07
11	Kozhikkode	396786	39.14	615487	29.7	1012273	32.80
12	Wayanad	440816	56.09	16585	52.52	457401	55.96
13	Kannur	217000	24.6	630400	38.42	847400	33.59
14	Kasargode	200822	25.16	51000	10.02	251822	19.26
Total		8917741	51.04	8596311	53.95	17514052	52.43

Source: Economic Review 2016

Table: 6.11 District wise Category wise number of Water Supply Schemes 2015-16

SlNo.	Name of District	No. of urban water supply schemes	Rural Water Supply schemes		Total
			Multi Pachayat	Single Panchayat	
1	2	3	4	5	6
1	Thiruvananthapuram	6	12	86	104
2	Kollam	3	6	83	92
3	Pathanamthitta	2	8	61	71
4	Alappuzha	4	1	49	54
5	Kottayam	5	21	43	69
9	Idukki	1	12	64	77
7	Ernakulam	8	17	73	98
8	Thrissur	4	8	95	107
9	Palakkad	4	8	49	61
10	Malappuram	6	10	38	54
11	Kozhikkode	2	13	70	85
12	Wayanad	0	5	23	28
13	Kannur	3	6	91	100
14	Kasargode	1	5	72	78
Total		49	132	897	1078

Source: Economic Review 2016

Table: 6.12 District wise number Water Supply connections and street taps 2015-16

SI No	District	Water supply Connections				Street Taps			
		Domestic	Non domestic	Industrial	Total	Panchayath	Corporation	Municipalities	Total
1	2	3	4	5	6	7	8	9	10
1	Thiruvananthapuram	230654	25799	143	256596	13987	4027	1809	19823
2	Kollam	150572	6699	212	157483	15132	3248	1522	19902
3	Pathanamthitta	65915	3943	38	69896	11189		1543	12732
4	Alappuzha	23970	2192	6	26168	3480		380	3860
5	Kottayam	165342	4471	273	170086	23523		4593	28116
9	Idukki	90967	5244	44	96255	7880		2111	9991
7	Ernakulam	440106	33661	405	474172	28560	5917	3438	37915
8	Thrissur	164424	5606	55	170085	21774	2301	3081	27156
9	Palakkad	123762	8033	91	131886	12569		3180	15749
10	Malappuram	76153	4191	19	80363	7117		2350	9467
11	Kozhikkode	72467	6703	62	79232	4547	2638	817	8002
12	Wayanad	15333	1512	6	16851	3686		222	3908
13	Kannur	57617	5221	91	62929	5823		1638	7461
14	Kasargode	19412	1104	10	20526	3301		651	3952
Total		1696694	114379	1455	1812528	162568	18131	27335	208034

Source: Economic Review 2016

Jalanidhi Project

Government of Kerala was a signatory State on the Cochin Declaration that brought in reforms in rural water supply sector in the Country. Subsequent to Cochin Declaration in 1999, Government of Kerala successfully negotiated a rural water supply and sanitation project with loan funding from the World Bank. This project has been subsequently renamed 'Jalanidhi'. It introduced some reforms in the rural water supply sector and is based on principles such as demand responsiveness, community ownership and sustainability of investments through cost recovery and participatory operations and management. The institutional architecture of Jalanidhi partners Gram Panchayaths, Beneficiary communities, Government of Kerala and NGOs acting as supporting organisations. The Jalanidhi model of rural water supply schemes has successfully demonstrated an equitable, inclusive and decentralized delivery system benefiting the SC, ST and BPL category of rural households in Kerala.

Jalanidhi was launched in four of the 14 districts of Kerala. It was subsequently scaled up to the whole State. 4772 water supply schemes were implemented and commissioned and are run by communities. The Jalanidhi project has also tried new institutional water supply experiments, partnering Kerala Water Authority, the Public Sector Water Utility of Kerala State. Wide variety of technology options ranging from surface open wells, bore wells, ponds, Lakes, River based sources and rainwater harvesting were used in the project. Jalanidhi-1 was implemented during the period 2000-2008.

The overall experience of Jalanidhi-I was considered satisfactory on all fronts project preparation, design, quality of entry, implementation arrangements, monitoring and evaluation, compliance with environmental and social safeguards, fiduciary management and procurement. The project's sustainability prospects were assessed as 'good' and overall performance of BGs in managing watsan facilities as 'excellent'. Also, as an implementing agency in Jalanidhi-I, the KRWSA showed its capacity to deliver satisfactory performance. The KRWSA's functioning was marked by: strong ownership of project principles; commitment of diverse and multi-disciplinary staff; emphasis on forging collaboration with GPs, SOs and user groups; adopting scheme cycle approach for activity sequencing; developing and managing an excellent M&E system; field-based capacity building programmes; and regular learning. Other implementing agencies like beneficiary groups (who demonstrated high level of interest, ownership and capacity) and GPs (who provided support to beneficiary groups) too performed satisfactorily.

