

# KERALA STATE BIODIVERSITY STRATEGIES AND ACTION PLAN 2022-2032



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**PINARAYI VIJAYAN**  
Chief Minister

## MESSAGE

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I am extremely happy to present the Kerala State Biodiversity Strategy and Action Plan (SBSAP), which has been undertaken with the support of the Government of India - Global Environment Facility - United Nations Development Programme (GOI-GEF-UNDP).

This ten year strategy and action plan has been prepared based on the Kerala State Biodiversity Board's vision, 'to protect biodiversity in its own right and ensure its enrichment and sustainable use for the development of Kerala'. The SBSAP document includes threats and constraints in biodiversity conservation based on which action points have been designed with clear-cut implementation mechanisms and resource mobilisation strategies.

Implementation of the SBSAP can be accomplished only with the active involvement of all the departments that directly or indirectly deal with biodiversity conservation and its sustainable utilisation. People's participation will remain central to its successful implementation, and I hope that all the Biodiversity Management Committees in the State will ensure it.

I congratulate all those who have contributed in formulating the SBSAP. My best wishes for its successful implementation.



Pinarayi Vijayan

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## ACKNOWLEDGEMENTS

**K**erala State Biodiversity Board with the funding support of MOEFCC-UNDP and GEF undertook updating of the Kerala State Biodiversity Strategies and Action Plan. Biodiversity related activities whether agricultural diversity conservation, native breed conservation, conservation of riverine ecosystem, water and energy conservation, sustainable use of natural resources, promoting responsible tourism or promoting livelihood through sustainable utilization of biological resources are being undertaken by various institutions. This exercise was undertaken for the mapping of programmes/activities by various state level departments and agencies towards biodiversity conservation and identifying key issues and prioritizing activities for the next 10 years. The SBSAP covers important issues of conservation of biodiversity through desk based policy research, field visits and stakeholder consultations. The Local Biodiversity Action Plan at Athirapilly developed through a consultative process with Biodiversity Management Committees and local community is a first of its kind in Kerala.

We would like to express our deep gratitude to Dr R V Varma, Chairman of expert committees, and Former Chairman, KSBB, Dr Satheeshkumar, Board member, KSBB, Dr Rita Pandey and all other members of the expert committees constituted for this purpose. We acknowledge the guidance and valuable inputs from Dr.Ruchi Pant, Head, Natural Resource Management and Biodiversity, UNDP. We are also grateful to Mr Jerin Thomas Abraham, Project Officer, Natural Resources and Environment Management, UNDP India, for his support in facilitating the study. This report has also benefitted from the valuable suggestions from experts in various government departments, academia, civil society organisations, and communities for which we are grateful.

We are indebted to Dr Venu V, IAS, Additional Chief Secretary, Department of Environment, Government of Kerala for his valuable guidance.

We are extremely grateful to the Hon'ble Chief Minister of Kerala, Shri Pinarayi Vijayan for his constant support in all our activities.

**Dr C George Thomas**

*Chairman, KSBB*



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## ABBREVIATIONS

ABS	Access and Benefit Sharing
ABT	Aichi Biodiversity Target
AYUSH	Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy
BHS	Biodiversity Heritage Sites
BMC	Biodiversity Management Committees
BSI	Botanical Survey of India
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
DOECC	Department of Environment and Climate Change
EIA	Environment Impact Assessment
EDC	Eco-development committees
GCF	Green Climate Fund
GEF	Global Environment Facility
GI	Geographical Indication
IMD	India Meteorological Department
INDC	Intended Nationally Determined Contribution
IUCN	International Union for Conservation of Nature
JFMC	Joint Forest Management Committee
KFD	Kerala Forest Department
KILA	Kerala Institute of Local Administration
KSBB	Kerala State Biodiversity Board
KSDMA	Kerala State Disaster Management Authority
LBHS	Local Biodiversity Heritage Site
LIFE	Livelihood Inclusion Financial Empowerment
LSG	Local Self Government Department
MAT	Mutually Agreed Terms
MoEFCC	Ministry of Environment, Forest and Climate Change
NAPCC	National Action Plan for Climate Change

NBA	National Biodiversity Authority
NBAP	National Biodiversity Action Plan
NBT	National Biodiversity Target
NDC	Nationally Determined Contribution
NGO	Non-governmental organization
NITI Ayog	National Institution for Transforming India
NSSO	National Sample Survey Office
NWCP	National Wetland Conservation Programme
NWFP	Non wood forest produce
OECM	Other Effective Area-based Conservation Measures
PAs	Protected Areas
PBR	People's Biodiversity Register
PIC	Prior Informed Consent
RKI	Rebuild Kerala Initiative
RET	Rare Endangered Threatened
SAPCC	State Action Plan on Climate Change
SBSAP	State Biodiversity Strategy and Action Plan
SDG	Sustainable Development Goal
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
TGA	Total geographic area
TOF	Trees Outside Forest
TSG	Technical Support Group
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
UN-PDNA	United Nations Post disaster needs assessment
VEDC	Village Eco development Committee
VSS	Vana Samrakshana Samithi
WLPA	Wild Life Protection Act
ZSI	Zoological Survey of India

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# Executive summary

**K**erala State Biodiversity Board (KSBB) under an initiative of the Ministry of Environment, Forest & Climate Change and the United Nations Development Programme (UNDP), through funding from Global Environment Facility (GEF) has been assigned the task of updation of the Kerala State Biodiversity Strategies and Action Plan. KSBB made the first set of Strategies and Action Plans during 2007, and the updated SBSAP for the present and future scenario was developed through a consultative process with experts drawn from different sectors. The present document focuses on identifying the threats to biodiversity in Kerala state in different sectors and makes policy recommendations for improving the conservation and status of biodiversity, natural resources and ecosystem services in the state.

The primary objectives were:

1. To update/develop Kerala State Biodiversity Strategies and Action Plan (SBSAP) considering the state priorities in line with national and global priorities of biodiversity conservation and wildlife protection
2. To develop a resource mobilization strategy for implementing State Biodiversity Strategies and Action Plans. This is being done independently by a team led by Dr Rita Pandey, International Public Policy Specialist (Biodiversity, climate Change and Sustainable Development), Gurugram, India and the same will be a part of this document.
3. To develop a pilot model of development of local biodiversity strategies and action plan in one of the project sites of UNDP funded Munnar landscape project. Local action plans are very important as ultimately the projects are being implemented at the local level. For this project, Athirapilly Panchayat located in Thrissur district was selected.

The activities included were:

1. Assessment of the present status of biodiversity conservation initiatives, species population trends and the threats relevant to the state;
2. Identification of gaps in the policy framework of various departments of the state government;
3. Mapping the schemes of various department/agencies that have a positive/ negative impact on biodiversity conservation in the state;
4. Preparation of short term, medium term and long-term strategies and action plans and the mitigation strategies for the identified threats.
5. Identification of indicators and developing a monitoring framework

The Kerala State Biodiversity Strategies and Action Plan (2022) was formulated with the technical guidance of a team of experts from different sectors. For the preparation of this document, a very exhaustive data collection from different sectors through stakeholders' consultations has been done. The consultations comprised of three state level workshops and several sectoral workshops. A review of the existing SBSAP and rapid assessment of the gaps in implementation was also done. In addition, a review was carried out for status and trends of biodiversity in the state and threats to biodiversity. Keeping in view of the status, trends and threats, the Biodiversity Strategies and Action Plan (BSAP) is presented under six themes

1. Forest and biodiversity
2. Coastal and Inland biodiversity
3. Agriculture and Animal Husbandry
4. Social sectors
  - a) Tribal development
  - b) Education
5. Cross cutting sectors
  - a) Environment and Climate change
  - b) Local Governance (Panchayat, Rural development, Urban development)
6. Infrastructure sectors
  - a) Water resources
  - b) Tourism
  - c) Energy and Transport

The SBSAP was also discussed with the relevant line departments and comments from the public invited through presenting the final draft of SBSAP in KSBB website and all the suggestions received were incorporated in the final document.

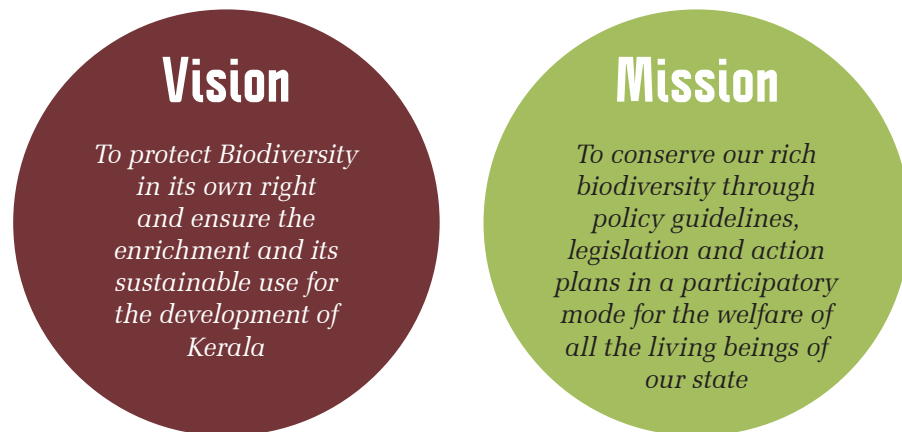
Kerala has a very small geographical area of 38,863 sq. km which constitutes 1.8% of the total geographical area of India. The population density of the State is 860 per sq km which is much higher than the national average. Kerala falls within two biogeographic zones: the Western Ghats and, the Coasts. Twenty-three agro- ecological units have been delineated in Kerala based on climate, land form and soils, with the Panchayats as the primary unit. The Western Ghats, one of the world's hottest hotspots of biodiversity traverses through Kerala. Out of the 39 serial sites of Western Ghats inscribed on the UNESCO World Heritage List 19 are located in Kerala. Kerala is known for homestead farming system, which integrates home with useful fruit trees and shrubs, vegetables, tuber crops, spice crops, fodder crops, livestock, and poultry in a small area of land. The coastal and inland ecosystems of Kerala are of prime concern and are productive with multitude of ecosystem services provided. The Government of Kerala has undertaken several positive steps to conserve the rich biodiversity and environment of the state and has many policies to address issues in the sectors like agriculture, forests, water resources/marine ecosystems. The efforts has borne fruit as is evident from the fact that in Sustainable Development Goals Index 2020-21 developed by NITI Ayog, the state is leading first. The environmental dimensions of SDGs are covered in Goal 12, 13,14 and 15. In SDG 12, SDG 13 and SDG 15, the state is in the Front Runner category , while in Life below water it is in Performer category .

In a State like Kerala, which is densely populated with limited natural resources compared to the population size, the developmental activities should go hand in hand with environmental sustainability and social equity. In forestry sector, there is a shift in the management from production forestry to conservation forestry. With regard to wood production from the state, some of the recent studies indicate that most of its requirements are met from homesteads, rubber wood plantations and imported wood from other countries. Reduced consumption of wood in favor of environmental conservation may be a positive aspect in the context of developing a low carbon economy. There is also a need to have a fresh look at the NWFPs collected from the forests, their value-added products and promotion of the livelihood of those who conserve bioresources in the forests. Productivity is very low even for species like teak and improved management practices are to be adopted based on scientific knowledge.

It is a fact that the food production in Kerala does not match with the demand over the last many years. The major crops including rice and coconut suffer mainly due to low productivity. There is also reduction in area under cultivation. The change in the structure of home gardens, has reduced biodiversity and thus food security as well. In recent times, exotic plants, mostly fruit bearing plants, are also cultivated by many farmers in a commercial scale. The challenges that we face in the coastal ecosystems are high density of population, lack of proper management plans for development,

coastal erosion, climate change related issues and excess pollution. Kerala faced a number of natural calamities, floods/landslides during 2018,2019 and in 2020 with varying intensities and also epidemics such as Covid 19/Nipha virus in recent times.

***The vision and mission of KSBB for the next 10 years is as follows:***



The SBSAP document is organized into 5 sections, and under Strategies and Action Plans, ten sectors were covered and the key drivers of change and threats/ issues have been identified for each and strategies developed. For each of the strategies, action plans have been prioritized and implementing agencies identified. The sector, Forest and Biodiversity has 21 strategies, Coastal and Inland biodiversity 16, Agrodiversity 6, Animal husbandry 7, Social sector 9, Environment and climate change 14, Local Governance 6 and Infrastructure 10. About 50 central and state government departments/institutes have been identified that are directly or indirectly implementing projects/ schemes related to biodiversity conservation/ research in Kerala. The implementation of the SBSAP will require cross-sectoral linkages with several of the above-mentioned departments and institutes. A resource mobilisation strategy for implementation of SBSAP in Kerala is also included.

Under Forest and Biodiversity sector, 21 strategies have been proposed with many action plans under each strategy. Restoration of degraded forest ecosystem, acceleration of carbon sink potential of forests, enhancing resilience to combat climate extremes like flood, drought, landslides, forest fire, natural calamities etc; managing human wildlife conflicts, forest plantation productivity, ecorestoration of river banks, landscape approach for conservation in protected areas, biosphere reserves/ community reserves etc are some of them. Documentation and conservation of NWFP/ medicinal plants, conservation of traditional knowledge associated with bioresources and eradication of invasive alien species are other important strategies

included under Forest and Biodiversity. All the action plans proposed under each strategy are in line with the current activities being followed by the Forest department, and wherever possible, a participatory approach has been suggested to make it socially acceptable. The possible linkages with the national targets and a rough idea on the success of the implementation of the action plans, based on indicators and the possible implementing agencies have also been provided in a tabular form.

Under agrobiodiversity sector, the strategies developed include documentation of crop diversity, incentivizing farmers, breeders, custodian farmers etc. Sustainable utilization of agrobiodiversity aspects related to protection of IPR on crop diversity and strategies dealing with animal husbandry are included. Under the action plans on each strategy, emphasis has been given to protect the traditional cultivars and on farm conservation measures. Protection of unique crop products of Kerala and facilitating GI tag were also taken care of. The action plans are linked with various ongoing programs of the Kerala Agricultural department/Kerala Agricultural University and other related stake holders. Under action plans of animal husbandry strategies and action plans are also proposed to conserve indigenous genetic resources like Vechur cow, Malabari goats etc.

Under Coastal and Inland biodiversity, some of the important strategies include conservation of mangrove ecosystem, ecorestoration of riparian vegetation, conservation of freshwater biodiversity, marine biodiversity conservation and sustainable utilization, sustainable utilization of aquatic bioresources and fishes and wealth from fish waste. Here, the action plans proposed are with a clear mandate to protect and conserve the coastal and inland bioresources and also to make available the bioresources in a sustainable manner. Thrust has also been given, wherever possible to suggest action plans to improve the livelihood of coastal people who are the real custodians of coastal biodiversity.

Under the Social Sector, the aspects covered are tribal development and education. The strategies included documentation of TK/folk practices associated with bioresources, sustainable collection of NWFP, supply chain and value chain analysis of tradable bioresources, developing entrepreneurship programme among the tribal communities, and biodiversity education among students and youth and also awareness creation for various stakeholders. Most of the action plans proposed are with a view to get the benefits to the tribals and other stake holders who protects the biodiversity at local level.

Under Environment and Climate change, climate or change predictions to suit Kerala conditions and also the impact of climate change in ecosystems like forests, agriculture, and other ecosystems and also the management of invasive species in the context of climate change and issues related to disaster management measures to minimize loss of biodiversity and human lives in a participatory mode are covered. All the relevant action plans under each

strategy are framed based on recent floods and landslides which happened in Kerala during 2018, 2019 and 2020. Preparing people at local level to face the impacts of climate change has been given a thrust in the action plans.

As part of the preparation of SBSAP, there was also a mandate to prepare a pilot model of development of strategies and action plan at one panchayat and Athirapally Panchayat in the Vazhachal Forest Division, Thrissur District was selected for the same. This panchayat was considered because of unique topography, rich biodiversity and the presence of bioresource dependent tribal communities. The LBSAP document of Athirapilly includes general profile, physiography, land use and vegetation, socio-economic and cultural aspects and biodiversity of the area covering flora, fauna, major ecosystems and agrodiversity. The action plan is categorized into five focus areas with a total of six strategies and relevant action plans.

All the action plans proposed are with a view to improve the livelihood of tribals and marginal people, who conserve local biodiversity. Human-wildlife issues are of prime importance and suitable action plans have been proposed. The panchayat has lot of potential on ecotourism and suitable action plans are made linking conservation with income generation. As part of the strategies and action plans titles of a few action oriented projects have also been provided, which the panchayat can take up on a priority basis.

As mentioned earlier, Kerala witnessed a series of natural calamities from 2018-2020 at varying intensities and also outbreak of COVID-19 pandemic and other epidemics in the health sector. It is in the backdrop of these happenings, SBSAP -2022 has been prepared. The document has further given thrust to attain sustainable development, livelihood security and nutritional security with an overall approach to reduce poverty especially at the local level.

# CHAPTER 1

## Introduction

The United Nation Conference on Environment and Development (UNCED) popularly called the Earth Summit (1992) was one of the major initiatives taken for promoting conservation of bioresources, its sustainable use and also the fair and equitable sharing of benefits arising out of their commercial utilization. The Convention on Biological Diversity was a legally binding agreement approved in the summit. This international treaty was signed by 196 Parties, including India, and stands as a turning point because it has recognized the sovereign rights of the countries on the naturally occurring bioresources and also to determine benefit sharing conditions subject to national legislation. The Nagoya Protocol of 2010, ratified by 132 parties, including India has provided an effective mechanism for implementing the access and benefit sharing objective of the Convention on Biological Diversity.

The Biological Diversity Act (BD Act) 2002 was enacted in India in response to the requirements of the CBD agreement. It also provided suitable linkage to the provision of patenting products and procedures/technologies, based on the bioresources occurring in India and associated traditional knowledge under Section 10(4) of the Patents (Amendment) Act, 2002.

The major outcome in course of time was the establishment of the National Biodiversity Authority (NBA) as the apex body in the three-tier system in 2003 with Chennai as its headquarters. Subsequently, State Biodiversity Boards (SBBs) were also established in different states of India. In Kerala, KSBB was

established in 2005. One of the major initiatives taken up by KSBB was to prepare a set of Biodiversity Strategies and Action Plans through interaction with various stakeholders, and the document was brought out in 2007. Soon after, KSBB brought out the Kerala Biological Diversity Rules, 2008 and became one of the few states in India to achieve this distinction. Another important achievement of KSBB was the establishment of Biodiversity Management Committees (BMC) in all the Local Self Governments (LSGs) by 2019, a rare feat achieved by a state in India for the first time. Documenting the People's Biodiversity Register (PBR) was also started simultaneously with the support from Technical Support Group (TSG) for each district and ably coordinated by KSBB with trainings at different levels. When many states were attempting to pass on this difficult task through an outsourced agency, KSBB prepared PBRs in a participatory mode as envisaged in the BD Act.

In a state like Kerala, which is densely populated with proportionately limited natural resources, the developmental activities should go hand in hand with environmental sustainability and social equity. Kerala faced a number of natural calamities, floods/landslides during 2018, 2019 and 2020 with varying intensities and also epidemics such as Covid 19/Nipha virus in recent times.

## 1.1 Introduction to some critical area of concern

**The climate-change** related impact on biodiversity is of prime concern. It is difficult to predict the intensity of rains /unexpected heavy rainfall at local level with the available technologies. However, it is possible to get a reasonably good prediction at district level. Conserving biodiversity is essential for our ecological security. The "Navakerala Mission" launched by Government of Kerala is also addressing many issues that we face with regard to climate change.



*The Government of Kerala started an initiative "Rebuild Kerala" in 2018 with the objective of building resilience and mitigating risk, adopting the concept of 'building back better'..*

It is gratifying to note that a new Working Group has been created in the LSGs 'Biodiversity, Climate Change, Environment and Disaster Management' to mitigate the challenges due to climate change. Panchayats are also encouraged to prepare local action plans on climate change and implement them.