Table: 6.13 Minimum and Maximum Observed values of water quality parameters at PWD sites and River Stations: 2016

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)	8	6.5	6.8	7.3	6	6.8	0.8	0.3	0.63	500	200	285	B
		Amaravila (Neyyatinkara Village)	8.5	6.5	7.3	7.3	6	6.56	1.8	0.4	1.008	900	360	757.08	C
2.	Mamom	Mamom Bridge (Attingal Village)	8.5	6	7	6.9	5.7	6.38	1.3	0.7	0.98	1650	500	1343.33	E
3.	Ayroor	Ayroor Bridge (Ayroor Village)	7.3	6.9	6.625	6.8	6.7	6.1	1.5	0.7	1.008	2600	1325	1635.41	C
4.	Karamana	Aruvikkara	7.2	6.5	6.87	7.8	6.5	6.95	0.8	0.1	0.365	300	100	186.25	B
		Moonnattumukku (Thiruvallom village)	7.5	6.5	6.92	2	1.2	1.55	56	8	43.95	39500	34000	36966.67	E
5.	Ithikkara	Ayroor Bridge	8	6.8	7.49	7.7	6.1	6.68	2.4	1	1.4	1100	320	680.83	C
		Ithikkara Bridge	7.7	6.8	7.22	7.2	5.6	6.35	2.4	1.2	1.81	800	400	554.16	E
6.	Vamanapuram	Vamanapuram Village	7.3	6.1	6.65	7.3	5.8	6.42	1.8	0.9	1.3	1800	1000	1493.33	E
	Pallickal	Nellimughal	7.7	6.7	7.12	7	5.8	6.59	2.1	1.2	1.51	560	300	438.33	C

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	
7.	Achenkovil	Kallarakkadavu	7.9	7	7.36	7.4	5.9	6.55	1.8	1.2	1.41	500	210	310.83	B
		Chennithala	7.8	6.8	7.31	7.3	5.2	6.35	2	1.2	1.43	920	160	446.66	C
		Thumpamon	7.8	6.5	7.36	7	4.9	6.24	2	1.2	1.42	320	180	233.33	B
		Pandalom	7.6	6.6	7.2	7.2	6.4	6.82	1.6	1.1	1.35	400	260	310.3	B
	Kallada	Perumthottamkadav	7.9	7.2	7.61	7.4	6.1	6.76	1.8	1.2	1.31	380	160	285.83	B
8.	Pamba	PambaDown (Parumala)	7.5	6.4	6.7	6.1	1.5	3.55	1.8	0.3	0.83	700	200	374.16	E
		Chenganoor Municipality	7.8	6.5	6.73	6.6	4	5.1	1.2	0.1	0.55	460	200	316.66	B
		Thakazhi Panchayath	8.5	6.4	6.9	5.5	2.8	4.14	1	0.1	0.55	520	180	341.66	C
9.	Meenachil	Kidangoor Panchayath	7.3	6.5	6.81	7.5	6	6.9	2.4	0.4	0.74	3600	800	2204.54	C
10.	Manimala	Thondara (Kuttoor Panchayath)	7.9	6.8	7.3	7.9	4.7	6.4	6.4	0.2	1.89	360	200	256.66	E
		Kallooppara Panchayath	7.9	6.4	7.2	7.9	6.1	7.41	6.3	0.8	2.55	380	100	285	E
11.	Periyar	Eloor (Kadungallore Panchayath)	7.2	6.5	6.94	9.9	3.6	5.2	3.6	0.9	2.06	1420	580	998.33	E
		Kalady Panchayath	7.6	6.5	6.9	7.6	6.1	6.97	2.9	0.3	1.36	1200	26	516.66	C
		KWAAluva	7.6	6.5	6.91	7.6	5.2	6.375	1.9	0.2	1.28	1100	260	666.66	C
		SDPALuva	7	6.5	6.63	7.2	4.9	5.97	2.4	0.3	1.25	1480	420	749.16	C