KSBB conducted a rapid assessment of the impact of 2018 floods in Kerala through BMCs. The major causes of disaster according to the community included land use changes in the wetlands, removal of the riverine vegetation, construction activities on hill slopes and unsustainable quarrying. As a follow-up, KSBB also floated a number of projects to R and D Centers and Universities



in Kerala to study the impact of floods/landslide on biodiversity and ecosystem and on riparian eco restoration.

Kerala has many policies to address climate change related issues in the sectors like agriculture, forests, water resources and marine ecosystems. However, a policy document to mitigate/adapt climate change is lacking. In this context, lack of a comprehensive land policy for the state is worth mentioning.

**In the forestry sector**, there is a shift in the management from production forestry to conservation forestry and currently with thrust on hydrological conservation. The prime importance is to strengthen water resources through the 44 river systems, locally and regionally. Conservation of soil, biodiversity, managing invasives and planting with native vegetation are equally important. Much of our biodiversity is in our forests and the same has to be protected at ecosystem, species and genetic levels.

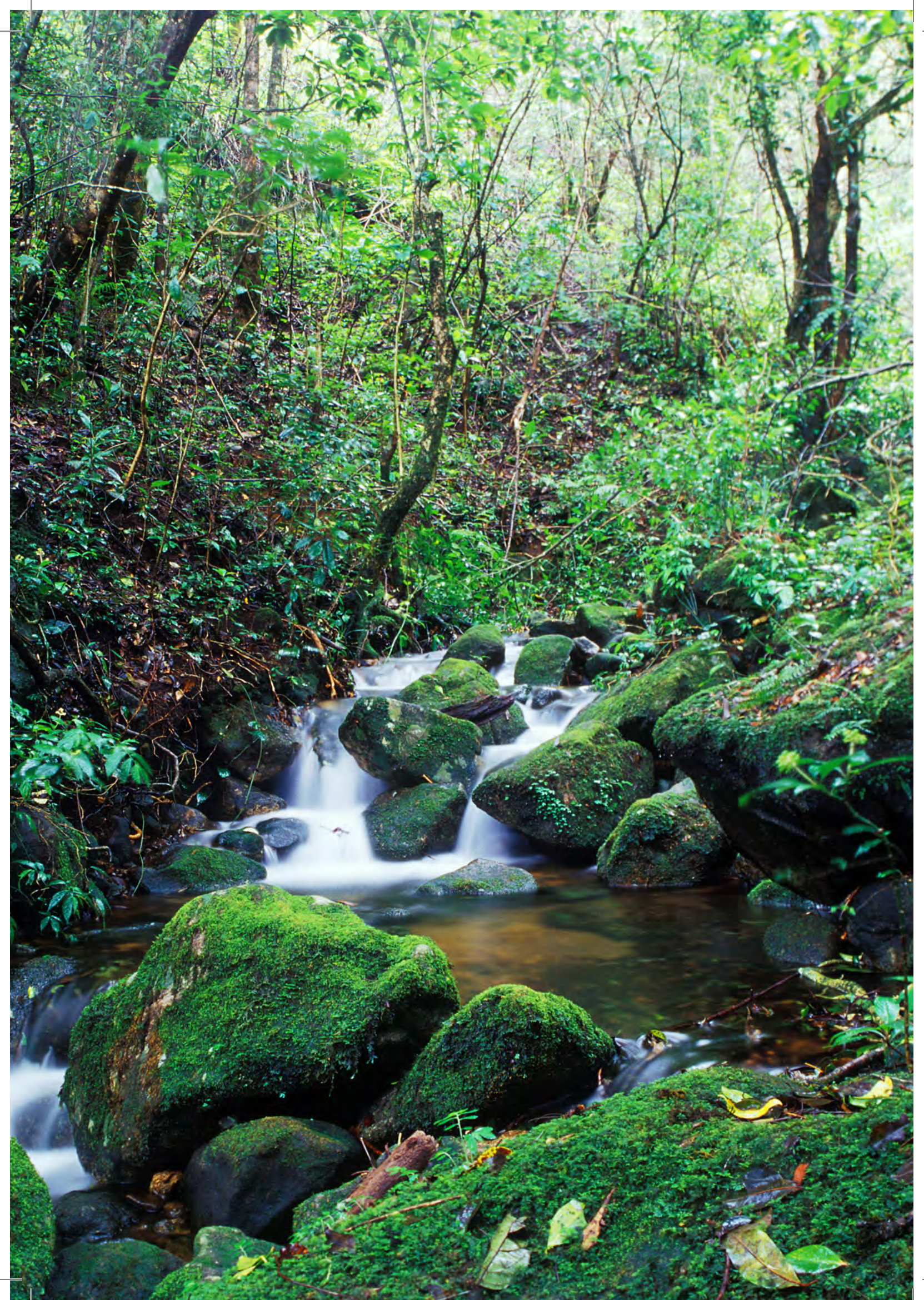
With regard to wood production from the state, some of the recent studies indicate that most of its requirements are met from homesteads, rubber wood plantations and imported wood from other countries. Reduced consumption of wood in favor of environmental conservation may be a positive aspect in the context of developing a low carbon economy. There is also a need to have a fresh look at the Non-wood Forest produce (NWFP) collected from the forests, their value-added products and promotion of the livelihood of those who conserve the bioresources in the forests. Involving the local communities in watershed management and biodiversity conservation needs to be ensured.

There is also a need to study the genetic diversity and population structure of important forest genetic resources and their *in-situ* conservation.

Reproductive studies on tropical trees in relation to applied aspects are rare and to be promoted. The relevance of forest seed banks is also not given the desired attention.

Implementation of Forest Rights Act, 2006 need to be taken up in its totality to ensure community rights. Delineating forest boundaries using modern technologies and ensuring protection of wildlife corridors has to be considered seriously. Wildlife-human conflicts are on the increase in the state in recent times and thus there is an urgent need to ensure food and water availability to the wildlife in forests. Once the established corridors are fragmented, wild animals can come to human habitats in search of food and water, which will result in loss of life and property.

There is also a need to look at the forest plantation sector. Productivity is very low even for species like teak and improved management practices are to be adopted on the basis of scientific knowledge. Among the high value trees, sandal tree has to be given importance and if more areas are



coming under sandal, it will boost the economy and can also prevent smuggling activities.

In general, an ecosystem approach for forest management must be evolved with a clear understanding of the local conditions and the BMCs located in the Panchayats close to the forests and Protected Areas to involve with biodiversity conservation.

**Sacred groves** of Kerala are storehouse of rich biodiversity and they almost serve the functions of tropical evergreen forests. Most of the sacred groves in the state are managed by traditional families, village communities or temple trusts or Government owned Dewaswom Boards. In spite of the efforts being made by many agencies to protect the sacred groves, many of them are also being destroyed.

**Mangroves** are ecologically and economically important, supporting fisheries, commercial forest products, prevent pollution and soil erosion and protect the coastline from cyclone, flood and other natural calamities. The ecosystem services provided by the mangroves run into crores of rupees. Many of the mangroves are also polluted due to demographic pressures and other sources of pollution and it is reported that there is drastic reduction in the zooplanktons in many mangroves, which can adversely affect fish resources.

Like any other conservation programme, people's participation is important for the conservation of mangroves as well. The "Kannur Mission", initiated by the District Collector in the Kerala State in 2014, along with Kerala Forest Department to survey, notify and save mangroves of the district is a model. There is also a move by the Kerala Forest Department to acquire mangroves from private owners by providing compensation and bringing more mangroves under reserved forests. Mangrove conservation and restoration are novel measures to counter global warming and climate change.

**Agrobiodiversity** refers to the nature and extent of variability present in the domesticated plants and their wild relatives. In Kerala, the average size of the holdings is very small. Most of the holdings are less than 1 ha in size. Large holdings are planted with tree crops and spices such as coffee, tea, rubber and cardamom. In the homesteads, generally a polyculture system is followed.

It is a fact that the food production in Kerala does not match with the demand over the last many years. Major crops like rice and coconut suffer mainly due to low productivity. There is also reduction in area under cultivation. In recent times exotic plants, mostly fruit bearing plants are also cultivated by many farmers in a commercial scale. However, in homesteads, a multiple cropping system is to be encouraged so as to

conserve our agrobiodiversity. The Government is trying to make farmers understand that farming is a respectable enterprise, and a social security system for them by way of pension is also being introduced. With regard to food diversity, especially of the tribal/ethnic communities, green leaves and other vegetables and tubers, which are potential for nutritional and health security are to be evaluated scientifically and popularized.

There is also a need to protect the pollinators and beneficial fauna in the agroecosystem for increased productivity. All crop plants benefit from wild and managed honeybees in pollination. This also ensures biodiversity conservation, ecosystem services and also food security. Wild honeybees mostly depend on nearby forests for nesting and foraging.

The change in the structure of home gardens has reduced the biodiversity and thus the food security as well. There is potential to revive the food basket in Kerala through appropriate policies and strict compliance of the existing rules and regulations. Farmers must be encouraged to register for Geographical Indications of products, native breeds, and also to protect intellectual property rights. This will enable to understand the importance of underutilized crop genetic resources and lead to scientific validation.

Livestock population of Kerala like cattle and goat is also on the decline. The demand for milk and meat is not met adequately; also a huge gap between the demand and production of eggs in the state is evident.

**The coastal and inland ecosystems** of Kerala are of prime concern and are productive with multitude of ecosystem services provided. These include backwaters, lagoons, estuaries, mangroves, etc. The coastal line of Kerala is almost 590 km and support nearly 30% of the population of Kerala, most of them engaged in fishing activities. Although the marine/costal biodiversity is quite rich compared to the terrestrial ecosystem, conservation strategies are meager in the marine /wetland ecosystems. The challenges that we face in the coastal ecosystems are high density of population, lack of proper management plans for development, coastal erosion, climate change related issues and excess pollution. It is worth considering to establish a network of coastal zone local bodies to address common issues being faced in the coastal areas and take up suitable proactive measures in a decentralized manner.

Fisheries are an important economic activity of the coastal area. The fish resources must be made available in a sustained manner for the community and hence vulnerable ecosystems like coral reefs, mangroves and estuaries are to be conserved for breeding and feeding of fishes. Similarly due to the natural calamities that we face often, the fishermen also have to be rehabilitated to safer zones with adequate amenities.

There is also a need to establish marine and coastal protected areas, similar to what we have in forests. This will enable better protection of the marine resources under law and also prevent the trade of resources under threatened categories. Introduction of non-native fishes into our water bodies and also non-compliance of strict quarantine measures have resulted in the loss of many of our local fish fauna.

Another important point in terms of biodiversity conservation is on the collection of ornamental fishes from the wild/natural habitat and their trade. These activities are mostly illegal and the R&D centers/Fisheries University ought to develop protocol for breeding such species for commercialization. Aquaculture can be a source for income generation, but should not be at the cost of our precious biodiversity. Other threats like aquatic invasives, destructive methods of catching fishes, pollution and waste dumping in water bodies are factors which negatively affect the inland and coastal biodiversity.

To sum up, biodiversity nourishes life and sustains our planet. The very purpose of the strategies and action plan is to attain sustainable production, nutritional security, reduce poverty and provide livelihood security of the community/local people who conserve our rich biodiversity.

The present action plan is prepared based on the project “Updating of Kerala State Biodiversity Strategies and Action Plan” funded by Government of India- Global Environment Facility and United Nations Development Programme.

## **1.2 The Convention on Biological Diversity**

The three Rio Conventions - Biodiversity (Convention on Biological Diversity), Climate Change (United Nations Framework Convention on Climate Change) and Desertification (United Nations Convention to Combat Desertification) – derive directly from The United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit or Rio Summit. The Convention on Biological Diversity (CBD) aims to put in place a comprehensive international regime for the sustainable management of biological resources through its three pillars: the conservation of biological diversity, sustainable use of its components for the benefit of present and future generations and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. Globally, 196 countries became members of Convention on Biological Diversity (CBD), India signed the agreement in 1993. The CBD affirms the sovereign rights of the countries over biological resources.

**Strategic Plan for Biodiversity 2011-2020**, (including Aichi Biodiversity Targets) provided an overarching framework on biodiversity, not only for the biodiversity-related conventions, but for the entire United Nations system and all other partners engaged in biodiversity management and policy development. In 2010 Parties to the Convention on Biological Diversity (CBD) adopted the Strategic Plan for Biodiversity 2011–2020, a ten-year framework for action by all countries and stakeholders to safeguard biodiversity and the benefits it provides to people. The Strategic Plan for Biodiversity has a vision that “by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people”. The 20 Aichi Biodiversity Targets was organized under five strategic goals (<https://www.cbd.int>)

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Strategic Goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

The Aichi Biodiversity Targets are given in **Annexure 1**

### **Environmental dimensions of Sustainable Development Goals**

The UN General Assembly’s Open Working Group on Sustainable Development Goals (OWG) brought out a proposal incorporating 17 goals, 126 level 1 targets and 43 level 2 targets to be achieved by the year 2030, linking social, economic and environmental dimensions (**Annexure 2**). / (<https://sdgs.un.org/goals>).

### **Post 2020 Global Biodiversity Framework**

The UN Convention on Biological Diversity (CBD) Secretariat on 12 July 2021 released the first official draft of a new Global Biodiversity Framework to guide actions worldwide through 2030 to preserve and protect nature and its essential services to people (<https://www.cbd.int>). The post-2020 global biodiversity framework builds on the Strategic Plan for Biodiversity 2011-2020 and sets out an ambitious plan to implement broad-based action to ensure that by 2050 the shared vision of ‘living in

harmony with nature' is fulfilled. It takes into account the long-term strategies and targets of other multilateral environment agreements, including the SDGs. The salient points are:

- At least 30% of land and sea areas of earth especially areas of particular importance for biodiversity and its contributions to people are conserved through effective, equitably managed, ecologically representative and well-connected systems of protected areas (and other effective area-based conservation measures)
- More than 50% reduction in the rate of introduction of invasive alien species, and controls or eradication of such species to eliminate or reduce their impacts
- Reducing nutrients lost to the environment by at least half, and pesticides by at least two thirds, and eliminating the discharge of plastic waste.
- Nature-based contributions to global climate change mitigation efforts of at least 10 GtCO<sub>2</sub> per year, and that all mitigation and adaptation efforts avoid negative impacts on biodiversity
- Redirecting, repurposing, reforming or eliminating incentives harmful for biodiversity, in a just and equitable way, reducing them by at least \$500 billion per year
- A \$200 billion increase in international financial flows from all sources to developing countries.

### **1.3 National Biodiversity Targets**

According to the Aichi Biodiversity Target 17, by 2015, each Party should have developed, adopted as a policy instrument, and commenced implementing an effective, participatory and updated national biodiversity strategy and action plan. The Governments have committed to establishing national targets in support of the Aichi Biodiversity Targets. National Biodiversity Strategies Action Plans reflect how a country intends to fulfil the objectives of the CBD and the concrete actions it intends to take. National biodiversity strategies and action plans are to be integrated into the broader national plans for environment and development. As a contracting party to CBD, India has developed national strategies and action plans for achieving the goals of CBD. NBAP 2008 has identified 11 Actions with 175 action points. In 2014, India has developed 12 National Biodiversity Targets (**Annexure 3**) which are aligned to the global Strategic Plan for Biodiversity 2011- 2020 adopted under the aegis of CBD in 2010 (<https://www.cbd.int>).

The road map for implementation of the NBAP and for achieving the NBTs involves the MoEFCC and 23 Ministries/Departments of the GOI including the National Biodiversity Authority (NBA), State Biodiversity Boards (SBBs), Biodiversity Management Committees (BMCs), State Forest Departments (SFDs), State Planning Boards and the relevant Departments of State Governments such as Fisheries, Forests, Agriculture, Livestock and Animal Husbandry, Mining, and Education. Local-level institutions include BMCs, Forest Rights Committees (FRCs), Village Ecodevelopment Committees (VEDCs), Joint Forest Management Committees (JFMCs) and Gram Sabhas. National Biodiversity Targets (NBT) 2, 3,4,5,6,8,9,10,12 and Aichi Targets 2,3, 4, 5,6, 7, 8, 9, 10, 11, 12, 14, 15, 17, 19, 20 are concomitant with SDG 15.



# CHAPTER 2

## Overview and Process Documentation

### 2.1 The project context

The Ministry of EF&CC and the United Nations Development Programme (UNDP) through funding from Global Environment Facility (GEF) supports the implementation of the project “Sustainable Livelihood and Biodiversity Conservation through Multiuse Management of Anchunad and Adjoining Landscape” with the objective of protecting biodiversity of the High Range Mountain Landscape of the southern Western Ghats. The project area consisted of 11 Grama Panchayats, covering an area of 2198.78 sq. km, spread across 4 block panchayaths of 3 districts – Idukki, Ernakulam and Thrissur. The Grama Panchayaths have been segregated into 4 clusters:

Munnar Cluster : Chinnakanal, Munnar and Devikulam

Anchunad Cluster : Vattavada, Kanthalloor and Marayoor

Idamalakkudy Cluster : Idamalakkudy

Kuttampuzha Cluster : Mankulam, Adimali, Kuttampuzha and Athirapalli.

The National Biodiversity Action Plan and the State Biodiversity Strategy and Action Plans are the principal instruments for implementing the activities related to biodiversity conservation and to achieve biodiversity mandate of the country at the national and sub-national level respectively. Achievement of objectives and implementation of activities for conservation and sustainable management of biodiversity cannot be accomplished by intervention of any one department/sector.

The Kerala State Biodiversity Strategies and Action Plan was prepared during 2005-2007 with the financial support of National Biodiversity Authority (NBA). Subsequently, National Biodiversity Action Plan was developed during 2008 and Kerala Biological Diversity Rules were also framed during 2008. Following the adoption of the Strategic Plan for Biodiversity 2011- 2020 and its Aichi Targets, India has developed 12 National Biodiversity Targets (NBTs) in line with the 20 Aichi targets and updated the National Biodiversity Action Plan (NBAP) by including the NBTs during 2014. For some of the NBTs, State Biodiversity Boards (SBB) are identified as responsible agencies for their monitoring and indicators have been developed. In addition, 17 Sustainable development goals were also adopted by all UN Member States in 2015 many of which are related to conservation of biodiversity. While the frequency of monitoring of the NBTs ranges from three to five years, data may be recorded yearly or more frequently by SBBs. NBA has directed that States may harmonise their SBSAPs with the updated NBAP to align with the National Biodiversity Targets (NBTs). At the subnational level, the State Biodiversity Strategy and Action Plans (SBSAPs) are the principle instrument to implement actions for conservation of biodiversity and sustainable management of natural resources through relevant sectoral plans and programmes, with participation of public and private stakeholders. In this context, updation of the existing Kerala SBSAP as a dynamic document along with a Biodiversity Financing Plan including ABS has been taken up with funding support of UNDP- GEF.