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	
		Pathalam (Kadungallore Panchayath)	8.9	6	7.025	8.1	4.6	6.65	3.5	0.5	2.29	1560	140	455.83	E
		Kalamassery Municipality	7.3	5.8	6.74	7.1	1.4	4.55	3	1.2	1.99	1460	350	695.83	E
		Purapallikadavu (Chengamanadu Panchayath)	7.7	6.6	7	9.9	5.5	6.84	3	0.7	1.6	1140	120	518.33	E
		Muppathadam (Kadungallore Panchayath)	7.3	6.5	6.85	7	4.4	5.73	2.6	0.5	1.575	1600	580	940	C
12.	Moovattupuzha	Vettikkattumukku (Mevallore Panchayath)	7.2	6.5	6.84	7.5	6	6.76	0.9	0.2	0.5	3400	1600	2354.54	C
13.	Chalaky puzha	Pullickakadavu (Kadakutty Panchayath)	7.1	6.5	6.77	7.5	5.1	6.39	2.2	0.6	1.19	1240	20	388.75	C
14.	Karuvanoor	Karuvanoor Bridge (Porathissery Village)	8.5	6.5	7.55	9.8	4	6.8	3	0.6	1.75	550	40	285	C
15.	Puzhakal	Puzhakkal Bridge (Adat Panchayath)	8.4	6.2	7.47	9	1.2	5.48	2.8	0.3	1.86	500	170	320	E
16.	Keecheri	Vadakkancherry (Eranellur Village)	8	6.5	7.38	10	4.1	6.47	2.7	1	2	580	190	347.27	C

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	
17.	Bharathapuzha	Kuttippuram Panchayath	8.1	6.5	7.13	8.9	5.9	7.57	1.8	0.8	1.2	760	0	270	C
		Pattambi Panchayath	8.2	6.4	7.3	9.4	0.7	7.06	2.1	0.8	1.18	520	0	228.63	E
18.	Kadalundi	Thirurangadi Village	7.2	6.5	6.82	7.7	5.1	6.57	2.1	0.6	1.27	600	24	133.45	C
		Hajiyarppally (Panakad Village)	7	6.5	6.7	7.5	5.6	6.82	2.8	0.8	1.49	180	40	78.9	B
19.	Tirur	Thalakkadathur (Cheriyamundam Village)	7.5	6.4	6.77	6.4	3.1	4.75	2.1	0.2	1.35	160	44	88.33	E
20.	Chaliyar	Koolimadu (Chathamangalam Panchayath)	7.5	6.5	7.05	7.7	4.9	6.68	1.3	0	0.64	890	30	337.66	C
		Nilambur	7.9	6.5	7.33	7.5	6.4	6.97	1	0	0.532	1020	0	253.92	C
		Chungapally (Perumana Panchayath)	7.6	6.7	7.13	8.2	5.4	6.55	1.5	0	0.69	670	0	254	E
21.	Kabani	Muthankara (Mananthavadi Panchayath)	7.5	6.8	7.24	7.6	6	7.02	0.8	0.3	0.49	140	60	99.09	B
22.	Bhavani	Elaichivazhi (Agali Panchayath)	8.2	6.5	7.5	9.2	6.2	7.6	1.9	0.4	1.009	170	0	85.45	B

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	
23.	Kuttiyadipuzha	Estatemukku (Chakkittappara Panchayath)	7.3	6.5	6.7	7.9	6	7.2	1.1	0	0.58	400	8	119.26	B
24.	Mahe	Valayam (Valayam Panchayath)	7.5	6.5	6.89	7.6	5.3	6.59	1	0	0.57	500	0	215.09	B
25.	Kallai Puzha	Kallai Bridge (Kozhikode Corporation)	8	7	7.34	6.2	2.8	4.18	1.9	0	1.08	6200	60	1770	E
26.	Korapuzha	Kanayankode	7.8	6.8	7.15	7.8	4.6	5.35	1.5	0	0.8	2400	120	1160	E
27.	Kuppam	Taliparamba (Taliparamba Village)	7.6	6.5	6.83	8.6	4.5	6.13	3.1	0.1	1.25	1520	200	912.73	E
		Rayoram (Alakkode Village)	7.7	6.4	7.06	8.9	5.5	7.45	3	.02	1.34	2400	120	898.91	C
28.	Thalassery	Pathipalam (Patyam)	7.6	6.5	6.55	7.3	4	6.02	1.17	0.15	0.39	2000	600	662.18	C
29.	Ancharakkandy	Ancharakkandy Village	7.7	6.5	6.73	8	4.6	6.55	2	0.3	1.12	1300	62	716	E
		Meruvamba (Vengad Village)	7.7	6.5	6.81	7.6	5	6.59	2.4	0.2	1.13	1500	256	680.55	C
30.	Ramapuram	Ramapuram Bridge (Cheruthazham Village)	7.4	5.9	6.71	6.3	2.7	4.5	3.3	0.5	1.309	770	8	229.27	E

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	
31.	Kavai	Kuttiyolpalam (Peralam Village)	7.3	5.9	6.53	8.7	4.2	6.25	3	0.4	1.53	970	40	400.36	E
32.	Valapattanam	Parassanikkadavu	7.6	6.6	7.2	8.6	4.3	6.5	2.1	0.2	1.6	1300	40	400.8	E
33.	Neeleswaram	Hosdurg (Neeleswaram Village)	7.6	6.3	7.009	7.7	4.8	6.09	2.1	0.3	1.24	2700	370	1009.09	E
		Nambiarckal (Hosdurg Village)	7.8	6	6.9	10.4	4.3	6.609	2.3	0.2	1.11	2000	100	868.18	E
34.	Karingode	Kakkadavu (Cheemeni Village)	8	6.5	7.2	8.7	6.6	7.56	1.8	0.2	1.03	2000	70	880.90	C
35.	Chandragiri Puzha	Padiayathadka	7.6	6.5	6.7	8.1	7.3	7.66	1.8	0.2	0.96	5000	40	1316	C
36.	Mogral	Mogral Bridge (Mogral Village)	7.7	5.6	6.76	7.8	4.2	5.49	2.5	0.5	1.44	1800	80	727.27	E
37.	Shriya	Angadimogaru Village	7.4	6.5	6.51	8.5	6.7	7.73	2.7	0.4	1.28	4000	200	1156.7	C
38.	Uppala	Uppala Bridge (Uppala Village)	7.7	5.4	6.98	8.3	4.2	6.4	2.7	0.7	1.609	2300	252	1158.36	E
39.	Manjeswaram	Bajrakkara Bridge (Vorcardi Village)	8.2	6.5	7.04	7.8	6.4	7.32	2.7	0.1	1.11	1120	100	452.85	C
40.	Peruvamba	Chandrapura (Kadanapally Village)	7.2	6	6.609	7.9	3.3	6	2.7	0.2	1.26	1200	100	575.63	E

Source:

State

Pollution

Control

Board

P13

Coast Line of Kerala

The coastal plain of Kerala also constitutes a special ecological mosaic. 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. A chain of water bodies, locally known as kayals running parallel/ oblique to the coastline is a characteristic feature of Kerala. These are mostly interconnected by natural or man-made canals, facilitating internal navigation almost for the entire length of the coast. Numerous perennial rivers discharge into these kayals and the southern half of the Kerala coast harbours more of larger backwaters. The kayals of the Kerala coast are mostly separated from the sea by elongated sandbars and based on this they can be treated as "coastal lagoons". The coast is well known for several places of historical importance, heritage areas and areas of outstanding natural scenic beauty.

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: ENVIS Centre, Kerala

Table: 6.15 District wise Distribution of Fishermen Population in Kerala 2015-16 (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	63248	55837	49616	168701	447	520	446	1413	170114
2	Kollam	39859	33262	19901	93022	13513	12723	8144	34379	127401
3	Pathanamthitta	0	0	0	0	932	810	377	2119	2119
4	Alappuzha	52139	47620	28738	128497	25014	23954	12962	61929	190426
5	Kottayam	0	0	0	0	9837	9327	5773	24937	24937
6	Idukki	0	0	0	0	268	268	170	706	706
7	Ernakulam	28706	26885	16935	72526	23721	23218	16874	63813	136339
8	Thrissur	20976	21434	13561	55971	7927	7259	4594	19780	75751
9	Palakkadu	0	0	0	0	863	854	873	2590	2590
10	Malappuram	35574	28491	25803	89869	1809	1577	852	4238	94107
11	Kozhikode	38937	33790	25813	98540	4178	4396	3412	11986	110526
12	Wayanadu	0	0	0	0	76	82	77	235	235
13	Kannur	17808	10771	9261	37840	2424	2563	1371	6359	44198
14	Kasargod	17440	16162	9756	43358	412	392	185	989	44347
	TOTAL	314687	274252	199384	788323	91421	87943	56110	235474	1023797

Source: Fisheries Hand Book P3

Table: 6.16 District wise details of Fish Production (in tones)

Sl.No.	District	2012-13			2013-14			2014-15			2015-16		
		Inland	Marine	Total	Inland	Marine	Total	Inland	Marine	Total	Inland	Marine	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Thiruvananthapuram	2720	42241	44961	3705	41836	45541	4944	33308	38252	5562	63518	69080
2	Kollam	16787	107816	124603	21877	105009	126886	19447	72270	91717	19757	108686	128443
3	Pathanamthitta	1640	0	1640	2025	0	2025	2888	0	2888	3525	0	3525
4	Alappuzha	20290	120965	141255	24828	116159	140987	31081	108312	139393	34930	44388	79318
5	Kottayam	6865	0	6865	8756	0	8756	11345	0	11345	12308	0	12308
6	Idukki	979	0	979	1344	0	1344	2946	0	2946	3536	0	3536
7	Ernakulam	35038	52026	87064	41449	51997	93446	37674	95023	132697	38951	80394	119345
8	Thrissur	18621	62386	81007	25564	63905	89469	26251	31164	57415	26781	21057	47838
9	Palakkadu	16156	0	16156	22036	0	22036	21833	0	21833	22064	0	22064
10	Malappuram	2778	26105	28883	3543	25155	28698	6517	20004	26521	6831	59920	66751
11	Kozhikode	3905	80375	84280	4561	80050	84611	5264	94740	100004	6124	93443	99567
12	Wayanadu	813	0	513	1005	0	1005	1988	0	1988	2274	0	2274
13	Kannur	2601	22444	25045	3139	22320	25459	3991	43121	47112	4786	23254	28040
14	Kasargod	19905	16280	36185	22505	15877	38382	25376	26526	51902	23333	22085	45418
	Total	149098	530638	679736	186337	522308	708645	201545	524468	726013	210762	516745	727507