## **2.2 Objectives:**

The primary objectives of the project are:

1. Update/develop Kerala state Biodiversity Strategy and Action Plan (SBSAP) considering the state priorities and also in line with national and global priorities of biodiversity conservation and wildlife protection
2. To develop a resource mobilization strategy for implementing State Biodiversity Strategy and Action Plans which is being done independently and the same will be a part of this document.
3. Develop a pilot model of development of local biodiversity strategies and action plan in one of the project sites. Local Action Plan is very important as ultimately the projects are being implemented at the local level. For the purpose of this project, Athirapilly panchayat located in Thrissur district has been selected for the model study

The scope of activities includes:

1. To assess the present status of biodiversity conservation initiatives, species population trends and the threats relevant to the state
2. To identify gaps in the policy framework of various departments of the state Government.
3. To map the schemes of various department/agencies that have a positive/ negative impact on biodiversity conservation in the state.
4. To prepare short term, medium term and long-term strategies and action plans and the mitigation strategies for the identified threats.
5. To identify indicators and monitoring framework

## **2.3 Methodology**

### **Constitution of Project Team**

The Kerala State Biodiversity Strategies and Action Plan (2022) was formulated under the aegis of the Kerala State Biodiversity Board with the technical guidance of a team of experts in 10 different sectors as

- I. Forest and Biodiversity
- II. Agriculture and Animal Husbandry
- III. Coastal and Inland biodiversity
- IV. Environment and climate change
- V. Tourism
- VI. Water resources
- VII. Energy and Transport
- VIII. Education
- IX. Local Governance
- X. Tribal Development

The Strategies and Action Plan of the ten above sectors is organized under six themes namely:

1. Forest and Biodiversity
2. Coastal and Inland biodiversity
3. Agriculture and Animal Husbandry
4. Social sectors
  - a) Traditional Knowledge and Tribal development
  - b) Education

5. Cross cutting sectors
  - a) Environment and Climate change
  - b) Local Governance (Panchayat, Rural development, Urban development)
6. Infrastructure sectors
  - a) Water resources
  - b) Tourism
  - c) Energy and Transport

### **Data collection and analysis**

The review and compilation of existing information on floral, faunal and other related components to map the existing status, trends and threats to biodiversity and ecosystem services in the state was carried out through both literature review and consultation workshops with various stakeholders. Desk top review included various sources as scientific papers, research reports, doctoral thesis, records from various line departments, handbooks, web sources and various projects funded by KSBB. In response to the 2018 floods, the Government of Kerala initiated the Rebuild Kerala Development Programme (RKDP) under the Rebuild Kerala Initiative (RKI), which focuses on building a “Resilient Kerala” by supporting key sectoral departments of the government align their development and planning process to a collective objective of building a more resilient state. A two-day workshop of technical experts on post flood reconstruction programmes of Kerala as part of ‘*Nammal Namma kayi*’ campaign was held in Thiruvananthapuram. The key outcome of this is the development of sectoral issues and approaches needed. The findings from this meeting are also incorporated in this document. A review of the existing SBSAP and rapid assessment of the gaps in implementation was done. Information was collected through discussions with relevant line departments, subject experts, research organizations, district and panchayat level officials, civil society organizations and communities. A review of the key threats and issues in different sectors both direct and indirect was also done.

The consultations comprised of three state level workshops and several sectoral workshops. The Strategies and Action Plan were also discussed with the relevant line departments in a validation workshop and also public comments invited and all the suggestions were incorporated in the final document.

A summary of the major meetings held in this connection is given in **Annexure 4**

### **Rapid assessment of gaps in existing SBSAPs**

The updated SBSAP will have the following new elements and components:

1. Updated Biodiversity profile of Kerala
2. Updated threats/ issues and gaps in conservation and management of Biodiversity
3. Identification of regulatory, institutional, and finance gaps in implementation of existing SBSAPs
4. Periodic monitoring frequency
5. Suggestions for mainstreaming and coordination with other flagship programmes
6. Resource mobilization strategy for implementation of SBSAP
7. Linkages of SBSAP with NBTs, NDCs and SDGs: Linkages of the strategies were mapped with NBTs and SDGs and the monitoring framework and SMART indicators in consonance with those of the relevant NBT and SDGs, which will facilitate monitoring.

# CHAPTER 3

## State Profile, drivers of change and gaps in Biodiversity Conservation

### 3.1 General Profile

Kerala, the southernmost state along the western coast of peninsular India lies between 8°17'30"–12°47'40" N latitudes and 74°51'57"–77°24'47" E longitudes. Kerala has a very small geographical area of 38,863 sq. km which constitutes 1.8% of the total geographical area of India. The population density of the state is 860 per sq km which is much higher than the national average. The state has an urban population of 15.9 million, which accounts for 47.7 per cent of total population against a rural population of 17.4 million (52.3 per cent). The decadal growth rate of the urban population is 92.72 per cent in 2011. Kerala is the third most urbanized state in India and also reckoned as the fastest urbanizing state in the country. Urban population has crossed 1 million in 8 Districts. Of these, Ernakulam (68.1 per cent) has the highest urban population, closely followed by Thrissur, Kozhikode and Malappuram Districts. Kerala has the highest effective literacy rate of 93.91 per cent among Indian states. In Kerala, 96.02 per cent men and 91.98 per cent of women are literate as against 82.14 per cent of men and 65.46 per cent of women at the all-India level. Poverty in Kerala is mainly concentrated in some social categories and groups such as scheduled casts and tribes, fisher-folk, potters and artisans.

*The Government's flagship programmes across the four missions, namely Haritha Keralam, Livelihood Inclusion and Financial Empowerment (LIFE), Education Rejuvenation Mission and Aardram Mission continue to make substantial improvements in the quality of life of the people of the State.*

Climate of the state is humid with mean temperature ranging from 19.8°C to 36.7°C and the average annual rainfall from 1,520 mm to 4,075 mm. The state has 14 districts out of which 10 districts are with hilly terrains and 9 districts have tribal population. The total cropped area covers about 67%, forests 28% and cultivable waste 3% of it. Barren and uncultivated lands are less than 0.3% and the area classified as permanent pastures and grazing lands is zero. With very high population density of 860 person/km<sup>2</sup>, land availability as per the 2011 Census is 0.116 ha/person.

### 3.1.1 Kerala General Profile

**Table 1: Kerala at a glance**

Geographical area	38,863 sq km
Location	8° 17'30" & 12° 47'40" North latitude 74° 51'57" & 77° 24' 47" East longitude.
Population (2011 census)	33.41 million
Urban	15.94 million (47.70%)
Rural	17.47 million (52.30%)
Tribal	0.48 million (1.45 %)
Average population density	860 person/ square kilometer
No of districts	14
Hill district	10
Tribal district	9
Climate	Southwest Monsoons (June - September) North east Monsoons (October, November) Winter (December - February) Summer (March - May)
Length of Arabian coast line	590 km
Western Ghats in Kerala	
Area	28008 km <sup>2</sup>
Length	450 km
Break	Palghat gap (30-40 km)
Highest peak	Anamudi
Rivers of Kerala	44 (41 west flowing and 3 east flowing)
Longest river	Periyar

Largest back water lake	Vembanad
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**State Symbols**

State Animal	Elephant ( <i>Elephas maximus indicus</i> )
State Bird	Great Indian hornbill ( <i>Buceros bicornis</i> )
State Flower	Golden shower ( <i>Cassia fistula</i> )
State Tree	Coconut Palm ( <i>Cocos nucifera</i> )
State Fish	Pearlspot ( <i>Etroplus suratensis</i> )
District Panchayaths	14
Block Panchayaths	152
Grama Panchayaths	941
Corporations	6
Municipalities	87
Thaluks	78
Revenue Villages	1664

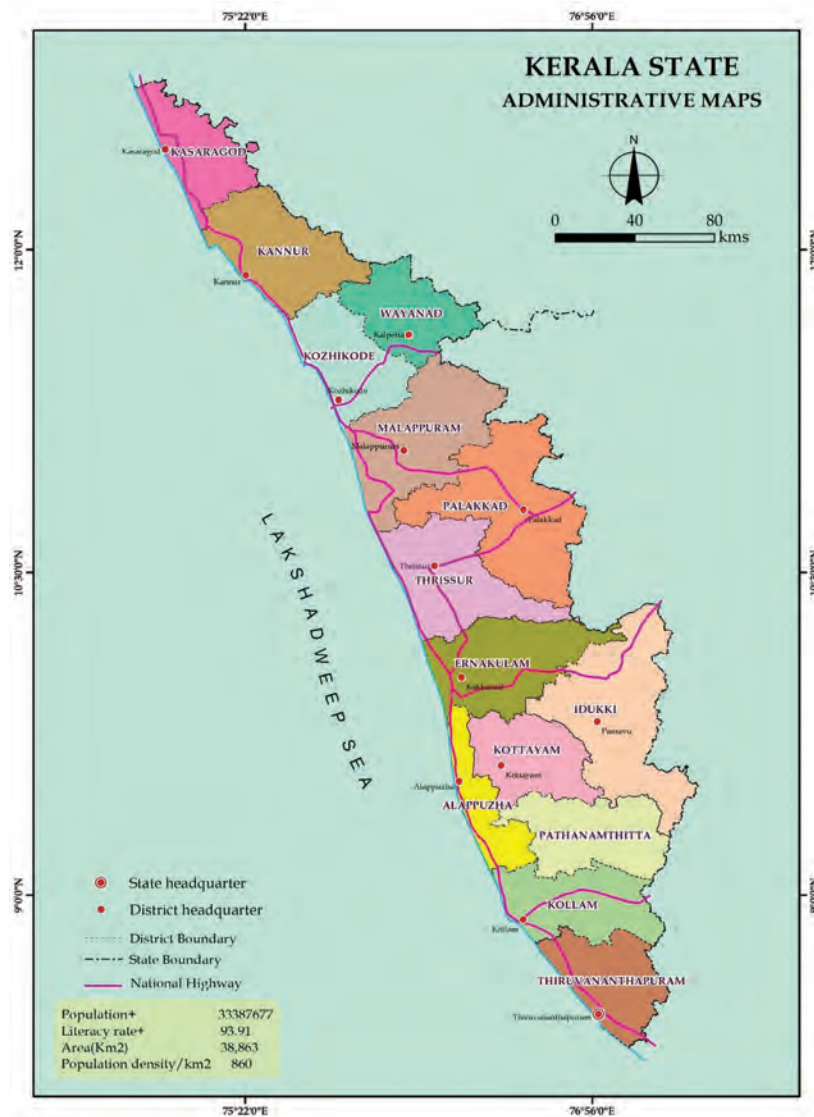


Fig.1 Administrative map of Kerala



## 3.1.2. Physiographic Features

### 3.1.2.1 Physiographic regions

Based on physiography, the state can be divided into three distinct regions, viz., lowlands or coastal zone, midlands and highlands.

**a) Highlands:** About 48% (18.7 thousand square kilometres) of the territory lies at altitudes exceeding 75 meters above sea level (MSL). The highlands zone is wet and relatively cool with large forest tracts. A breach in the continuity of the ranges at the altitudinal level of 100 to 200 m marks the 30 km wide Palghat Gap. A part of highlands, which lies above 750 MSL is often called the high ranges. Entire districts of Wayanad and Idukki (except Thodupuzha) Nelliampathy and Attappady in Palakkad district, Thannithode and Seethathode in Pathanamthitta district, Aryankavu, Kulathupuzha, and Thenmala in Kollam district and Ponmudy in Thiruvananthapuram district bordering Western Ghats come under this tract. About 15% of Kerala lies in the high ranges (Table 2)

**b) Midland:** The midland is made up of lateritic plateau. The area consists of numerous floodplains, terraces, valley fills and colluviums. At some places, this unit borders the sea without intervening coastal plains. The midland constitutes 41.8 per cent of the territory.

**c) Coastal lowlands:** The coast is low lying, alluvial and fertile and is the most densely populated. Beach dunes, ancient beach ridges, barrier flats, coastal alluvial plains, flood plains, river terraces, marshes and lagoons form this area. The low-land and the plains are generally less than 10m above MSL. The lowlands represent only about 10.2 per cent of the entire territory. (Source: [www.kerenvis.nic.in](http://www.kerenvis.nic.in))

**Table 2 Area-altitude distribution in Kerala**

Altitudinal zones	Area in % to the total area	Cumulative area (%)
0-10	8.80	8.80
10-50	25.85	34.65
50-100	19.90	54.55
100-300	15.30	69.85
300-600	7.15	77.00
600-900	10.85	87.85
900-1200	7.20	95.05
1200-1800	3.65	98.70
>1800	1.30	100.00

(Source: CESS, 2013)

### 3.1.2.2 Bio-geographical Zones

India is divided into 10 biogeographic zones, each zone is further subdivided into biogeographic provinces, which comes to a total of 27 in number. 1. Trans Himalayan zone. 2. Himalayan zone 3. Desert zone. 4. Semiarid zone. 5. Western ghat zone. 6. Deccan plateau zone. 7. Gangetic plain zone. 8. North east zone. 9. Coastal zone. 10. Islands. Kerala falls within two biogeographic zones: the Western Ghats and the Coastal zone.

#### Agroecological zones of Kerala

The analysis of agro-ecology of Kerala State based primarily on climate, geomorphology, land use and soil variability lead to the delineation of Kerala into 5 agro-ecological zones and 23 agro-ecological units. The spatial bounding limits of the agroecological units have been made to correspond to the administrative boundaries of panchayats. Any agro-ecological unit is a collection of panchayats.

The 23 agro-ecological units come under 5 agro-ecological zones (AEZ's). Coastal Plains, Midland Laterites, Foothills, High Hills, and Palakkad Plains are the five AEZ's

#### I. Coastal Plains ( 7 AEU's)

This AEZ includes sandy beaches, sandy plains, coastal laterites and low lying areas such as estuaries, backwaters, submerged lands, swamps, marshes, Kayal lands and broad valleys. The zone covers 5,09,246 ha (13.10%) in the state.

#### II. Midland Laterites( 4 AEU's)

The elevation ranges from 30 to 300 metres. The zone covers 10,56,385 ha (27.18 %) in the state.

#### III. Foothills( 2 AEU's)

The elevation ranges from 300 to 600 metres. The zone covers 4,60,074 ha (11.84 %) in the state.

#### IV. High Hills (8 AEU's)

In some areas of the state, the slopes of hill ranges can be as high as 80 per cent. The zone covers 15,53,225 ha (39.97 %) in the state.

## V. Palakkad Plains (2 AEU's)

This zone is seen along the valley of the Bharathapuzha river. It covers 1,60,006 ha (4.12 %) in the state.

### Agro-ecological units

In the state, 23 agro-ecological units (AEU's) have been delineated based on climatic variability, landform and soils. Of them, 5 are identified for the special soil and hydrological conditions in the coastal zone requiring unique management strategies. The spatial bounding limits (external) of the agroecological units have been made to correspond to the administrative boundaries of Panchayats. In other words, any agro-ecological unit is a collection of Panchayats. This has been done to facilitate planning of development activities on an administrative basis.

## I. COASTAL PLAINS ( 7AEU's)

### AEU 1: Southern Coastal Plain

This AEU include nearly level coastal lands where sands are the dominant soil type. It comprises of 42 panchayats along the coast from Thiruvananthapuram to Ernakulam district. Tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 2360 mm).Coconut plantations on uplands and rice in lowlands. The unit covers 56,782 ha (1.46%) in the state.

### AEU 2: Northern Coastal Plain

Coastal plains north of Ernakulam district. Comprises 77 panchayats along the coast from Thrissur till the northern end of the state. Tropical humid monsoon climate (rainfall 3133 mm; mean annual temperature 28°C) Coconut plantations on uplands and rice in lowlands. Covers 1,22,970 ha (3.16 %) in the state.

### AEU 3: Onattukara Sandy Plain

Sandy plains extending into the midlands from coast Covers 43 panchayats in Kollam and Alappuzha districts. Tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 2492 mm) . Coconut plantations on uplands and rice in lowlands. Covers 67,447 ha (1.74 %) in the state.

### AEU 4: Kuttanad

Represents the waterlogged lands in 69 panchayats of Alappuzha, Kottayam and Pathanamthitta districts. Tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 2,746.1 mm). Coconut is grown on the uplands

and bunds of the unit and rice in lowlands. Covers 1,26,931ha (3.27%) in the state.

#### **AEU 5: Pokkali Lands**

Seen in coastal areas of Ernakulam district and extending to parts of Thrissur and Alappuzha districts. Covers 34 panchayats. Tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 3,049 mm). Coconut is raised on uplands and a special kind of rice cultivation, locally known as Pokkali is done in lowlands. The unit covers 39,765 ha (1.02%) in the state.

#### **AEU 6: Kole Lands**

Spread over the coastal part of Thrissur district and extending to southern coastal parts of Malappuram district, it covers 40 panchayats. Climate is tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 2,902 mm). The soils are hydromorphic acid clays, often underlain by potential acid-sulphate sediments. Coconut is grown on the uplands and bunds and rice in lowlands. The unit covers 71,142ha (1.83 %) in the state.

#### **AEU 7: Kaipad Lands**

This unit occurs along the coast of Kozhikkode, Kannur and Kasaragod districts as isolated stretches of waterlogged lands. The unit covers only 16 panchayats. Climate is tropical humid monsoon type (mean annual temperature 27.3°C; rainfall 3,254 mm). Soils are hydromorphic, acid-saline, and clay, which are often underlain by potential acid sulphate soils. Coconut is grown on the uplands and bunds and rice in lowlands. The unit covers 24,209 ha (0.62 %) in the state.

## **II. MIDLAND LATERITES( 4 AEU's)**

#### **AEU 8: Southern Laterites**

Spread over 24 panchayats in south-western part of Thiruvananthapuram district. Tropical moist subhumid monsoon climate (mean annual temperature 27.1°C; rainfall 1,884 mm). Coconut on uplands intercropped to a variety of annual and other perennial crops and rice, tapioca, banana and vegetables on lowlands are the major land uses. The unit covers 38,727 ha (1.02%) in the state.

### **AEU 9: South Central Laterites**

The South Central Laterites agroecological unit is delineated to represent midland laterite terrain with typical laterite soils and short dry period. The unit covers 161 panchayats of midlands, which extends from Thiruvananthapuram to Ernakulam district. The climate is tropical humid monsoon type (mean annual temperature 26.5°C; rainfall 2827 mm). Soils are strongly acid, lateritic clay soils, gravelly and often underlain by plinthite. Mono-cropped rubber and coconut intercropped to a variety of annual and other perennial crops is the major land use on uplands and rice, tapioca, banana and vegetables on lowlands. The unit covers around 3,65,932 ha (9.42 %) in the state.

### **AEU 10: North Central Laterites**

Represents midland laterite terrain with longer dry period than southern laterites, but less than the one in the north. The unit is spread over 62 panchayats, 3 municipalities and a corporation in Thrissur and Palakkad districts. The climate is tropical humid monsoon type (mean annual temperature 27.6°C; rainfall 2795 mm). The uplands have strongly acid, gravelly, lateritic, low-activity, clay soils, often underlain by plinthite. The lowlands have strongly acid, non-gravelly clay soils with impeded drainage. Coconut intercropped to a variety of annual and other perennial crops is the major land use on uplands and rice, tapioca, banana and vegetables on lowlands. The unit covers 1,71,469 ha (4.41 %) in the state.

### **AEU 11: Northern Laterites**

Represents midland laterites from Malappuram to Kasaragod districts experiencing long dry period. It is spread over 163 panchayats and 6 municipalities. The climate is tropical humid monsoon type (mean annual temperature 27.3°C; rainfall 3217 mm). The uplands have strongly acid, gravelly, lateritic, low-activity, clay soils often underlain by plinthite. Coconut intercropped to a variety of annual and other perennial crops is the major land use on uplands and rice, tapioca, banana and vegetables in lowlands. Rubber and Cashew plantations are also extensive on uplands. The unit covers around 4,60,257 ha (12.36 %) in the state.

## **III. FOOTHILLS (2 AEU's)**

### **AEU 12: Southern and Central Foothills**

Represents the undulating lands with low hills, between midland laterites and the high hills of Western Ghats. It covers 90 panchayats from Thiruvananthapuram to Thrissur districts. The climate is tropical humid monsoon type (mean annual temperature 27.5°C; rainfall 3462 mm). The

strongly acid, gravelly, lateritic, low activity, lateritic clay soils are rich in organic matter. The narrow valleys have similar but non-gravelly soils with impeded drainage conditions. Plantations of rubber, coconut, pepper and coffee abound in the unit.

The unit covers 3,15,893 ha (8.13 %) in the state.

#### **AEU 13: Northern Foothills**

Represents foothills from Thrissur to Kasaragod and differs from its southern counterpart for longer dry period. It covers 27 panchayats of Palakkad, Malappuram, Kannur and Kasaragod districts. The climate is tropical humid monsoon type (mean annual temperature 27.5°C; rainfall 3462 mm). The strongly acid, gravelly, lateritic, low activity, clay soils are rich in organic matter. The narrow valleys have similar, but non-gravelly, soils with impeded drainage conditions. Plantations of rubber, coconut, pepper and coffee are the major land use. The unit covers 1,44,181 ha (3.71 %) in the state.