Source: Fisheries Hand Book

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.

The occurrence and availability of ground water vary considerably from place to place within the State depending on the prevailing climatic, geomorphological and hydrogeological conditions. About 88 percent of the total geographical area of the state is underlain by crystalline rocks devoid of any primary porosity, with limited ground water prospects. The alluvial formations having multiple aquifer systems, quality is sometimes a constraint in the optimal development of available resources. Increasing population, rapid urbanization and industrialization resulted in increasing use of ground water resources over the last few decades in the State. Judicious and planned development of ground water and its scientific management have become necessary to ensure long-term sustainability of this precious natural resource in Kerala. The dynamic ground water resources of the State are being periodically assessed by the Central Ground Water Board (CGWB), jointly with the State Ground Water Department and other Central Government as well as State Government agencies, according to the methodology recommended by the Groundwater Estimation Committee constituted by Govt. of India from time to time.

Groundwater has been the mainstay for meeting the domestic needs of more than 80% of rural and 50% of urban population besides, fulfilling the irrigation needs of around 50% of irrigated agriculture. The ease and simplicity of its extraction has played an important role in its development. Recent problems in declining in water table, contamination of groundwater, seawater intrusion etc. are being reported at many places.

Table: 6.17 Physical Achievements under Ground Water Development Schemes

SI No	Items	Unit	2013-14	2014-15	2015-16
1	2	3	4	5	6
1	Detailed hydrological survey (Site selection)	No.	9230	8829	7409
2	Sitting and providing technical assistance for open wells	No.	904	553	563
3	Sitting and construction of different types of drilled wells	No.	2130	1925	1622
4	Creating of additional irrigation facilities	ha.	1079	1076	1189
5	Training of personnel	No.	29	16	34
6	Water Sample analysis	No.	4400	2876	3310

Source: Economic Review 2016

Table: 6.18 Ground Water Resources of Kerala (as on 2011)

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 Draft for Irrigation (Ha.m)	Existing Gross Ground Water Draft for domestic and industrial water supply (Ha.m)	Existing Gross Ground Water Draft 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	35595.85	2724.39	32871.46	3984.99	13315.72	17300.71	14699.19	14187.28	52.63
2	Kollam	46755.58	4534.58	42221.00	4014.94	11932.86	15947.83	13015.56	25190.47	37.77
3	Pathanamthitta	27880.87	2469.45	25411.42	3462.72	6004.47	9467.20	6304.40	15644.29	37.26
4	Alappuzha	48645.90	3355.78	45290.11	2991.87	1004.47	13032.34	10371.16	31926.64	28.78
5	Kottayam	49182.06	4611.98	44570.08	3490.69	9214.29	12704.99	10704.21	30375.18	28.51
6	Idukki	21838.47	2183.85	19654.62	2873.72	5495.94	8369.67	5985.83	10795.57	42.58
7	Ernakulam	64499.47	6172.78	58326.69	10308.49	13931.32	24239.82	15295.83	32722.37	41.56
8	Thrissur	75504.97	7352.16	68152.81	22167.50	13720.24	35887.73	15216.48	30768.84	52.66
9	Palakkad	85814.18	7431.58	78382.60	35494.33	13151.26	48645.59	14197.15	28894.24	62.06
10	Malappuram	54530.67	4975.66	49555.00	8166.41	20234.67	28401.08	24392.10	16996.50	57.31
11	Kozhikkode	37903.86	3441.58	34462.28	5200.40	14023.92	19224.32	15792.55	13469.33	55.78
12	Wayanad	30674.72	3067.47	27607.25	652.00	4318.70	4970.70	4815.96	22139.29	18.01
13	Kannur	53231.51	5218.87	48012.65	10943.33	10939.17	21882.50	11932.23	25137.09	45.58
14	Kasargod	36543.61	3654.36	32889.25	16704.82	6774.71	23479.53	7797.51	8386.91	71.39
	Total	668601.72	61194.49	607407.22	130456.24	144061.74	283554.01	170520.10	306634.00	46.68

Source: Economic Review 2016

The total number of GMMWs as on 31.3.2016 is 1672. Out of these, 1404 are dug wells tapping phreatic aquifers and 268 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: 6.19 Ground Water Monitoring Wells in Kerala 2015-16

Sl. No.	Districts	No. of GMMW			Density
		Dug Wells	Piezometers	Total	(Sq.Km)/ GMMW
1	Thiruvananthapuram	114	22	136	12.1
2	Kollam	109	20	129	12.4
3	Pathanamthitta	82	14	96	11.1
4	Alappuzha	81	22	103	12.6
5	Kottayam	99	8	107	19.2
6	Idukki	69	8	77	31
7	Ernakulam	124	18	142	15.1
8	Thrissur	120	20	140	13.7
9	Palakkadu	120	45	165	18.0
10	Malappuram	121	21	142	17.3
11	Kozhikode	84	20	104	18.2
12	Wayanadu	75	9	84	15.5
13	Kannur	100	16	116	20.8
14	Kasargod	106	25	131	14.5
TOTAL		1404	268	1672	16.2

Source: Dynamic Ground Water Resources of Kerala, Year Book, 2015-16

CHAPTER - VII

Human Settlements

Human Settlement is defined as a settlement, locality or populated place where people live. A settlement traditionally includes 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.

Rural settlements are most closely and directly related to land. They are dominated by primary activities such as agriculture, animal husbandry, fishing etc. Characteristics are namely, smaller in size, lack of modern facilities and density of population is not very high. Urban Settlements are densely populated area in which people are engaged mainly in secondary and tertiary activities. Characteristics are namely large in size, population density is very high, complex culture and equipped with modern facilities.

In Kerala there exists a high rate of urbanisation with Malappuram District, having the largest upliftment in urban content with in a decade 2001-2011 followed by Kozhikode. The population density of urban agglomerates in Kerala is less compared to other states. The analysis of population growth indicates that Kerala is likely to achieve zero population growth in the coming 25 to 30 years. The low population growth rate with high level of urbanisation will increase the scarcity of labour in agriculture and related activities. The maximum population density is achieved in urban areas in the present human settlement pattern. Most of the people migrated in urban area for availing employment opportunities likely in industrial works, banking, IT field and other related activities.

Population

Kerala is the leading state of India in terms of social development. The state is currently home to about 2.76% of India's total population. Present Population of Kerala is estimated to be 34 million. A large number of populations in Kerala belong to Malayali ethnicity. In terms of Population, Kerala is the twelfth largest state of India. Kerala is the only state in the country which has the lowest positive population growth rate in India. During 2001-2011, the state has added only 1.5 million people to its population. Thus, Kerala adds around 1.5 lakh human beings to its population each year which is considered to be descent in India. The state has shown major signs of improvement in social development

of the people living there. The state also tops the chart in maintaining a highest literacy rate of 95% which is far above the national figure of 74.04% in India. There are 1084 women available for every 1000 males in the state, thus its sex ratio is considered to be the best of all Indian States. From 1951 to 1991, Population growth in Kerala was steady, from there on there has been a decrease in the population growth rate. Between 1991 to 2001, there was a growth of 9.4% in population of Kerala; this further was down to 4.9% in last finished Census of 2011. Kerala has witnessed a slow population growth rate in the last 20 years. Census figures are detailed in the tables 7.1 to 7.11

Natural Resources

Natural Resources played important role in the early development of Human settlements. The greatest resource of Kerala is her natural beauty with her blue mist - capped mountains, undulating hills and valleys of a thousand shades of green, the blue spread of an endless stretch of lagoons and long seacoast blessed by world famous beaches coupled with an amiable people of rich culture, and art forms which all together earned for her the sobriquet God's own country making her one of the biggest tourist attractions of the world.

Kerala's forests are rich with the pristine silent valley and Agasthyavanam biospheres home to a plethora of rare species of plants and animals making them one of the seven biological hot spots of the world. Kerala ranks 14th among all the States/Union Territories in respect of the geographical area under forest cover which as per 2003 assessment of FSI was 15577 sq.km (dense forest 334 sq.km moderate dense forest 9294 sq.km. and open forest 5949 sq.km.) Forest plantation constitutes major source of raw materials to the forest based industries. Teak is the major species planted in 75767 ha. followed by eucalyptus 14274 ha. softwood species 28832 ha. bamboo and reeds 5912 ha. Plantation crops 1712 ha.