### **IV. HIGH HILLS ( 8 AEU's)**

#### **AEU 14: Southern High Hills**

The Southern High Hills extends from Thiruvananthapuram to Nelliampathy in Palakkad district. Elevation more than 600 metres. Steep slopes, low temperatures and covers 30 panchayats in Thiruvananthapuram to Palakkad district. Tropical humid monsoon type, but lower temperatures than in coastal plain and midlands (mean annual temperature 21.6°C; rainfall 3602 mm). The steeply sloping hilly terrain has deep, well drained, strongly acid, organic-matter-rich clay soils. Forests cover major part of the unit. Plantations of rubber, coconut, pepper, tea and coffee covers 6,72,675 ha (17.31 %) in the state.

#### **AEU 15: Northern High Hills**

This extends from Thrissur to Kannur, and similar to its southern counterpart except for the longer dry period. The unit comprises of 61 panchayats spread over the northern districts. The climate is tropical humid monsoon type (mean annual temperature 26.2°C; rainfall 3460 mm). The hilly terrain has deep, well drained, strongly acid, organic-matter-rich, clay soils. The valleys have deep, imperfectly drained, acid clay soils. The unit includes forests, rubber, coconut, pepper, and coffee plantations. The unit covers 5,28,434 ha (13.60 %) in the state.

### **AEU 16: Kumily High Hills**

Represents low-rainfall parts of the High Hills zone. Differs from Southern High Hills, lower rainfall, extensive occurrence of very deep, non-gravelly clay soils. It include 13 panchayats distributed in Peerumedu and Udumbanchola taluks of Idukki district. The climate is tropical humid monsoon (mean annual temperature 22.5°C; rainfall 1809 mm). The soils for most part are very deep, well drained, acid, non-gravelly, low-activity clay. They are rich in organic matter. Plantations of cardamom, tea, coffee, pepper, and forest trees are seen. The unit covers around 1,50,984 ha (3.81%) in the state.

### **AEU 17: Marayur Hills**

Represents the low rainfall region(rain-shadow) of the high hill zone and comprises of only 3 panchayats of Idukki district. The climate is tropical subhumid monsoon type (mean annual temperature 23.7°C; rainfall 1276 mm). The unit enjoys low temperatures and low rainfall. The clay soils are fertile, deep, and rich in organic matter with favourable soil reaction (slightly acid to neutral), well supplied with bases. The unit include forests, temperate fruits, potato, sugarcane, temperate vegetables, and rice. The unit covers 28,968 ha (0.75 %) in the state.

### **AEU 18: Attappady Hills**

It is a narrow strip of land along the valley in central part of the hills in North Palakkad, representing land areas of comparatively low rainfall. It comprises parts of Sholayur and Agali panchayats. The climate is subhumid tropical monsoon type (meanannual temperature 24.3°C; rainfall 1482 mm). Fertile, near neutral to slightly alkaline clay soils rich in organic matter and bases. Coconut plantations, banana, vegetables, maize, rice, and millets. The unit covers 8,872 ha (0.23 %) in thestate.

### **AEU 19: Attappady Dry Hills**

Represents land areas of very low rainfalland dry period around eight months in a year. This unit in the north-eastern corner of Palakkad district comprises parts of Puthur, Agali and Sholayur panchayats. The climate is tropical dry subhumid to semi-arid type(mean annual temperature 24.7°C; rainfall 856 mm). The length of growing period for annual crop is limited only to 15 weeks while the length of dry period (duration of soil moisture deficit) is more than eight and half months. The hilly terrain has shallow, slightly acid or neutral, stony and gravelly clay soils. Thorny shrubs with occasional trees are the dominant land cover. Cultivation is confined to limited areas of valley lands and around tribal hamlets. The unit covers 18,495 ha (0.48 %) in the state.

### **AEU 20: Wayanad Central Plateau**

Represents highland plateau with low temperature and high rainfall. The unit covers 11 panchayats in Wayanad district. Climate is tropical humid monsoon type (mean annual temperature 22.6°C; rainfall 2659 mm). Upland soils are deep, acid clays and are fairly rich in organic matter. Valley soils are similar, but suffer from impeded drainage conditions. Plantations of coffee, tea, coconut, arecanut and pepper rice and banana in lowlands. Forests represent a significant area. The unit covers 74,471 ha (1.92 %) in the state.

### **AEU 21: Wayanad Eastern Plateau**

Represents parts of the high land plateau with lower rainfall. The unit comprises 6 panchayats, one in Mananthavady taluk and the rest in Sulthan Bathery taluk of Wayanad district. The climate is tropical subhumid to humid monsoon type (mean annual temperature 22.6°C; rainfall 1394 mm). Soils slightly acid to neutral and are well supplied with bases. Plantations of coffee, tea, coconut, arecanut and pepper on uplands and rice and banana in lowlands. Forests cover a significant area. The unit covers 70,325 ha (1.81 %) in the state.

## **V. PALAKKAD PLAINS (2 AEU's)**

### **AEU 22: Palakkad Central Plain**

Represents the land areas of moderate rainfall and dry period around five months in the Palakkad plain. The unit comprises of 37 panchayats spread over Alathur, Chittur and Palakkad taluks and the Palakkad Municipality. The climate is tropical subhumid to humid monsoon type (mean annual temperature 27.6°C; rainfall 1966 mm). The deep, well drained upland soils are non-gravelly loams and clays. Soil reaction is slightly acid or neutral and the soils are well supplied with bases. The valley soils are similar, but with impeded drainage conditions. Coconut intercropped to a variety of annual and perennial crops. Rice in lowlands. The unit covers 1,12,957 ha (2.91 %) in the state.

### **AEU 23: Palakkad Eastern Plains**

Represents the drier parts of Palakkad plain in the gap region of Western Ghats, having low rainfall, long dry period and fertile soils. The unit comprises of 11 panchayats in eastern Palakkad. The climate is tropical dry subhumid monsoon type (mean annual temperature 27.6°C; rainfall 1340 mm) and dry period around six months. The uplands of the unit have slightly acid or neutral red clay soils well supplied with bases and plant nutrients. Lower parts of the uplands and lowlands have alkaline, swell-shrink clay soils. The fertile soils are rich in bases and plant nutrients. Lowlands have impeded drainage. Coconut, arecanut and mango are the major crops. Annual crops include rice, groundnut, cotton, banana, maize, jowar and sugarcane. The unit covers 47,049 ha (1.21 %) in the state. (Kerala Agricultural University 2016)



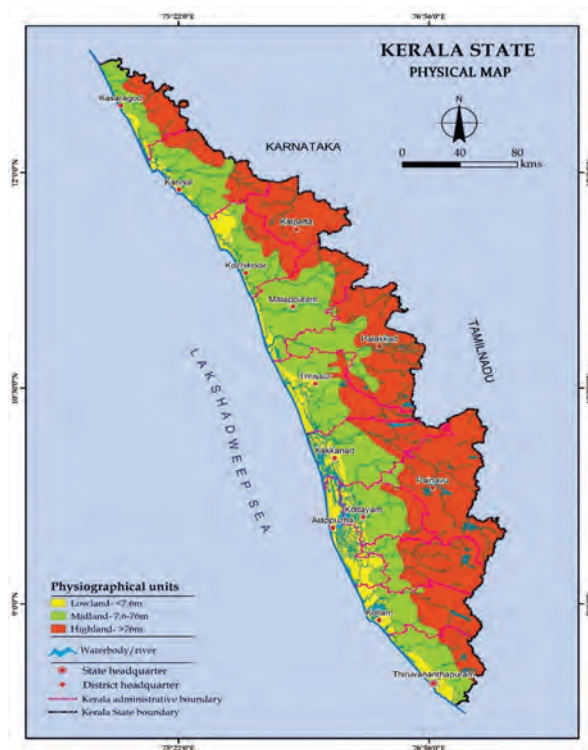


Fig. 2 Physiographic regions of Kerala

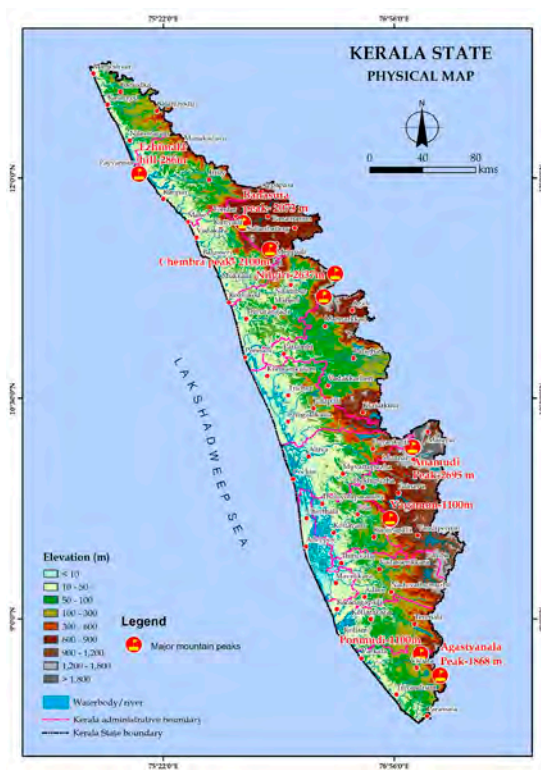


Fig. 3 Altitude distribution in Kerala

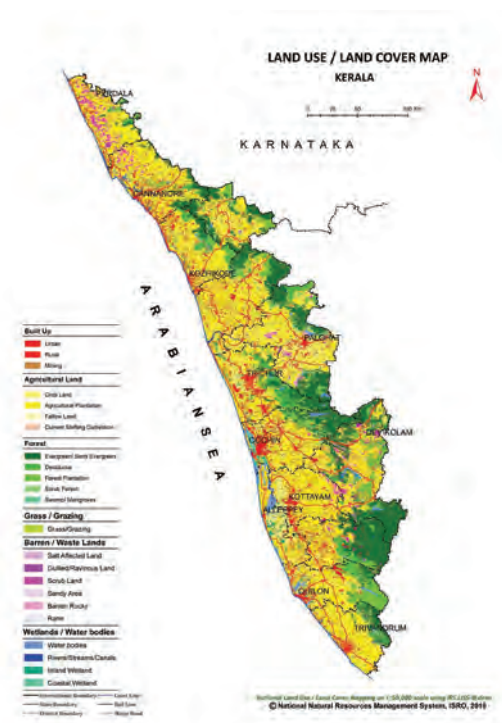


Fig 4 Land use/ Land cover map of Kerala

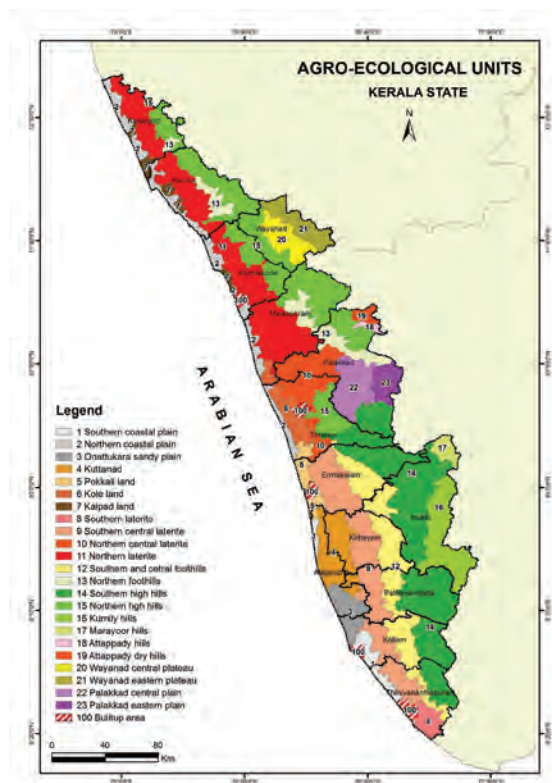


Fig. 5 Agroecological units

## Soils of Kerala

Soils of Kerala differ widely in their characteristics and properties. In Kerala, the topo-lithosequence along with rainfall characteristics, temperature and alternate wet and dry conditions and fast flowing rivers cause the development of different types of soils. Considering these aspects, the soils of Kerala can be broadly grouped into nine general types, coastal alluvium, mixed alluvium, acid saline, kari, laterite, red, hill, black cotton and forest soils.

### 1. Coastal alluvium

Coastal alluvial soils of marine origin are identified along the coastal plains and basin lands as a narrow strip. The elevation of the coastal area is generally below 5m MSL. The area has high water table. The soils are very deep and the texture generally ranges from sand to loamy sand with greyish brown to reddish brown and yellowish red colour. Even though these soils have high water table, the water holding capacity is poor due to the predominance of sand. Coconut is the major crop in the area. Cashew and other fruit trees are also grown

### 2. Mixed alluvium

These soils are developed from fluvial sediments of marine, lacustrine and riverine sediments or its combinations. They occur below 20m MSL in the lowland plains, basins, valleys and along the banks of major rivers. The mixed alluvium is mainly noticed close to coastal alluvium, in Kuttanad and adjacent area and Kole lands of Thrissur district. The soils are frequently flooded and submerged. The soils of depressions and broad valleys are subject to occasional flooding and stagnation. The ground water table of these soils is generally high and it reaches above the surface during rainy season. A wide variation in texture is noticed in these soils. Sandy clay loam to clay is the predominant texture. The colour is often light grey to very dark brown. Rice and other annual and seasonal crops like banana, tapioca and vegetables are grown.

### 3. Acid saline

Acid saline soils occur throughout the coastal area in patches, especially in the coastal tract of Ernakulam, Thrissur and Kannur districts. The tracts under these soils comprise of low-lying marshes, waterlogged and ill drained areas near the rivers and streams, which are subject to tidal waves. Sea and backwater tides make these soils saline. During monsoon season, when rainwater and fresh water from rivers enter the fields, salinity is partially washed off. These soils occur mostly on plains at or below sea level. A wide

variation in texture from sandy loam to clay is noticed with dark grey to black colour. Rice is the only crop that is cultivated in acid saline soils.

#### **4. Kari soil**

Kari soils are like the peaty soils. They occur in isolated patches on the south west and north east margins of Kuttanad in Alappuzha and Kottayam districts. These soils are formed from the dead remains of plants, and usually contain a large quantity of undecomposed organic matter in a partially carbonised form, which do not decompose easily due to excess water and lack of air. They are characterised by deep black colour, heavy texture, poor drainage, and very strong acidity; pH may approach as low as 3.0 during summer months. The soils are rich in total nitrogen, but often deficient in phosphorus and calcium. Soluble salts of iron and manganese are observed in toxic concentrations in many places.

#### **5. Laterite soil**

The midlands and the mid-upland regions of Kerala largely comprise of these types of soils. Heavy rainfall and high temperature prevalent in the state are quite favourable for the formation of laterite and lateritic soils. Extensive stretches of indurated laterites with hard surface crusts are a common sight in Kannur, Kozhikode, and Malappuram districts. Laterites are formed by the leaching of bases and silica from the original parent rock with the resultant accumulation of iron and aluminium oxides. The surface is reddish brown to yellowish red, and is mostly gravely loam to gravely clay loam in texture. In such soils, induration and zonation are more pronounced. This induration is greater if the iron content is higher. The area comprises of mounds and low hills with gentle to steep slopes. Laterite soils are generally suitable for most of the dryland crops. Common crops are coconut, arecanut, banana, tapioca, fruit trees, vegetables, yams, pepper, and pineapple. The percentage of gravel content in the soil and reduced soil depth limits the choice of crops.

#### **6. Black cotton soils**

Black soils are seen in Chittur areas of Palakkad district as an extension of the black soils of Deccan plateau. These soils contain high percentage of clay and possess high cation exchange capacity. They contain high amount of sodium and magnesium but usually deficient in organic matter, nitrogen, and phosphorus. Due to this character, they become highly sticky on wetting and develop cracks on drying. Inadequate aeration and high amount of sodium make these soils unsuitable for most of the crops. The soils are alkaline in reaction, and pH varies from 7.0-8.5. Crops such as coconut, sugarcane, cotton, rice chilly, pulses and vegetables are grown here.

## **7. Red loam**

Red loams soils are of localised occurrence and are mainly seen in Thiruvananthapuram district. They are yellow, red, or deep red. Redloams are deepsoils without much expression of horizons. They contain high amount of haematite (iron oxide ore), which impart a red colouration. They are low in organic matter, nitrogen, and almost all essential plant nutrients. The soils are acidic in reaction (pH 4.0-5.5). The texture of the soil generally ranges from sandy clay loam to clay loam with red to dark red colour. Gravels are rarely noticed in these soils. A variety of crops such as coconut, arecanut, banana, yams, pineapple, vegetables, fruit trees etc., can be grown under proper management.

## **8. Hill soils**

The hill soils mostly occur above an elevation of 80m MSL. The area is hilly and has highly dissected denudational hills, elongated ridges, rocky cliffs and narrow valleys. The general slope range is above 10%. The texture of these soils generally range from loam to clay loam with average gravel content of 10 to 50%. In addition, stones and boulders are noticed in the subsoil. These soils have reddish brown to yellowish red/strong brown colour. An increase in clay content is noticed down the profile. The depth of the soil varies considerably from 60 to 200 cm depending on the lie of the land, erodibility of soil and past erosion. These soils are mostly friable and subject to heavy soil erosion. The area is suitable for all dryland crops like rubber, coconut, arecanut and fruit trees based on the topography. Crops such as banana, pepper, pineapple, vegetables can be grown in foot slopes.

## **9. Forest soils**

These soils are developed from crystalline rocks of archaean age under forest cover. They occur along the eastern part of the State, generally above an elevation of 300m above MSL. The area is hilly and mountainous with steep slopes, escarpments, elongated rocky summits and narrow 'V' shaped valleys. The depth of the soil varies considerably depending on erosion and vegetative cover. The soils are generally immature due to slow weathering process. Rock outcrops and stones are noticed on the surface. Gneissic boulders under different stages of weathering are noticed in the subsoil. The texture of the soil ranges from sandy clay loam to clay with reddish brown to very dark brown colour. Forest trees, shrubs and grasses naturally grow in forest soils.

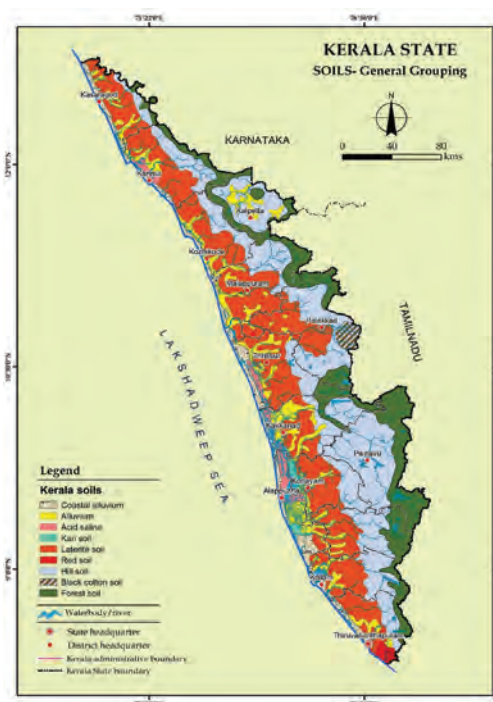


Fig 6 Soils of Kerala

### Kerala Coastline

Kerala has a coastline of 590 km, approximately 10 per cent of India's total coastline, with a continental shelf area of about 41 km<sup>2</sup>.

**Table 3 Kerala coastline**

Continental Shelf Area in different Depth Zones

Continental Shelf	41 sq. km
Depth Zones (in m)	Area
18m depth	5000
18-73	25000
73-182	Balance area
Types of coastlines	
Sandy beach (%)	80
Rocky Coast (%)	5
Muddy flats (%)	15
Marshy coast (%)	-
Total Length(km)	590

(Source: <http://iomenviis.nic.in>)

**Table 4 District wise distribution of coast line of Kerala**

Sl. No.	District	Length of Coast Line	
		Length (in Km)	Percentage of Total
1	Thiruvananthapuram	78	13.22
2	Kollam	37	6.27
3	Alappuzha	82	13.9
4	Ernakulam	46	7.8
5	Thrissur	54	9.15
6	Malappuram	70	11.87
7	Kozhikode	71	12.03
8	Kannur	82	13.9
9	Kasaragod	70	11.86
Total		590	100



*Fig.7 Coastal areas of Kerala*

## Wetlands of Kerala

The major wetland types are river/stream (65162 ha), lagoons (38442 ha), reservoirs (26167 ha) and waterlogged areas (20305 ha). Compared to coastal land, the highland and midland hold very few wetlands.