Kerala has 41 west flowing rivers and three east-flowing rivers namely Pambar, Bhavani and Kabani. The biggest river system among the west flowing rivers is Bharatapuzha with most of its water impounded in the Parambikulam- Aliyar dam providing irrigation to Tamilnadu and its tributary Siruvani providing drinking water to Coimbatore. The major portion of water of the second biggest river system Periyar is impounded in the Mullaperiyar dam providing water for irrigation in the neighbouring districts of Tamil Nadu. Other important river systems are the

Chaliyar, Pamba etc. Kerala also has constructed a number of irrigation dams like Malampuzha for irrigation purposes. There are 24 hydel projects owned by Kerala State Electricity Board with an installed capacity of 1883.60 M.W. Kerala has tremendous wind power with only a fraction of it tapped by the 2.25 MW wind farm at Kanjikode in Palakkad district and a 40 MW wind farm at Ramakkalmedu in Idukki district.

The water resources in the State are not abundant but over exploited. The drinking water projects of five corporations and most of the 53 municipalities are based on the water yielded by the west flowing rivers. Although Kerala gets a normal rain of 2360.6mm per year the topography of Kerala with undulating hills and valleys and deep rivers except the narrow strip of the coastal region allows poor retention of water. So rainwater retention structures and watershed management schemes are needed. In Kerala ground water occurs under phreatic, semi-confined and confined conditions. Ground water is largely concentrated in the sedimentary aquifers of the coastal regions. It is mainly tapped for drinking and to a lesser degree for irrigation. The ground water potential of Kerala is very low compared to that of other States.

The State has all the requisite natural endowments for building a strong fisheries economy with 590 km. Coastal belt and inland water spread of over four lakh hectares. The exclusive economic zone lying adjacent to the coast is 36,000 sq.km. almost equivalent to the land area of the State. The State has a fresh water area of 158358 ha. consisting of reservoirs 42890 ha. private ponds 21986 ha. irrigation tanks 1847 ha. and the area of rivers 85000 ha. The brackish water resource consists of 65213 ha. of estuaries and backwaters and 12873 ha. of prawn filtration fields. The polders of Kuttanad have a water-spread area of 35,000 ha. Another 17000 ha. area of Kole lands of Thrissur is also ideal for aquaculture development activities.

Kerala is endowed with a number of deposits such as heavy mineral sand containing mainly thorium, titanium, lithium, zircon etc, china clay, iron ore, graphite and bauxite, silica sand, lignite, lime-shell, granite etc. However mineral sand and china clay contribute more than 90 percent of the total value of mineral production in the State.

Human use natural resources to meet their basic needs of food, clothing, and shelter. As they do so, they consume natural resources. Each time a resource is used, its supply is reduced. If consumption goes unchecked, the availability of the natural resource may be threatened and even exhausted. Two practices that protect natural resources are conservation and preservation.

Water Supply

Access to safe drinking water plays a fundamental role in economic and social development. The way that people secure their drinking water has a direct impact on their health. Further, it is also central to human right and personal dignity. With high density of population and rapid urbanization on the one hand, as well as the impact of climate change on the other, availability of different user groups. Low consciousness about the scarcity of water and its life sustaining nature and inadequate comprehension of its economic value results in its mismanagement, wastage and inefficient uses. Geographically, Kerala has plenty of water resources and is one of the few states which experiences both North East and South West Monsoon. However, due to large spatial and temporal variation in the rainfall system, the abundance of water resources and is one season leads to shortage in the next season. Moreover, the undulating topography with steep terrain coupled with deforestation and sand mining results in the decline of ground water recharges, surface soil erosion in water sheds, sedimentation in rivers and draught in summer.

Kerala is the most vulnerable state in the country in terms of waer quality parameter. People in Kerala generally depend upon well water system. Around 75 percent of rural people do not have access to piped drinking water system and lack of piped water connection enhances the level of bacterial and chemical contaminations in the drinking water. It is indicated that 39.9 percent of rural drinking water in Kerala has been contaminated with iron, fluoride, salinity, nitrate, arsenic, faecal coliform and other multiple contaminations. Unscientific waster disposal, unplanned construction of toilets in highly populated areas, discharge of industrial waster etc, are the major reasons. Most of the states which had chemical and bacterial contaminations have been successful in reducing the contamination level.

Kerala Water Authority and Ground water Department are the two major Government Departments responsible for the regulation of water supply and waste water management in the State. Kerala Water Authority is the largest entity in the field of water supply and implemented thousands of small, medium and large urban-rural piped water supply schemes. Ground Water Department is having 1672 no's of GWMWs as on 31.03.2016. Out of these , 1404 are dug wells tapping phreatic aquifers and 268 are borewells/tubewells tapping deeper aquifers of confined/semi confined nature .

Life Expectancy

Life expectancy at birth in Kerala is 74 years where as it is 63.5 years in India. Female life expectancy in Kerala exceeds that of the male, just as it does in the developed world and the maternal mortality rate is lowest, compared to India...

Health Indicators	Kerala	India
Birth rate(per 1000 population)	14.6	22.8
Death rate (per 1000 population)	6.6	7.4
Infant mortality rate (per 1000 population)	5	33.6
Maternal mortality rate (per lakh live birth)	34	130
Total fertility rate (per women)	1.8	2.9
Couple protection rate	62.3	52
Life expectancy at birth (Male)	71.4	62.6
Life expectancy at birth (Female)	76.3	64.2
Life expectancy at birth (average)	74	63.5

Table: 7.1 Population of Kerala

Sl No.	Districts	Census 2011			
		Male	Female	Population	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.	State/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.	State /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 Population Rural and Urban break-up – 2011 Census								
Sl no	State /District	Total Population	Rural			Urban		
			Male	Female	Total	Male	Female	Total
1	Thiruvananthapuram	3301427	724864	804967	1529831	856814	914782	1771596
2	Kollam	2635375	680687	767530	1448217	566281	620877	1187158
3	Pathanamthitta	1197412	499820	565979	1065799	61896	69717	131613
4	Alappuzha	2127789	464713	514930	979643	548429	599717	1148146
5	Kottayam	1974551	692673	716485	1409158	275616	289777	565393
6	Idukki	1108974	527245	529684	1056929	25563	26482	52045
7	Ernakulam	3282388	518510	529515	1048025	1101047	1133316	2234363
8	Thrissur	3121200	488303	536491	1024794	992460	1103946	2096406
9	Palakkad	2809934	1031466	1101658	2133124	328012	348798	676810
10	Malappuram	4112920	1095308	1200401	2295709	865020	952191	1817211
11	Kozhikode	3086293	484784	528937	1013721	986158	1086417	2072575
12	Wayanad	817420	386283	399557	785840	15401	16179	31580
13	Kannur	2523003	425682	456335	882017	755764	885222	1640986
14	Kasaragod	1307375	387716	410612	798328	240897	268150	509047
	Total	33406061	8408054	9063081	17471135	7619358	8315568	15934926

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

Sl. No.	State/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

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

Sl. No.	State/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

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

Sl. No.	State/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

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

Sl. No.	State/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

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

Sl. No.	State/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

Table : 7.10 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
01	Kasaragod	22162	9802	12360	14054	5958	8096	14798	5745	9053	1754	937	817
02	Kannur	55799	24181	31618	38295	15248	23047	40770	14743	26027	5761	2935	2826
03	Wayanad	12686	5737	6949	8542	3524	5018	9482	3741	5741	698	385	313
04	Kozhikode	60549	27251	33298	41629	17021	24608	44026	16860	27166	2959	1560	1399
05	Malappuram	57916	25771	32145	36779	15070	21709	35037	13043	21994	3243	1587	1656
06	Palakkad	59901	26530	33371	39364	16215	23149	38937	14287	24650	3135	1555	1580
07	Thrissur	77623	32997	44626	53997	21454	32543	55539	19501	36038	2963	1468	1495
08	Ernakulam	79552	35457	44095	55915	23493	32422	62456	23351	39105	2690	1249	1441
09	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 :7.11 Age Wise, Sex Wise Population 2011&Mid Year 2016

age group	2011 census Population			Mid year population 2016		
	Male	Female	Total	Male	Female	Total
0-4	1247534	1205558	2453092	1280159	1237084	2517243
5to9	1303190	1251922	2555112	1337270	1284661	2621931
10to14	1438917	1383853	2822770	1476546	1420043	2896589
15to19	1328299	1282253	2610552	1363036	1315785	2678821
20to24	1298826	1366983	2665809	1332792	1402731	2735523
25to29	1203978	1400114	2604092	1235463	1436729	2672192
30to34	1128217	1327284	2455501	1157721	1361994	2519715
35to39	1161819	1417854	2579673	1192202	1454932	2647134
40to44	1117424	1295074	2412498	1146646	1328942	2475588
45to49	1105598	1242932	2348530	1134511	1275436	2409947
50to054	931191	996954	1928145	955543	1023025	1978568
55to59	861527	880881	1742408	884057	903917	1787974
60to64	685136	729535	1414671	703053	748613	1451666
65to69	459232	542902	1002134	471241	557100	1028341
70to74	326562	406810	733372	335102	417449	752551
75to79	208317	293050	501367	213765	300713	514478
above80	204348	337501	541849	209692	346327	556019
age not stated	17297	17189	34486	17749	17640	35389
TOTAL	16027412	17378649	33406061	16446548	17833121	34279669

Surce: Statistical Hand Book, DES

The background of the page is a repeating pattern of green leaves and stems on a lighter green gradient. The leaves are small and pointed, arranged in a dense, overlapping manner.

**DEPARTMENT OF ECONOMICS AND STATISTICS
VIKAS BHAVAN, THIRUVANANTHAPURAM, KERALA**