**Table 5 Area estimates of wetlands in Kerala**

Sr No	Wetland category	Number of wetlands	Total wetland area (ha)	% of wetland area	Open water	
					Post monsoon	Pre monsoon
Inland wetlands-Natural						
1	Lakes/Ponds	3	2643	1.65	2259	2125
2	Riverine wetlands	18	410	0.26	410	410
3	Waterlogged	922	20305	12.64	11495	7771
4	River/ Stream	172	65162	40.58	61853	60338
Inland wetlands-human made						
5	Reservoir/Barrages	39	26167	16.29	24583	23421
6	Tanks/Ponds	439	2435	1.52	1466	530
Total- Inland		1593	117122	72.93	102066	94595
Coastal wetlands-Natural						
7	Lagoons	39	38442	23.94	36819	35796
8	Creeks	19	80	0.05	77	77
9	Sand/Breach	111	2354	1.47	0	0
Total-Coastal		169	40876	25.45	36896	35873
Sub-Total		1762	157998	98.39	138962	130468
10	Wetlands ( $\leq 2.25$ ha, Tanks)	2592	2592	1.61		
Total		4534	160590	100.0	138962	130468

(Source: National wetland atlas, 2010)



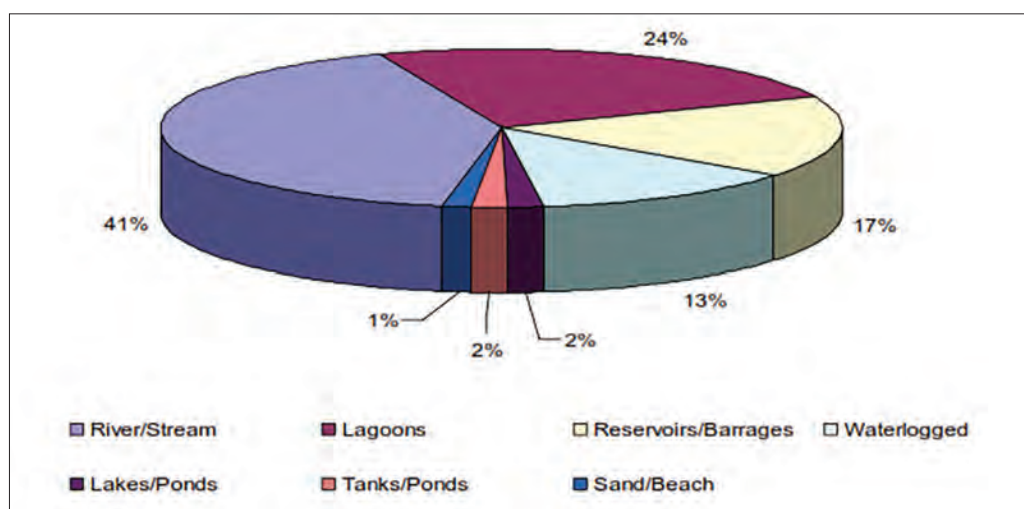


Fig 8 Type-wise wetland distribution in Kerala

Table 5.a : District wise wetlands area in Kerala

Sr. No.	District	Geographic Area (km <sup>2</sup> )	Wet-land Area (ha)	% of total wetland area	% of district geographic area
1	Kasaragod	1961	7561	4.71	3.86
2	Kannur	2997	10870	6.77	3.63
3	Wayanad	2132	3866	2.41	1.81
4	Kozhikode	2345	7690	4.79	3.28
5	Malappuram	3548	9511	5.92	2.68
6	Palakkad	4480	11892	7.41	2.65
7	Thrissur	3032	13285	8.27	4.38
8	Ernakulam	2408	25065	15.61	10.41
9	Idukki	4998	10655	6.63	2.13
10	Kottavam	2204	9523	5.93	4.32
11	Alappuzha	1256	26079	16.24	20.76
12	Pathanamthitta	2731	4948	3.08	1.81
13	Kollam	2579	13703	8.53	5.31
14	Thiruvananthapuram	2192	5942	3.70	2.7
	Total	38863	160590	100	

(Source: National wetland atlas, 2010)

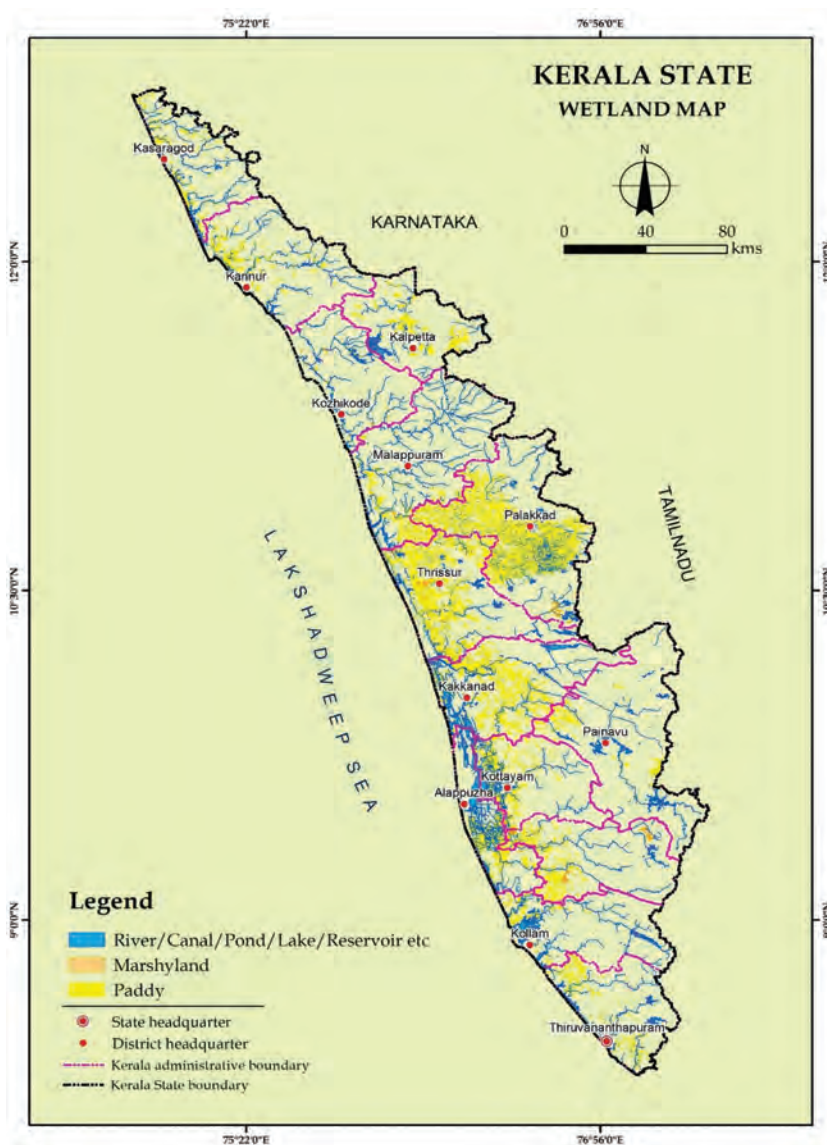


Fig 9 Wetland map

### Rivers of Kerala

Kerala has 41 west-flowing and 3 east-flowing rivers originating from the Western Ghats. River length varies from 16 km for the Manjeswaram river to 244 km for the Periyar. Only 11 rivers have more than 100 km length each. The Periyar with a length of 244 km is the longest river in the State, and it drains a catchment area of 5398 sq. km, of which 5284 sq. km are in Kerala (Annexure 6). The combined length of the trunk stream of all the major rivers is around 3200 km, thus 1 km of main river is fed by 12 sq. km of catchment area. This indicates a higher capacity of the land to sustain a river and also high-water yield compared to other States.

### Backwater/ Estuaries/ Freshwater lakes of Kerala

Estuaries are semi-closed water bodies connected to the sea, within which sea water is measurably diluted by freshwater. Interaction of two chemically and physically different water masses gives rise to complex sedimentological process, morphological response, biological process and chemical characteristics. The backwaters of Kerala are a unique ecosystem in Kerala wherein lagoons, lakes, canals, estuaries and deltas of several rivers meet the Arabian Sea. The backwaters of Kerala are made up of over 900 km of interconnected waterways, rivers, lakes and inlets. (Annexure 7). Fresh water lakes of Kerala are given in Annexure 8.

### Land Use Pattern

The net area under cultivation during the year 2019- 20 was 2,02,6064 ha. The total cropped area during the year 2019-20 was 2586452 ha. Crops, livestock, fishing, and forestry contributed 8.03 per cent to Kerala's Gross State Value Added (GSVA) in 2019-20.

**Table 6: Land use pattern**

Sl No	Category	Area (ha)	Percentage of geographical area
1	Forest	1081509	27.83
2	Land put to non-agricultural use	455897	11.73
2	Barren and uncultivable land	10619	0.27
3	Permanent pastures and other grazing land	00	0
4	Land under miscellaneous tree crops	2143	0.06
5	Cultivable waste	99810	2.57
6	Fallow other than current fallow	46931	1.21
7	Current fallow	57387	1.48
8	Marshy land	11	0
9	Still water	100160	2.58
10	Water logged area	3077	0.08
11	Social forestry	2679	0.07
12	Net area sown	2026064	52.13

### 3.1.3 Biodiversity profile including threatened ecosystems and species

India, a megadiverse country with only 2.4% of the world's land area, harbours 7-8% of all recorded species, including over 45,000 species of plants and

91,000 species of animals. Of the 36 global biodiversity hotspots, 4 are in India, represented by the Himalayas, the Western Ghats, the North-east, and the Nicobar Islands.

Thirty-nine sites in the Western Ghats covering the States of Kerala, Karnataka, Tamil Nadu and Maharashtra were inscribed in the United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage List in 2012, considering their outstanding universal value and high levels of endemism. Out of this, 19 of the serial sites inscribed on the UNESCO World Heritage List are located in Kerala. About 95 % of the flowering plants and about 90% of the vertebrate fauna in the Western Ghats are found in Kerala. There are 44 rivers in Kerala; all but three originating in the Western Ghats which are entirely monsoon fed. Kerala with 1.88 % of India's landmass harbours 28.41 % of flowering plant species and 26.59% of Pteridophytes recorded in India. Kerala is rich in Amphibian and bird diversity with 44.1 % and 38% species found in India. The diverse physical features of Kerala have resulted in a variety of ecosystems such as forests, grasslands, wetlands, coastal and marine ecosystems which harbour high biodiversity. Kerala has more than 6000 sacred groves which are distinct and unique in biological diversity. The vegetation in the undisturbed groves is luxuriant and with multi layered trees mixed with shrubs, lianas and herbs. Sacred groves act as an abode for many rare, endemic, endangered species and economically important plants of fruit bearing and medicinal properties, birds, reptiles especially snakes and a number of rare and endemic fauna.

### **Kerala's part of the Western Ghats**

The Western Ghats, stretches nearly 1600 km in length from Tapti River in north to Kanyakumari in the south traversing through Gujarat, Goa, Maharashtra, Karnataka, Kerala and Tamil Nādu running parallel to the west coast at a distance of 40 km, on an average, from the shoreline. The mean elevation of the Western Ghats ranges from 600m to 2000m in some places. The Anaimudi peak in the high ranges of Kerala which rises to the height of 2695 is the highest peak. The high western slopes of the Ghats harbour evergreen forest, and as one move from western to eastern slopes the vegetation changes to moist and dry deciduous forest types along the rainfall gradient. The western ghat region has considerable area under forest cover. The dominant forest type in this region is moist deciduous forest, which constitutes 21.13 % of the TGA, followed by semievergreen and evergreen forest, constituting 6.38% and 6.33% of the TGA, respectively. In the Western Ghats, based on the ecological factors and floristic composition, 4 major forests and 23 floristic types have been distinguished

**Table 7 Forest types of Western Ghats**

Vegetation types	Alt. ASL (m)	Rainfall (mm)
Tropical Evergreen Forests	200-1500	2500-5000
Moist Deciduous Forests	500-900	2500-3500
Dry Deciduous Forests	300-900	1000-2000
Scrub jungles	200-500	300-600
Sholas	> 1500	Medium to high
Savannahs	1700-1900	Medium to High
Peat bogs	> 2000	High
Myristica Swamps	2000	Medium to High

Western Ghats harbour more than 7388 species of flowering plants, of which 5584 species are indigenous ( India's Fifth National Report to Convention on Biological Diversity ,2014). Out of this, 2242 species are Indian endemic and 1261 are Western Ghat endemics. The Agasthyamalai Hills harbour high levels of plant diversity and endemism at the species level. The Western Ghats region is also a rich germplasm centre of a number of wild relatives of our crop plant such as the cereals & millets, legumes, tropical &sub-tropical fruits, vegetables, spices & condiments and a few *others*. Species of *Piper*, *Oryza*, *Myristica*, *Elettaria*, *Amomum*, *Zingiber*, *Phaseolus*, *Vigna*, *Atylosia*, *Cinnamomum* and *Curcuma* show great variability in southern Western Ghats

### 1) Forest cover

Champion and Seth (1968) recognized 26 forest types in Kerala of which the major ones are the west coast tropical evergreen, west coast semi-ever-green, southern moist mixed deciduous, southern dry mixed deciduous, southern montane wet temperate forests, southern subtropical hill forests, southern montane wet temperate grass- lands and littoral forests (man- groves). Certain edaphic vegetational types recognized in the State are Bamboo brakes, Cane brakes, Reed brakes, Euphorbiaceous scrub jungles, Laterite thorn forests and Myristica swamp forests. Based on dynamics, they recognized secondary forests such as secondary evergreen, secondary moist deciduous, secondary dry deciduous, etc.

Tropical rainforests are seen along the windward side of the Southern Western Ghats, the Palghat gap area is in the rain shadow region of Western Ghats and the wetlands are confined to the low land regions of Kerala.

There are 5 national parks, 17 wildlife sanctuaries and one community reserve with a total area of 3213.24 sq km which cover 27.89 % of the total forest area and 8.26 % of the geographical area of state ([www.forest.kerala.gov.in](http://www.forest.kerala.gov.in)).

**Table 8 District wise Forest cover of Kerala (sq. km)**

District	Geo-graphical areas	2021 Assessment				Total	% of GA	Change with respect to 2019 assessment	Scrub
		Very Dense Forest	Moderately Dense Forest	Open Forest					
Alappuzha	1,415	0.00	27.00	53.54	80.54	5.69	0.64	0.00	
Ernakulam	3,063	165.52	614.40	604.56	1,384.48	45.20	18.77	5.60	
Idukki	4,356	355.72	1,783.33	1,016.27	3,155.32	72.44	4.67	2.51	
Kannur	2,961	58.00	489.63	1,121.23	1,668.86	56.36	14.89	0.18	
Kasaragod	1,989	1.90	288.70	692.97	983.57	49.45	17.09	0.00	
Kollam	2,483	104.40	656.88	572.50	1,333.78	53.72	11.27	0.00	
Kottayam	2,206	11.31	525.73	562.01	1,099.05	49.82	-5.24	0.00	
Kozhikode	2,345	70.77	409.94	967.11	1,447.82	61.74	10.85	0.80	
Malappuram	3,554	142.67	424.68	1,416.32	1,983.67	55.82	2.34	6.47	
Palakkad	4,482	402.14	637.77	1,063.77	2,103.68	46.94	20.09	12.71	
Pathanamthitta	2,652	164.92	1,229.12	554.88	948.92	73.49	-6.60	0.51	
Thiruvananthapuram	2,189	59.12	702.42	555.50	1,317.04	60.17	13.11	0.07	
Thrissur	3,027	218.86	477.79	469.60	1,166.25	38.53	7.03	0.62	
Wayanad	2,130	188.99	1,204.61	186.91	1,580.51	74.20	0.29	0.43	
Grand Total	38,852	1,944.32	9,472.00	9,837.17	21,253.49	54.70	109.20	29.90	

*(India State of Forest Report 2021, Forest Survey of India)*

**Table 8(a): Classes of forests in Kerala**

Class	Area	% of geographical area
VDF	1,944.32	5.00
MDF	9,472.00	24.38
OF	9,837.17	25.32

Class	Area	% of geographical area
Total	21253.49	54.70
Scrub	29.90	0.08

GA - Geographical area

VDF - Very dense forest

MDF - Moderately dense forest

OF - Open forest

**Table 8.b: Forest Cover inside and outside Recorded Forest Area (or Green Wash) in sq km**

Forest cover inside the recorded forest area (or Green Wash)				Forest cover outside the recorded forest area (or Green Wash)			
VDF	MOF	OF	Total	VDF	MDF	OF	Total
1,804	5,299	2,576	9,679	140	4,173	7,261	11,574
18.64%	54.75%	26.61%		1.21 %	3.05%	62.74 %	

(India State of Forest Report 2021, Forest Survey of India)

**Table 8.c: Altitude-wise Forest cover in Kerala (sq km)**

Altitude Zone(m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	28,678	78	5,193	7,985	13,356	13
500-1000	6,478	837	2,889	1,167	4,893	8
1000-2000	3,441	750	1,343	650	2,743	4
2000-3000	255	179	47	35	261	5
Total	38,852	1,944	9,472	9,837	21,253	30

**Table 8.d: Forest cover in different slope classes in Kerala (sq km)**

Slope(in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	7,923	169	2,206	3,913	6,288	7
5-10	8,347	271	2,268	2,623	5,162	5
10-15	4,607	322	1,713	1,432	3,467	4
15-20	3,051	335	1,271	866	2,472	4
20-25	2,137	305	932	544	1,781	4

25-30	1,402	236	616	319	1,171	4
>30	1,385	306	466	140	912	2
Total	38,852	1,944	9,472	9,837	21,253	30

(India State of Forest Report 2021, Forest Survey of India)

### Forest types and Biodiversity

The different forest types according to the Atlas Forest Types of India 2020, are as follows:

**Table 9: Forest types of Kerala**

Sl. No.	Forest Type	Area (sq km)	% of the total mapped area*
1.	1A/C3 Southern hilltop tropical evergreen forest	294.34	1.38
2.	1A/C4 West Coast tropical evergreen forest	3,005.85	14.10
3.	1/E2 Wet bamboo brakes	25.04	0.12
4.	1/2S1 Pioneer Euphorbiaceous scrub	18.60	0.09
5.	2A/C 2 West Coast semi-evergreen forest	2,664.21	12.50
6.	3B/C1a Very moist teak forest	162.58	0.76
7.	3B/C1b Moist teak forest	130.69	0.61
8.	3B/C1c Slightly moist teak forest	442.38	2.07
9.	3B/C 2 Southern moist mixed deciduous forest	1,704.93	8.00
10.	4B/TS2 Mangrove Forest	8.90	0.04
11.	4C/FS1 <i>Myristica</i> swamp forest	1.56	0.01
12.	5A/C3 Southern dry mixed deciduous forest	331.95	1.56
13.	6A/C1 Southern thorn forest	1.03	0.00
14.	11A/C1 Southern montane wet temperate forest	303.98	1.43
	Sub Total	9,096.04	42.67
15.	TOF/Plantation	12,061.62	56.58



Total (Forest Cover & Scrub)		21,157.66	
Grassland forest types (outside forest cover)			
16.	5/DS4 Dry grassland	11.41	0.05
17.	11A/C1/DS2 Southern montane wet grassland	149.12	0.70
Sub Total		160.53	0.75
Grand Total		21,318.19	100.00

(India State of Forest Report 2021, Forest Survey of India)

#### Table 9.a: Fire Prone Forest Areas of Kerala

Forest cover under different classes of forest fire proneness is given in following table.

SL No.	Forest Fire Prone Classes	Forest Cover	% Total Forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	54.79	0.26
3.	Highly fire prone	461.06	2.17
4.	Moderately fire prone	1,266.42	5.96
5.	Less fire prone	19,470.73	91.61
Total		21,253.00	100.00

(India State of Forest Report 2021, Forest Survey of India)

#### Tree Cover

Tree cover is defined as all tree patches of size less than 1 ha occurring outside the recorded forest area. Tree cover includes trees in all formations including scattered trees. Tree cover in Kerala has been estimated as give in following table.

#### Table 9.b.: Tree cover in Kerala

2019 Assessment in sq km	2021 Assessment	Change with respect to 2019 Assessment
2,936	2,820	-116

(India State of Forest Report 2021, Forest Survey of India)

### Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. Extent of TOF estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in following table.

**Table 9.c. Extent of Trees Outside Forest (TOF)**

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
11,574	2,820	14,394

*(India State of Forest Report 2021, Forest Survey of India)*

### Growing stock Bamboo

**Table 9.d: Growing stock bamboo**

Growing Stock (GS)		% Of Country's GS of Bamboo
Bamboo bearing area inside RFA/ Green Nash (in sq km)	2,404	1.61
Total number of cut ms (in millions)	1,087	2.04
Total equivalent green weight (in '000 tons)	14,681	3.65

### Carbon Stock in Forest

The total carbon stock of forest in the state including the TOF patches which are more than 1 ha in size is 205.52 million tonnes (753.57 million tonnes of CO<sub>2</sub>, equivalent) which is 2.85 % of total forest carbon of the country. Pool wise forest carbon in Kerala is given in the following table.

**Table 9.e.: Carbon stock in forest**

Sl. No.	Carbon Pools	Forest Carbon
1.	AGB	61,802
2.	BGB	17,440
3.	Deadwood	1,534
4.	litter	3,198
5.	SOC	1,21,549
	Total	2,05,523

*(India State of Forest Report 2021, Forest Survey of India)*

## 2. Floral Diversity of Kerala

The Kerala State harbours 5094 taxa under 1537 genera and 221 families of flowering plants (Sasidharan, 2012). A total of 1709 taxa that are endemic to Peninsular India are found in Kerala; of which 237 species distributed in 47 families are exclusively endemic to the state (Nayar *et. al.*, 2008). There are about 1170 species with established medicinal properties. The flowering plants of Kerala include 858 exotics that have been introduced for agriculture, forestry as well as accidentally entered species (Sasidharan, 2012); of which around 200 species have become naturalised in the state. Gymnosperms are represented by just 5 species belonging to 3 genera. The State also harbours 337 species of pteridophytes, and 465 taxa of bryophytes (Manju-*et al.*, 2008).

**Table 10. Species in major groups of Plants - India and Kerala.**

Sl. No	Plant Groups	India*	Kerala **	% To India
1	Bryophytes	2504	465***	18.57
2	Pteridophytes	1267	337	26.59
3	Gymnosperms	74	5	6.75
4	Angiosperms	17,926	5094	28.41

\* India 5<sup>th</sup> National Report to the Convention on Biological Diversity, 2014

Herbs constitute 50.1%, shrubs 15.8 % and trees 15.08% of the total flowering plant species of the state. About 5094 taxa under 1537 genera and 221 families of flowering plants are distributed in Kerala (Sasidharan, 2012).

## 3. Faunal Diversity of Kerala

The vertebrate faunal wealth of Kerala is well documented and KSBB had recently assigned a project to Zoological Survey of India and Central Marine Fisheries Research Institute to prepare a red data book of threatened species of Kerala including terrestrial fauna and marine fauna respectively. The final report was submitted in 2022. The number of terrestrial species in Kerala evaluated as part of the project is summarised in Table 11.

**Table 11: Threatened animals of Kerala**

	Total	ENDE	CR	VU	EN	NT	LE	End WG
Mammals (IUCN)	101			45	36	13	6	15
Birds (Regional assessment)	540		10	35	30	15	10	
Reptiles (Regional assessment)	201		2	36	30	32		109

Amphibians (IUCN)	186	22	24	46	8	
Fishes (Regional assessment)	196	4	28	66	2	53
Butterfly's (Regional assessment)	326		235	23	7	18
Dragon Fly's (IUCN)	175		45	11	44	
Fresh water Crabs (Regional assessment)	35		19	19	4	
Non-Marine Mollusca	68 terrestrial Mollusca and 28 fresh water Mollusca	75		1	2	

(Sureshan, Subramanian and Palot, 2022)

A total of 101 species of terrestrial mammals belonging to 67 genera under 31 families and 11 orders are recorded from Kerala (Palot, 2020). Of these, 15 species are endemic to Western Ghats.

According to the recent checklist, 540 species of birds are reported from Kerala (Chandran *et al.*, 2020). Of these, 43 species fall under various threatened categories of the IUCN global assessment.

In the case of reptiles, a recent estimate from the state showed a total of 201 species of terrestrial reptiles classified under 24 families belonging to 3 orders. The updated list consists of two species of crocodiles, 12 species of turtles and tortoises, 75 species of lizards and 112 species of snakes. Of these, 109 species (54%) are endemic to the Western Ghats, which include 14 species endemics to the geographical boundary of Kerala. One species of crocodile, estuarine crocodile (*Crocodylus porosus*) has been documented from the coastal habitats of Kerala. Accordingly, 54 species are grouped under various categories of IUCN at regional level (Critically endangered 16, Near threatened 17 and Vulnerable 20) Two species viz. Indian pond terrapin *Melanochelys trijuga* and flying lizard *Draco dussumieri* are proposed for notification under Section 38 of Biological Diversity Act 2002.

In the updated checklist of amphibians for the State, a total of 186 species are reported, wherein, type localities for the 125 species are within the political boundaries of the state and the rest of the 56 species reported are either described from the adjacent states or the adjacent countries which have their distribution in Kerala. Among these, 54 species are categorized as threatened as per the latest IUCN assessment (IUCN, 2004) (13 species

Critically Endangered: 27 species as Endangered and 14 Species as Vulnerable) 5 Species as Near Threatened, 27 Species as Least Concern 32 species as Data Deficient and 68 Species as not assessed category. (Sureshan, Subramanian and Palot, 2022)

#### **4. Marine Biodiversity of Kerala**

India has rich water resources in the form of marshy wetlands, ponds, channels, streams, rivulets, rivers, backwaters and coastal waters which harbour rich bio-resources comprised of micro-organisms, flora and fauna. The total number of reported aquatic fauna of India consists of about 29,900 species excluding micro-organisms (Marine fauna 20,444 and freshwater 9456 species). India has the representation of almost all types of wetlands as defined by the Ramsar convention. The wetland ecosystems in India constitute the natural water bodies, such as rivers, lakes, coastal lagoons, mangroves, peat land, coral reefs and human-made wetlands such as ponds, farm ponds, irrigated fields, sacred groves, salt pans, reservoirs, gravel pits, sewage farms and canals. At present, 115 wetlands have been identified under the National Wetland Conservation Programme (NWCP), and about 49 wetlands declared as Ramsar sites of international importance under Ramsar Convention (<https://www.ramsar.org>).

The marine habitat includes ecosystems such as the shallow coral reef ecosystem, mesophotic reef ecosystem, soft sediment ocean floor ecosystem to coastal estuarine ecosystem, saline wetland ecosystem, mangrove ecosystem, gulf waters, creeks, tidal flats, deltaic plains etc. India has a long coastline of 7516.6 km. (Mainland: 5422.6 km. and Island Territories: 2094 km.), with an exclusive economic zone of 2.02 million sq. km, a continental shelf area of 372424 sq. km. and a territorial waters area of 193834 sq. km. spread across 9 maritime states, 2 Union Territories and 2 Island Territories. The extensive marine biodiversity of India is mostly reported from the four major areas in coastal and island habitats such as the Gulf of Mannar and the Gulf of Kutch, Andaman and Nicobar Islands and Lakshwadweep. The contribution of marine biodiversity to the sustenance of human populations is immeasurable. But this ecosystem faces serious threats of destruction and consequent biodiversity loss.

Kerala has a coastline length of 590 km. The exclusive economic zone is approximately 2.19 lakh square km (continental shelf area 0.39 lakh sq. km.). The marine fisheries sector of the State has long been an important source of occupation and livelihood for the coastal population. There are nine maritime districts for Kerala: Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Trissur, Malappuram, Kozhikkode, Kannur and Kasaragod.

From Kerala, region, 12 species of seagrasses have been reported and among them the most important ones are: *Thalassia hemprichii*, *Halphila ovalis*, *H. decipiens*, *Cymodoce aserrulata*. The most abundant species found in the sea grass bed were *Hemirhamphus far*, *Lutjanus lutjanus*, *L. malabariucus*, *Sardinella gibbosa*, *Parupeneus indicus*, *Siganus canalicualtus* and large number of crustaceans and mollusks. A total of 480 species of phytoplanktons, 120 species of sea weeds and 12 species of sea grasses have been reported from Kerala waters. Sponges have medicinal potential due to the presence in sponges themselves or their microbial symbionts of chemicals that may be used to control viruses, bacteria, tumors and fungi and about 34 spp. are reported from Kerala. About 200 species of corals have been reported from marine waters of Kerala and nearby states and are included under Wild Life Protection Act (WLPA) 1972.

From Kerala, 218 species of crustaceans have been reported which includes prawns and shrimps (84 species), coastal crabs (marine and inland 182), anomuran crabs (73), lobsters (9). Prawns and shrimps are highly economically important group of crustaceans. Their export value is enormous. Hence it contributes a major share in the economy of the State. Several families are represented in this section and about 84 spp. are reported and about 182 coastal crab resources are also reported. Eleven species of lobsters have been reported from Kerala waters. They are commercially important and export oriented tradable marine bio-resources Molluscs are another important group of marine bio-resources of Kerala. Reports indicate that 730 species of mollusks are reported from Kerala. Echinoderm fauna of Kerala coast consists of 60 species belonging to starfish, brittlestar, sea urchins and sea cucumbers. Holothurians (or sea cucumbers) are included as Schedule I under Wild Life (Protection) Act (1972). The marine fish diversity of Kerala is reported to be around 1020 species of marine fin fishes.

Reptilian bio-resources include five species of turtles and five species of snakes. Marine bird fauna is vast. A total of 223 species of birds were recorded from the coastal wetlands of India, belonging to 30 families under 9 orders. Marine mammals are categorized under schedule of Wild Life Protection Act 1972. (Jayachandran, 2022)

IUCN Red List Assessment of 975 species occurring in Kerala showed that 20 species are in the Critically Endangered, 53 in the Endangered, 47 in the Vulnerable, 37 in the Near Threatened, 59 Data Deficient, 198 Not Evaluated and 561 under Least Concerned categories. A total of 10 marine species out of 20 are included in Critically Endangered (CR) category and include two species of grey sharks, one species of hammer-headed shark, three species of rays, two species of guitar fishes and two species of sawfishes. Among these *Carcharhinus hemiodon*, *Rhynchobatus djiddensis*, *Pristis microdon* and *Pristis zijsron* are also included in the Wildlife (Protection) Act 1972. A total

of 53 species of fishes are included in the Endangered (EN) category includes 10 species of sharks, 6 species of rays, 7 species of catfishes, 28 species of fresh-water fishes and eel and pearl spot one each. Shark species include huge species such as Whale shark, Mako shark, Thresher shark, Grey shark, Hammer head shark and ray species include the great eagle rays of the species *Mobula*. A total of 47 species included in the Vulnerable (VU) category which includes sharks, stingrays, catfish and fresh-water species. It includes bigger sharks such as *Nebrius ferrugineus*, *Alopias suprcilioisus*, *Alopias vulpinus*, *Carcharhinus falciformis* and rays such as *Manta birostris* and *Rhinoptera javanica*. According to the decadal trend analysis by Central marine fisheries research institute cat fishes, Unicorn cods were under declined category, white fish, sharks, rays are in the declining category and threadfin, ribbon fish, mullets and sardine in less abundant category. Three Crocodiles and five marine Turtles listed under the Schedule I of Wildlife (Protection) Act, 1972. They are *Crocodylus porosus*, *Crocodylus palustris*, *Gravialis gangeticus*, *Dermochelys coriacea*, *Caretta caretta*, *Lepidochelys olivacea*, *Eretmochelys imbricata* and *Chelonia mydas*. Seahorse belongs to the family Syngnathidae, which includes pipe fishes and sea dragonets. They have peculiar biological characteristics such as spouse distribution, low fecundity, narrow habitat ranges and lengthy parental care makes these vulnerable to exploitation. Sea horse is under Schedule I of Wild life (Protection) Act, 1972.

The marine mammals (Cetaceae) include 87 species of whales, dolphins, porpoises and dugong. All the marine mammals are protected under the Indian Wild life (Protection) Act, 1972. The IUCN has classified seven species as endangered and nine species as vulnerable. CITES listed holothurians in the Appendix II or III to control trade of these organisms. All the sea cucumbers are under the Wild Life (Protection) Act, 1972- Schedule I. Coral diversity and distribution occur along the Vizhinjam, Thagassery, Thirumullavaram and Enayam of Kerala coast. Among these *Montipora aequituberculata* categorized as dominant, *Acropora efflorescence*, *Pocillopora verrucosa*, *P. damicornis* and *P. meandrina* belong to common category. Coral species are included in the Schedule I of the Indian Wild life (Protection) Act, 1972. Protected Corals as per the Indian Wildlife (Protection) Act, 1972 Schedule are Reef building corals (Scleractinians), Black Corals (Antipatharians), Organ Pipe Corals (Tubiporamusica) and Fire corals (*Millipora* spp.).

**Table 12. Marine fishes belonging to IUCN category-reported from Kerala**

No	IUCN	Category	Number of fish species
1	CR –	Critically Endangered	20
2	EN-	Endangered	53
3	VU-	Vulnerable	47

No	IUCN	Category	Number of fish species
4	NT-	Near Threatened	37
5	DD-	Data Deficient	59
6	NE-	Not Evaluated	198
7	LC	Least concern	561

(Gopalakrishnan *et.al*; 2022)

### 5) Domesticated Biodiversity- Diversity of Agricultural crops

Agricultural biodiversity is a broad term that includes the components of biological diversity of relevance to food and agriculture, and those that constitute the agro-ecosystem: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes. It plays a crucial role in achieving food security, eradicating hunger, improving human nutrition and provides essential functions in the agricultural landscapes. The tropical evergreen forests of Western Ghats are home to two major spices- black pepper and cardamom. It is also a secondary centre of origin of cinnamon. The sub-mountainous tracts of Western Ghats are believed to be the centre of origin of *Piper nigrum* L; the cultivated black pepper and the area has been identified as the hotspot for the biodiversity concern (Myers *et al.*, 2003). Seventeen *Piper* species are reported from Western Ghats, of which 12 are endemic.

Kerala is known for homestead farming system, which integrates the home with useful fruit trees and shrubs, vegetables, tuber crops, spice crops, fodder crops, livestock, and poultry in a small (usually about 0.10 ha or more) area of land. The typical hamlet type of villages in Kerala, pressure on land, and the fragmentation of holdings encouraged this type of farming system. Homesteads are havens of rich agrobiodiversity, where one could see an assortment of crops in typical multiple cropping or mixed farming style. A total of 452 crops belonging to 82 families are being grown in Kerala (Thomas, 2022). Among these, 256 crops have edible uses (cereals and millets, pseudo cereals, pulses, oil seeds, tuber crops, sugars and starches, fruits and nuts, and vegetable crops). A total of 118 fruits and nuts have been recorded including 22 subtropical fruits. Others in the list are cereals and millets-11, pseudo cereals-4, pulses-10, oil seeds-8, tuber crops-24, sugars and starches-8, vegetables-73, spices and condiments- 21, beverages-5, stimulants- 3, cut flowers-20, cut foliage plants-14, green manure crops-10, cover crops-4, fodder crops-42, fibre crops-6, rubber crops-1, essential oil yielding plants-7, medicinal plants-45, and crops of miscellaneous uses-18. In Kerala, there are only four crops— coconut, rubber, rice, and banana (including plantain),



which have an area above one lakh hectares. Crops occupying more than 10,000ha are 17 only. The maximum area is under coconut followed by rubber and rice. Other crops in the order of rank based on area occupied are banana and plantain (4), arecanut (5), jack fruit (6), coffee (7), black pepper (8), mango (9), cassava (10), cashew nut (11), cardamom (12), tea (13), nutmeg (14), papaya (15), drumstick (16), and cocoa (17) (Thomas, 2022)

A prominent structural feature of agricultural ecosystem in Kerala is the prevalence of smallholder production systems. As the demand for food, fodder grows and farmers intensify farming the, agricultural systems cause depletion of soil fertility and water resources are also affected. Agricultural lands in Kerala are faced with two problems, intensification and abandonment. Intensive agriculture has caused degradation of some ecosystem services. For instance, intensification of rice farming in the past, has threatened aquatic plants, invertebrates, frogs, fish and birds since the mid-1960s. On the other hand, abandoned farmlands (e.g., paddy) are increasing in the state since the 1980s, and vegetation succession has changed the dominant species in rice field from aquatic to terrestrial species (**Annexure 9, 10 and 11**)

## **6) Environment and Climate Change**

Sustainable development of any state is based on three pillars – economic growth, social progress and protection of environment. A healthy, properly functioning natural environment is the foundation of sustained economic growth, and healthy people. Natural landscape such as coastal and inland waters, mountains, forests, ecosystems, farm land, human dominated landscape in urban and rural areas, and the social, political, cultural, economic, and other factors influence the environment. People are an integral part of the environment and plays the major role in ensuring its sustainability.

### **Environment scenario of Kerala**

Kerala is blessed with a long coastline, stretching 590 km in length and 30 – 130 km in breadth, with an intricate system of backwaters along the coast, rich biodiversity in the tropical moist forests on the Western Ghats, diverse agricultural crops all of which make the State a unique geographical and environmental entity.

### **Climate of Kerala**

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. Kerala experiences two rainy seasons, viz., the South-West (*i.e.*, June to September) and the North-East (*i.e.*, October to December) seasons. The southwest monsoon (June- October) is the principal rainy season when the State receives about 70 % of its annual rainfall. March is the hottest

month with a mean maximum temperature of about 33°C. Mean minimum temperature (28.5°C) is in the month of July. The Western Ghats and Palghat gap play a major role in the climatic conditions that prevail all along the state. The state is extremely humid due to the existence of Arabian sea in the west. The annual precipitation varies between 100 cm (around Chinnar) to 500 cm (around Neriya Mangalam), with a state average of about 300 cm. Winds over the State are seasonal; diurnal variation is felt owing to the maritime influence. Annual relative humidity varies between 79 – 80% in the morning and 73 – 77% in the evenings. During the last 43 years, the mean maximum temperature in Kerala has risen by about 0.8°C, the minimum by 0.2°C and the average by 0.6°C, showing a clear upward trend. Kerala witnesses an increase in annual mean temperature by 0.01°C/year. Climatological analysis of rainfall data for the last 140 years shows cyclic pattern with a significant declining trend in the south-west monsoon season for the last six decades. IMD in its 'State level climate change trends in India' documents that Kerala is witnessing an average decline in south-west monsoon rainfall by about 2.42 mm per year. There is a long-term decreasing trend in the annual mean rainfall over Kerala during the last 146-year period. There is a significant increasing trend in monthly rainfall during February, March, October and November. A decrease of (28 % to 22.4%) rainfall contribution of June and a decline from 23 to 18.4% in the contribution of July rainfall to the annual rainfall is noticed over a period of 146 years.

### **Protecting our environment - State Initiatives**

Department of Environment, Government of Kerala through its three arms Department of Environment and Climate Change, Pollution Control Board and Kerala State Biodiversity Board, is taking several proactive steps to promote environmental protection.

***Kerala is the first State in the country to set up Biodiversity Management Committees (BMCs) in all the Local Self Governments under the guidance of Kerala State Biodiversity Board, which was established in 2005. BMCs of the State has been empowered to function as Environmental Watch Groups through a Government Order and take care of protection of the environment at local level.***

The State Wetland Authority and Coastal Zone Management Authority were also established in the State. The Environmental Policy of Kerala was brought out in 2009. It envisages nine broad objectives such as (i) Ensure conservation of resources; (ii) Ensure equitable access and sustainable use of resources; (iii) Optimise the efficiency in environmental resource use; (iv) Mitigation and restoration activities (v) Promulgate guidelines and policies for waste disposal; (vi) Integration of environmental concerns in economic and social development; (vii) Environmental governance; (viii) Enhancement

of resources for environmental conservation; and (ix) Create environmental awareness for all sections of the society.

The Department of Environment and Climate Change, Government of Kerala has been identified as the nodal agency for coordinating activities related to climate change in the State. Kerala State Action Plan on Climate Change (SAPCC) was formulated by Department of Environment and Climate Change as Government of Kerala's strategy for action in the State in response to climate change. Based on climate change vulnerabilities, key sectors relevant for state action, namely agriculture, animal husbandry, fisheries and coastal resources, forests and biodiversity, waters resources, health, energy, urban and transport and tourism have been identified. In addition, an institute of climate change, studies have been set up for focussed research and climate action. Kerala state disaster management authority (KSDMA) has been managing hazards, vulnerability and disasters and has created state and district level disaster management plans, flood and drought susceptibility maps, hazard vulnerability and risk analysis in selected regions.

*With a participatory approach towards "Building Back Better", Hon'ble Chief Minister of Kerala launched 'Nammal Namukkayi' Campaign under the Rebuild Kerala Initiative (RKI). As Disaster resistance and mitigation activities have to be implemented with people's participation thrust has been given to preparation of district disaster management plan by the local self-government institution. In all 1034 LSGIs including 941 Grama Panchayats, 87 Municipalities and 6 Municipal Corporations have prepared their DM plans based on the template and training provided by the Kerala State Disaster Management Authority (KSDMA) and the Kerala Institute of Local Administration (KILA). This was a pioneering feat in India. An Emergency Response Team was also formed as per the stipulations in the National Disaster Management Act, comprising local level volunteers who are trained on the basis of the disaster management plan.*

A separate working group on Environment, Climate change, Disaster management and Biodiversity was constituted in all LSGIs in which BMC members are also a part. Responsibilities of the Working Group includes the co-ordination of activities for the preparation of Disaster Management Plan and Integration of Disaster Management Plan with Annual Plan.

***Government is encouraging to follow Green Protocol to reduce and manage waste in a systematic manner and thereby reducing the carbon footprint. A significant achievement in this direction is ban of single use plastics***

The Government has also brought out a white paper on environment, which aims to ensure an environment friendly economic system and reiterates the commitment of the government in preserving clean water, soil, air and biodiversity.

***Haritha Keralam Mission is one of the three missions under the umbrella mission of “NavaKeralam” of the Government of Kerala. The mission addresses the major threats to the environment of Kerala namely, depletion of water resources, unscientific methods of solid waste management, air pollution, dumping garbage and chemical effluence in the water bodies, loss of green cover and agricultural land.***

The Haritha Kerala Mission aims to promote eco-friendly environment, sustainable development of natural resources, effective solid waste management, rejuvenation of water reserves, sanitation and social hygiene, promotion of organic cultivation, zero pesticide food products, healthy foods, promotion of organic farming and protection of biodiversity. The mission is implemented through a participatory approach through Local Self-Government bodies. As part of this, 390 km long rivers and 34289 km long streams have been revived, 16665 wells recharged, 20,00,00 source waste disposal units established in home, 30,00,0000 trees planted and 28 panchayats declared barren land free.

Planning Commission of India has developed an Environmental Performance Index (EPI) to account environmental parameters like air pollution, forest, water quality, water management and climate change. As per Environmental Performance Index 2020, Kerala is ranked 4<sup>th</sup>. In Sustainable Development Goals Index 2020-21 developed by NITI Ayog also the state is leading, the environmental dimensions are covered in Goal 12, 13,14,15. In SDG 12, SDG 13 and SDG 15 the state is in Front runner category, while in Life below water, it is in performer category.

## **3.2 Drivers of Change: Key factors impacting biodiversity**

### **1. Forests and Biodiversity**

Most of the forests in Kerala are under public sector and managed by the Kerala Forest Department (KFD). However, due to the non-forestry operations over last several years, the quality of our forests has deteriorated considerably. The extent of forests is not the only criteria, but its quality is equally important. The main concern now is on water availability and to see that the catchment areas in the forest watersheds are well conserved so as to ensure the steady availability of water for various purposes. Loss of biodiversity in closed canopy systems and virgin forest areas is yet another issue and the forest genetic resources are to be conserved in a sustainable manner for the sake of our

future generation. Not much attention is also paid to the conservation of grassland/shola forests and these ecosystems must be conserved as fully protected forests, without disturbances from any biotic interference.

Enhancing productivity of forest plantations is a challenge. High value plantations like teak, sandalwood etc., should get special attention and scientifically proven management plans need to be implemented. At the same time, plantations in poor quality sites are to be converted into natural forests. The practice of planting of trees under agroforestry outside forest areas also to be popularised to meet the demands of wood and other services.

Implementation of Forest Rights Act in its true spirit to address many issues connected with the rights of communities/forest dwellers is yet another issue. This is essentially needed to improve the livelihood of tribals. The possibility of involving BMCs/LSGs in the management of forests which are lying close to the forest area may also be considered to ensure a participatory approach. Presently considerable areas are under lease to many agencies and once the lease period is over, the KFD may get back the land and convert to natural forests/forest-based activities.

The wildlife-human conflict is a serious issue, which we come across on a daily basis. The Western Ghats is a biodiversity hotspot, at the same time high in human population density also. Many scientific studies have been conducted on this aspect by different agencies, but a proven / practical approach to manage this issue is yet to be evolved. Essentially it is the question of protecting the wildlife habitat and the wildlife corridors. A practical oriented method in a participatory mode has to be worked out and the coordination of different line departments is also essential.

Other issues of concern include the impact of forest fire on biodiversity and loss estimation; introduction of invasive plants/animals and the difficulties in managing them once it spreads into wider areas; unscientific/illegal mining and quarrying in the forest areas; waste disposal in the forest areas and also leaching out chemical fertilizers/pesticides applied in plantations like cardamom, tea/coffee etc., to the river system through forests; the current issue of zoonotic diseases, viruses and spreading from wild to humans and domestic animals; the carbon sink potential of forests and reduced resilience to combat climate extremes like floods, drought and landslides.

In general, there is an added need to enlighten the common public on the several ecosystem services being provided free by the forests and realisation dawns only when a natural calamity occurs.

## 2. Aquatic Biodiversity

Marine and inland ecosystems ensure food and nutritional security, economic growth and socio-economic development of the nation. In India, fisheries constitute an important economic activity contributing significantly to the national food security, income to the stakeholder community and for earning valuable foreign exchange. About 16 % of the total agricultural and allied product is contributed by fisheries and it accounts for 1.1 % GDP and 5.15 % of agriculture GDP. India contributes to approximately 4% of the world sea food trade with 5<sup>th</sup> position in world sea food export. The total export of marine products from India showed an impressive growth of 19 % during the last year, 2019-20 (12.0 lakh metric tonnes) for a value of Rs. 46,663 crores.

Kerala's share in the national marine fish production is about 15 % and fisheries sector contributes 3 % of the GSDP of the state. Although the state forms only 1.1 % of geographic area, its long coastline of 590 km., the 41 rivers that flows to the sea and the extensive backwaters and other wetlands ecologically connected to the sea turn the south west Arabian sea as one of the most productive marine zones in the world. The total fish production of Kerala in 2019-20 was 6.8 lakh metric tonnes with a contribution of 4.75 lakh metric tonnes from marine sector and 2.05 lakh metric tonne from inland sector. Total fish production in Kerala, which had been declining since 2015-16, witnessed a significant increase in 2018-19.

### Inland Biodiversity

Stagnation in marine fish production and increasing demand for fish and fish products in national and international markets necessitated developing inland fish production. The inland water bodies of 117,122 ha and coastal wetlands of 40,876 ha (Wetland Atlas of Kerala, 2011) offer immense scope for production of fish and shellfish. The potential of inland water resources for fish production is yet to be utilized optimally in Kerala. The State has made conscious efforts in increasing the inland fish production through projects like '**Subhikshakeralam**'. Inland fish production is an area which holds promise for future in Kerala and insufficient availability of good quality fish seeds has been identified as a major problem. To increase the production of good quality fish seeds, the department made efforts to strengthen the existing hatcheries, nurseries, fish farms and construct new units with the existing infrastructure. The area utilized for fish farming in ponds has increased from 5325 ha to 5700 ha in the year 2019-20, cage culture units established have increased from 80 to 1800 units, mussel farming units have increased from 2000 to 3500 units, Recirculatory Aquaculture System/ Aquaponics units have increased from 100 to 500 units and zero water exchange shrimp farming was carried out in 200 ha area. One paddy one fish farming in Kole lands of Thrissur and Malappuram Districts have increased from 1600 ha to 4500 ha and in Kuttanad area from

2100 ha to 5350 ha. New hatcheries were established in Neyyar, Peechi, West Kallada, Kulathupuzha, Kallanodu, Thalipuzha and Karapuzha. Cage culture in reservoirs was implemented in Malampuzha, Kannur, Ernakulam and Cage farming initiated in Pothundi reservoir of Palakkad District and Banasurasagar reservoir. As part of conservation of inland fishery resources, fish stock enhancement programme was implemented and 217.87 lakh fish seeds have been stocked in various public water bodies. Through aquaculture development project, area of 8300 ha was utilized for shrimp farming and 9800 ha for fish farming. A total of 6.31 crore fish seed production was achieved through Department hatcheries in 2019-20.

Major issues confronting the sector are the following:

1. Biodiversity of inland aquatic systems are poorly recorded and urgent measures are necessary to document the fauna.
2. Inland fish catch data is scanty, unsustainable and illegal fishing methods catching of brooder fishes and other organisms is a very serious problem and with the present regulations, it is difficult to control also.
3. Dwindling area of wetlands (including rice fields), both freshwater and brackish water is a major concern.
4. Less diversified culture practices: Cage culture in reservoirs should be encouraged with native high range fishes and prawns with good growth traits. Introduction of fishes like tilapia in reservoirs for purpose of aquaculture creates problems need to be regulated.
5. Pollution of wetlands is steadily increasing. It is causing damage to biota, polluting the open water source, aquifers and ground water. Brackish water aquaculture mainly concentrating on shrimps, high stocking density, heavy feeding lead to increased ammonia in water, ultimately resulting in pollution and degradation of inland wetlands
6. Encouraging value added product development and marketing is needed. At present storage facilities for storing produce in the inland sectors is limited. Government owned storage facilities will help to control adulteration of fish and fishery products.

### **Marine fisheries sector**

Among the Maritime states in India, Kerala occupies an important position in fish production accounting for about 15 % of the total landings. The well-known Wadge Bank is situated within the exploitable limit of Kerala. The mud banks (*Chakara*) between Alappuzha and Kannur are associated with the seasonal capture of certain species of fish. Capture fisheries face multiple pressures as a result of overfishing, habitat modification and pollution. Major issues in the marine sector include increased fishing pressure in the coastal

areas- stocks decline, overcapitalization and unwarranted capacity overload – more vessels, more powered and over exploitation of resources in the inshore waters. Discards/indiscriminate exploitation of juveniles/sub adults mainly by trawlers, biodiversity decline due to habitat destruction and damage to the benthos and benthic ecosystem, often destroying the food web of commercial species – mainly by bottom trawling, ornamental fish trade are also some of the issues flagged. The sector is also burdened by increasing fishing cost and diminishing returns and inefficient domestic marketing system. There is a need to fix floor price and development of storage facilities under government as the product is highly perishable, this will also address the issues of adulteration. Nutraceutical, probiotic, bioactive compound production at industrial levels are still in its infancy stage. The higher diversity of fish and shellfish resources available in Kerala coast offers better prospects for diversification, especially with regard to development of new products and value addition.

Adoption of code of conduct for Responsible Fisheries (CCRF) is necessary and this includes taking measures to control open access by strict enforcement of a system of licenses (authorization to fish) in traditional, motorized and mechanized sectors. Since the Coastal Regulation Zone (CRZ) notification of February 1991 and Coastal Management Zone (CMZ) notification of 2011 are in vogue, 200 meter width of coastal areas are to be statutorily earmarked as no development zones, except for utilizing it for fishery related activities of the coastal fisher folk. Ecosystem services of the critical coastal and marine habitats have to be analysed specifically through integrated inclusive research so as to prepare Integrated Coastal Zone Management Plans and for identifying hotspots for conservation and sustainable management. Mudflats, coastal wetlands, reefs, mangroves, sand dunes and shoals should be categorised as ecologically sensitive areas and conserved.

Periodically revalidating maximum sustainable yield of resources in the existing fishing grounds and determine fishing units in each category for sustainable harvesting of resources is needed. Promotion of selective fishing gear and practices, which include (i) Optimum mesh size in trawl cod ends, (ii) Optimum hook size and shape for lines, (iii) Square mesh windows in trawls, (iv) By-catch reduction devices in trawls, (v) Turtle Excluder Devices in trawls, (vi) Juvenile Excluder Devices in trawls, (vii) Trawl designs with improved resource specificity, (viii) Optimum mesh size for gill nets, (ix) Optimum mesh size for purse seines, and (x) Escape windows in fish and lobster traps will enable to conserve biodiversity to a large extent and promote its sustainable use.

A major portion of the coastal areas of Kerala are protected by construction of sea wall. Alternate bio-engineering technologies need to be explored. Restoration of beaches and protection of sea shore through natural shields such as mangroves and typical coastal vegetation have to be promoted with the participation of



coastal communities. In addition to mangroves, cultivation of economically valuable plants such as various species of *Pandanus*, *Calophyllum inophyllum* (beach touriga/ Indian doomba oiltree Punna/Avanakku) and *Morinda citrifolia* (Indian mulberry/noni) can be promoted in the littoral zone of coastal areas of the State. Coastal tree shield with indigenous coastal vegetation of a minimum of 30 m width should be promoted in areas of human settlements, with the participation of local communities. Planting of vegetation and deriving benefits from these resources should also be promoted as an alternate employment opportunity to the local population. Since coastal zone has a dense population in the State and local communities are least adapted for facing the climate vagaries, there is an urgent need for strengthening coastal protection methods with the participation of local communities, especially by promoting coastal bio-shields wherever ecologically feasible.

Considering the unabated increase in the quantity of marine debris, especially plastics in the coastal waters along Kerala coast, urgent interventions are required to manage plastic wastes in oceans and strengthen monitoring plastic debris. 'Suchitva Sagaram' (clean ocean) project launched by the fisheries department of Kerala in Kollam to remove plastic waste from the ocean with the help of fishers (and use the plastics collected for the construction of roads) should be extended throughout Kerala. Local bodies should take urgent measures to control the solid waste generation and take eco-friendly measures for proper recycling or disposal of the wastes. Specific programmes should be launched for the effective awareness on marine debris issue in Kerala coast, monitoring and management with the involvement of local communities and citizen scientists. Ocean acidification problems currently facing is very serious and adequate planning on a multi layer model has to be adopted. Number of houseboats in backwaters should be strictly limited, based on carrying capacity studies. Strict rules and regulations for waste management, especially in backwater tourism using house boats, shall be formulated and enforced.

One of the pre-requisites for conservation is a strong quantitative and qualitative data base on the living marine resources of Kerala coast in order to frame conservation and management plans. Data base on coastal and marine biodiversity should be prepared with the help of researchers and made available in the public domain. The maximum sustainable yield of the commercially exploited species should be determined in coastal and brackish water habitats and harvesting should be regulated accordingly. Sustainable harvesting of resources should be ensured by strictly adhering to the existing rules such as Kerala Marine Fishing Regulation Act (1985) and by assessing the maximum permissible limit of mechanised fishing vessels. Mandatory registration and licensing of all motorized and mechanized boats, review of licensing every year, cancellation of registration of vessels violating fishing regulations, and temporary moratorium for further sanction of mechanized vessels for inshore

waters should also be considered to reduce fishing pressure. Minimum legal size should be imposed on all commercially exploited fishery items of Kerala coast. By-catch reduction devices should be made mandatory in trawl nets to reduce the loss of biodiversity, especially the destruction of Rare, Endangered and Threatened (RET) species. Stake nets are found to be highly destructive in the sustenance of brackish water fishery resources of the State and therefore, may be removed in a phased manner.

Implementation of an integrated national conservation strategy involving *in situ* and *ex situ* and *in vitro* and *in vivo* methods for all marine threatened species has also become imperative. The sea ranching programme needs to be strengthened in India in order to replenish stocks, especially that of overexploited and threatened species. At present there is no concerted effort to make the coastal communities aware of the present ecological status of the ocean ecosystem and impacts due to the depletion of biodiversity. Fishery co-operatives, self-help groups in coastal areas, NGOs and religious institutions should be networked along with government systems for this purpose. Similarly, conservation efforts should be strengthened taking clues from the rich traditional knowledge of the local fishing communities. Such technological knowledge of the local fisher folk remains to be documented. Considering the skills of marine fishers in Kerala, their services may be fully utilized in coastal biodiversity monitoring, climate change adaptation and for disaster management programmes of the State. The traditional method of integrated farming system practiced in Kuttanad, with salt and flood tolerant rice varieties at below sea level would serve as a model to plan adaptation strategies elsewhere.

Knowledge base has to be strengthened for better understanding of the impact of climate change on fish stocks in our coastal waters with proper modelling studies as the first step towards planning and framing better management strategies. Adaptation measures for the communities' reliance on fisheries for food and income should also consider options such as education, entrepreneurial training, training in tourism and aquaculture to prevent potential deterioration of social conditions in fisher communities associated with climate change. Value-addition to products and improved market access through eco-certification and other mechanisms should support not only better utilization of resources, but also ensure its effective management and responsible handling of resources. The fish processing sector in Kerala is managed predominantly by the women workforce and the efficiency and productivity are likely to be improved by ensuring that the rights and responsibilities of women are recognised in their employment conditions and their sustainable income is ensured.

### Section 38 in THE BIOLOGICAL DIVERSITY ACT, 2002

38. Power of Central Government to notify threatened species.— Without prejudice to the provisions of any other law for the time being in force, the Central Government, in consultation with the concerned State Government, may from time to time notify any species which is on the verge of extinction or likely to become extinct in the near future as a threatened species and prohibit or regulate collection thereof for any purpose and take appropriate steps to rehabilitate and preserve those species.

*KSBB had recently assigned a project to Zoological Survey of India, Central Marine Fisheries Research Institute and Jawaharlal Nehru Tropical Botanic Garden to prepare a red data book of threatened species of Kerala including terrestrial fauna, marine fauna and flora respectively. The species suggested for regulation are listed in Annexure 12 to 19*

### 3. Agrobiodiversity

Kerala is witnessing a steady rise in the share of non-agricultural area from 7 % in 1970s to about 12 % in 2018-19. The share of net sown area also fell from about 57 % to about 53 %. The share of fallow land (as a sum of current fallow, fallow other than current fallow and cultivable waste) rose from about 1.7 % to 3.6 % during this period. The total area under food crops in the 1970's was around 20 lakh ha. Presently, it is around 13 lakh ha. Besides rice, other crops such as coconut, pepper, cashew and tubers have also recorded sharp decline in area and production in the recent years. (Thirteenth Five-Year Plan (2017-2022) Working Group on Agriculture)

The decline in area under paddy has a major impact on the biodiversity of the State as well. The ecosystem services provided by paddy fields include; groundwater recharge, flood control, soil erosion and landslide *prevention*, climate-change mitigation, water purification, and support of ecosystems and biodiversity. In 2018-19, Kerala's consumption of N, P, and K fertilizers was 36.4 kg per ha, which was the lowest among all Indian States.

The data from the Situation Assessment Survey (SAS), conducted by the NSSO in 2012-13, showed that only 27 % of agricultural households in Kerala reported agriculture as a major source of income as against 61 % at all India level. The homestead farms with small and marginal land holdings of 0.18 ha (0.45 acre) is another unique feature. Marginal farmers accounted for 96.3% of the total number of land holdings. The UN-PDNA report of Rebuild Kerala Initiative has pointed out the need for Agroecological zone wise planning and it is important to identify suitable ecological niche for food crops, cash crops,

other natural resources etc., in the available land area for the effective land use in Kerala. Climate resilient farming is now being given due consideration as a major adaptation strategy in the present context.

The agrarian economy is further impacted by the decline in productivity of most of the crops. Incidence of pests and diseases which adversely affects crop production is a major problem experienced by farmers. Integrated pest/disease management strategies recognising the fact that crop health is an integral part of sustainable agriculture are to be implemented ensuring farmers participation. Soil health has an important role in augmenting crop production. Soil related issues as high acidity, deficiency of macro, secondary and micro -nutrients adversely affect crop health and productivity. Best management practices for improving soil health suitable for different agroecological units in the State are lacking.

Kerala contributes about 45 % to the total plantation production in India, and accounts for about 37 % of the total area cultivated with plantations in India. In rubber, Kerala accounts for about 77 % of the national production. In cardamom, the State accounts for about 89 % of the national production. In coffee and tea, these shares are 22 % and 5 % respectively. The contribution of the plantation sector to Kerala's GSDP fell from Rs 21,000 crore in 2011-12 to Rs 9950 crore in 2018-19. Majority of the plantations in the state are with senile and unproductive plants leading to low productivity and income. Cashew production in Kerala is low but processing capacity of cashew industry is much higher than domestic availability and hence Kerala had to depend on imports of raw nuts. Similarly, for many of the essential oils, oleoresin companies favour imported pepper.

Major challenges in the medicinal plant sector include lack of facilities for collection storage and transportation of the raw material and wide adulteration, leading to loss of quality of finished products. The important flowers traded are marigold, chrysanthemum, jasmine, lily, lotus, vadamulla, anthurium, and orchids but floriculture is not gaining momentum in Kerala although agro climatic situations in Kerala are ideal for cultivation and commercialization of flower crops.

Lack of a consolidated data base of existing agro-diversity including high-yielding varieties, extant varieties, farmer varieties, landraces, crop wild relatives and underutilised crops in homesteads, farmers' fields, R&D institutions, Govt. farms, nurseries, educational campuses, religious campuses and public institutions is one of the major issues. Gaps in knowledge of biodiversity in an agricultural landscape that can deliver a positive contribution to the productive function of agriculture such as Soil microorganisms, pollinators, natural biocontrol organisms etc need to be addressed.

In terrestrial ecosystem invasive species such as *Mikania micrantha*, *Merremia hederacea*, *Hyptis capitata*, *Calopogonium mucunoides* and *Pennisetum pedicellatum* compete with native plants for nutrients and minerals and change the entire crop rotation strategies and convert productive land to barren land.

Inadequate availability of quality planting materials and seeds of crop varieties, farmer varieties, landraces, crop wild relatives and eroding seed storage practices by farmers is a major challenge in the state. Need for conservation and enrichment of urban agro-biodiversity, and involvement of young generation in agrobiodiversity conservation, protection of IP rights on biodiversity, especially variety registration, geographical indication registration and benefit sharing have been identified as critical issues.

More research for development of locally adapted, climate resilient varieties and varieties resistant to biotic and abiotic stresses using traditional varieties as gene donors and validation of TK related to medicinal and nutritional benefits of agrobiodiversity is necessary.

## 4. Social sector

### 4.1 Tribal development

The subsistence of tribal communities is mainly dependent on various components of bio-resources available within the forest areas. It also provides basic livelihood needs like fodder, fire wood, edible fruits, edible tubers, medicinal and food plants, etc. Collection, processing and selling of NTFP is also a source of income generation to meet their immediate requirements like food, medicine, education, housing etc. In spite of implementing various local/national/international project/ programmes, the socio economic conditions of these communities are still not much improved due to various reasons like unscientific implementation of programmes, the increased rate of exploitation, improper extraction of natural resources, lack of value addition, inability to introduce good collection, processing, storage and selling practice and lack of biodiversity conservation practices, both at *in-situ* and *ex-situ* level. Therefore, it is highly essential to evolve new pragmatic approaches in understanding the needs, aspirations and problems of the tribal/local communities with a view to formulate scientific methods to resolve their issues more effectively by implementing unique project/ programmes in a sustainable manner. In this context, the tribal/ local communities must be brought under various awareness and capacity building programmes with a view to educate them about their rights and the necessity of self-help, by empowering them in acquiring the skills, knowledge and experience to take greater responsibility for the development, through implementing various activities with an ultimate objective to alleviate poverty by improving the

access to and control of resources which they need to sustain. Location-oriented production technology will provide them with respectful, gainful employment which in turn help will them to lead a socially, economically and healthy productive life.

To achieve these goals, a multi-disciplinary, multi sector participatory programme on biodiversity conservation and sustainable utilization specifically focusing on NWFP including medicinal, food and aromatic plants is necessary. The participatory programme with different action plans and definite vision, mission and objectives should be chalked out and implemented in the field accordingly by involving the tribal/ local communities as main stake holders. They should be involved in all the phases of the programme, right from planning, implementation, monitoring and evaluation. People's participation can ensure sustainability; can also make developmental activities more effective and meaningful and in turn help to build local capabilities.

The major activities envisioned in the participatory programmes must include

- Creating mass awareness among the target group through Biodiversity Management Committee (BMC) regarding the aims, objectives, importance and benefits of the participatory programme through contact programme such as seminars, exhibitions workshop, field demonstration etc.
- Developing a user-friendly database based on Peoples Biodiversity Register (PBR/e-PBR) of each local self-government bodies covering health, socio economic status of people, passport script data of plants, animals, microbes, Non Wood Forest Produce (NWFP) especially medicinal/food/aromatic plants and associated traditional knowledge.
- Implementation of various biodiversity conservation strategies with a view to evolve location specific/ package programme for afforestation of degraded forest land /forest fringe areas using medicinal, edible and aromatic plants. It includes setting up of nurseries, cultivation units and vegetable/medicinal/aromatic plants gardens. Extended training for systematic/ sustainable collection of NWFP from the forest exclusively for tribal communities.
- Establishment of 'Green Pharmacy' concept exclusively for the tribal community (Preparation of simple/single home remedies and its administration for primary health care with the support of AYUSH Department)
- Semi processing, value addition, marketing of medicinal / edible / aromatic plants, and plants collected under NWFP developing entrepreneurial capacity building programme within the target group and marketing the raw materials and value-added products without any intermediary, so that they can share their benefits in an appropriate manner.

## 4.2 Education

### **Inadequate emphasis on biodiversity in educational curricula is one of the major issues flagged**

1. Lack of adequate understanding of the significance of issues related to biodiversity loss.
2. Inadequate information regarding the topics on biodiversity to be included in the educational curricula of schools and colleges and the degree & mode of education required.
3. Lack of sufficient books and teaching materials covering various aspects on biodiversity to be taught at different levels.
4. Lack of trained and motivated teachers well versed with topics on biodiversity.

### **Lack of awareness on biodiversity related issues.**

1. Biodiversity related issues are yet to get adequate attention among general public. The importance of biodiversity for the social, economic, ecological and cultural well-being of the present and future generations is not properly understood by most of the people who have access to natural resources and the decision-making process connected with its utilization and management.
2. Inadequate understanding of the ecosystem services provided by biodiversity and potential of biodiversity as a means for sustainable development.

### **Lack of adequate research on different aspects pertaining to biodiversity and its sustainable utilization**

1. Inadequate understanding of the significance of different aspects pertaining to biodiversity and its conservation among policy planners, administrators and scientists.
2. Investment in R & D and utilization of the knowledge generated by public research for the welfare of the community is the key to robust economic growth. Most of the research undertaken relating to sustainable utilization of bioresources are not commercialized. Most academic research results are at the stage of laboratory prototype or preclinical trials and require substantial further research and development before they can be turned into a commercially viable product. In India, only less than 5% of patents reach the market, and two-third of the research originates from Government labs. Better communication between research organizations and industry is necessary for realizing the benefits of biodiversity.

## 5. Cross cutting sectors

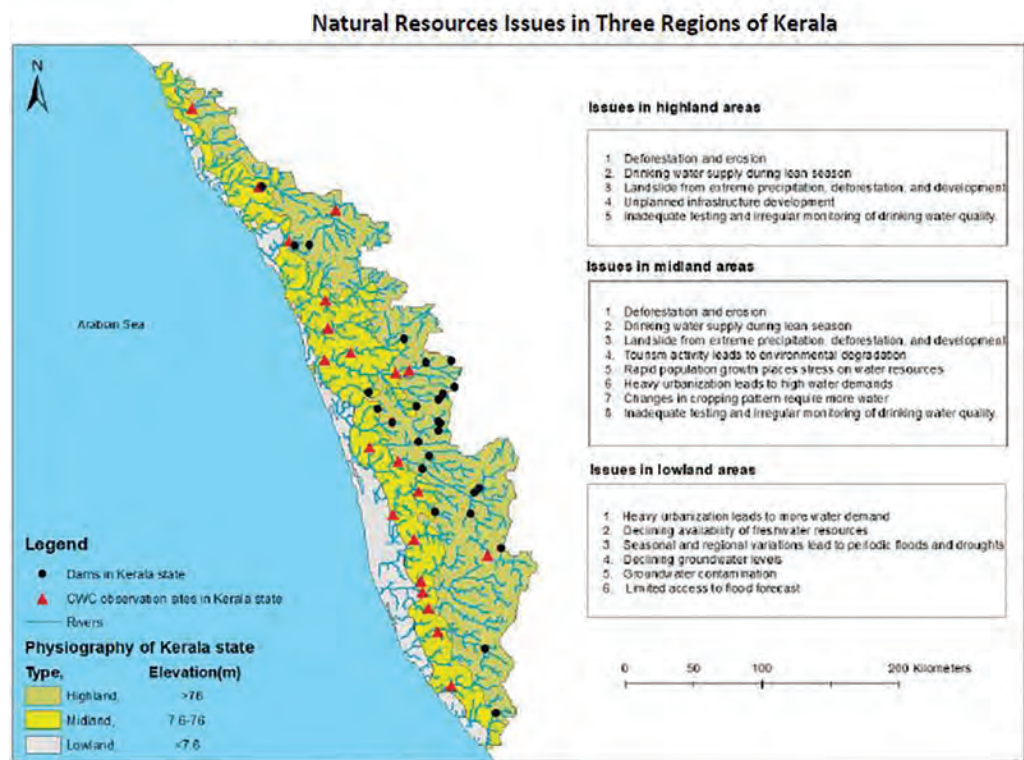
### 5.1 Environment and Climate Change

The state is facing pressures due to (i) Loss and degradation of natural ecosystems as forests, mangrove, coastal, wetland and ecosystems (ii) Depletion of biodiversity in wild and domesticated areas (iii) Increased sand and clay mining; (vi) Deterioration of the rivers; (v) Increasing scarcity of water; (vi) Loss of farmland productivity; (viii) Air, water and soil contamination; (viii) Fast urbanization.

In Kerala the total quantity of solid waste generated is 11449 TPD of which 3452 TPD is generated from urban area and 7997 from rural area. The total quantity of biomedical waste generated in the year 2020 is 40.4 TPD. Kerala state has more than 16,000 poultry stalls where around 18 lakh poultry are slaughtered and sold daily and it is estimated that about 1,080 TPD of poultry waste is produced. Plastic waste generation is around 1, 31,400 Tonnes Per Annum in the State. Haritha Karma Sena is working in 88 urban local bodies and 850 Grama panchayaths for collection of dry waste. For wet wastes disposal decentralized treatment methods such as aero bins, pipe compost, compost pits, kitchen bins, biogas plants etc. are followed. Managing this huge quantity of wastes has been recognized as a major challenge for the state. Absence of disposal and recovery facilities have adverse impacts on environment and public health with increasing incidence of communicable diseases

The major environment problems in the state associated with water resources are flood, drought, salinity intrusion, over exploitation of groundwater, water logging and pollution. Huge demand for river sand for construction has caused indiscriminate sand mining from all rivers of Kerala leading to bank erosion, lowering of water table, etc. The riverine ecosystems and backwater systems are also highly contaminated due to the indiscriminate discharge of solid and liquid wastes, agrochemicals, eutrophication, etc., and the environmental flow of water has also been affected. The downstream flows are lean during summer in many of the rivers affecting their hydrological cycle and ecological functions of purifying water, depositing sand, sediments and nutrients or providing freshwater. The ground water problems due to high fluoride content are reported from Palakkad and Alappuzha districts. Ground water contamination due to industrial pollution has been reported from many places in Ernakulam, Palakkad, Kollam, Kozhikode and Kannur Districts.





During 2018, Kerala experienced severe flood, situation during the monsoon season and the Government has taken precautionary measures by equipping/empowering the Local Self Governments to face such situations and reduce the impacts and mitigate such hazards.

The history of Kerala of a successful decentralized planning and participatory approach through the three-tier Panchayat Institutions is unique. Subsequent to 2018 floods, Govt. of Kerala ordered the LSGs to have a Working Group on Environment, Biodiversity Management, Climate change, and Disaster Management and specific duties were also assigned. This include preparation of strategies/action plans for BD conservation at local level. What is needed is eco restoration programmes in various ecosystems like forests, wetlands, coastal areas, riverbanks etc., to prevent halt and reverse the degraded ecosystems. KSBB is providing guidance/technical support to LSGs/BMCs in developing suitable BD conservation plans at local level.

### Climate change

One of the major impacts of deterioration of environment is climate change which is affecting the world with adverse effect on economy and life and wellbeing of all living beings. The Paris Agreement adopted in 2015 aims to strengthen the global response to the threat of climate change by keeping

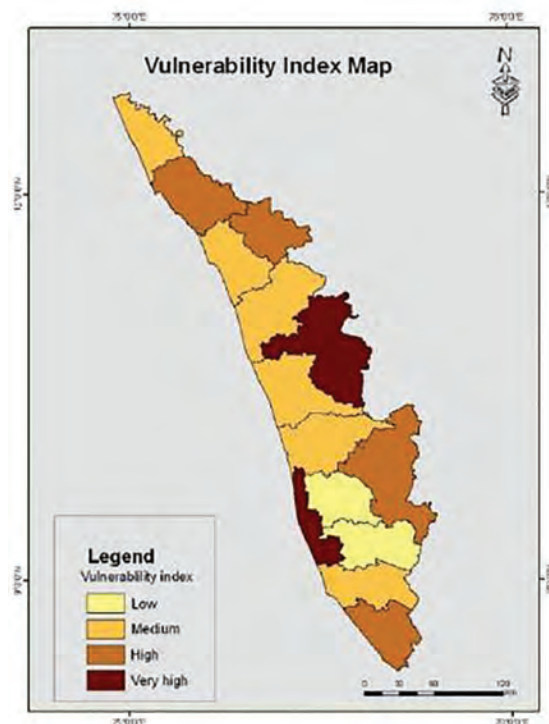
global temperature rise well below 1.5 degrees Celsius above pre-industrial levels. The IPCC's 6th Assessment outlines that climate changes will increase in all regions across the globe over the coming decades and that even with 1.5°C of global warming, there will be increasing heat waves, longer warm seasons, and shorter cold seasons – which will become more intense at 2°C of warming. Climate change will also intensify the water cycle and bring more intense rainfall (and flooding events). On the other hand, more intense drought events will take place in many regions like Northern, Western, and Central Europe.

It has been predicted that heavy precipitation events will intensify and become more frequent in most regions with additional global warming. At the global scale, extreme daily precipitation events are projected to intensify by about 7% for each 1°C of global warming (high confidence). The proportion of intense tropical cyclones (categories 4-5) and peak wind speeds of the most intense tropical cyclones are projected to increase at the global scale with increasing global warming (high confidence) (IPCC, 2021). India was ranked 2<sup>nd</sup> in the 2011 Climate Change Vulnerability Index (CCVI), released by global risks advisory firm Maplecroft, that evaluates 42 social, economic and environmental factors to assess national vulnerabilities across three core areas, namely, exposure to climate-related natural disasters and sea-level rise; human sensitivity in terms of population patterns, development, natural resources, agricultural dependency and conflicts. The above prediction by IPCC is certainly of great concern to Kerala, as we are in the tropics with monsoonal rainfall regulated by three oceans.

Climate change in Kerala is likely due to the combined effect of natural features and anthropological interventions such as the land-use change, urbanisation, development activities and population density. Kerala is vulnerable to natural disasters due to its unique geographical features of steep gradient along the slopes of Western Ghats and long coast line. The state's high dependency of climate sensitive sectors like agriculture, fisheries, forest, water resource and health, make the state vulnerable to climate change. The maximum distance between the eastern and western parts of Kerala is only 120 km (in some places it is only 35 km). Within this 120 km, there are places above 2,695 metres (Anamudi, Idukki district) and places up to 2 metres below sea level (Alappuzha and Kottayam districts). The state has received unprecedented heavy rainfall in 1924, 1961, 2018 and 2021 and drought during 2017. In 2021, the state logged its highest annual rainfall in 60 years and the sixth highest annual rainfall in the past 120 years. The state recorded an annual rainfall of 3,610.2 mm during the 12-month period against the 'normal' of 2,924.7 mm, an excess of 23.4%. The winter rainfall (January-February) and the northeast monsoon rainfall (October-December) in 2021 were the highest ever recorded in the state, while the pre-monsoon rainfall (March-May) was

the sixth highest in 120 years. The southwest monsoon, which contributes most of the state's annual rainfall quota, was normal.

The Kerala State Disaster Management Plan has identified 39 hazards including natural hazards and anthropogenic hazards. Kerala is also one of the most densely populated Indian states (860 persons per square kilometres) making it more vulnerable. Floods being the most common natural hazard and nearly 14.5% of the state's land area is prone to floods and the proportion is as high as 50% for certain districts. The low-lying areas in the western part of Kerala are prone to flash floods. Landslides are major hazards along the Western Ghats in Wayanad, Kozhikode, Idukki, and Kottayam districts. Quarrying, mining and large-scale construction activities, which affect the ecological stability of the landscape, could be the major factors causing these landslides. An estimated 5,924 quarries are functioning in Kerala. Kerala State Biodiversity Board conducted a rapid assessment of the impact of flood on Biodiversity-community perspectives through BMCs in 2018 which recorded that about 771 different landscapes including riverine, forest, plantations and agricultural fields were affected. About 287 varieties of agricultural crops, 1053 flora and 695 fauna were also affected. Major causes of disaster according to community perception include land use change in wetlands, removal of river bank vegetation, construction activities in hill slopes and unsustainable quarrying.



*Map of the vulnerable Districts in Kerala (Source: Kerala State Action Plan on Climate Change, 2014).*

The major climate change hotspot districts in Kerala are Alappuzha, Palakkad and hilly districts of Wayanad and Idukki. Four districts that are under highly vulnerable groups include the districts located in hilly region *i.e.*, Idukki and Wayanad and Southern district of Thiruvananthapuram and Northern district of Kannur.

### **Impact on coastal areas**

The potential impacts of climate change are reflected on coastal and marine ecosystem in an increase in sea level change, alterations in precipitation patterns and delivery of freshwater, increased sea surface temperature, increase in ocean acidity alterations in circulation patterns and increased levels of atmospheric carbon dioxide.

Higher sea levels may make groundwater more saline, harming freshwater fisheries, aquaculture and agriculture limiting industrial and domestic water uses. The sea level is on the rise due to global warming and the projected sea level rise along Kerala coast on a conservative estimation is about 100 to 200 mm over the next 100 years. Sea level rise is likely to result in loss of land due to submergence of coastal areas, saline intrusion and ground water contamination and may have wide economic, cultural and ecological repercussions. The sea level rise for Kochi is estimated to have been 2 cm in the last one century. If the sea level rises by 1m, 169 sq. km of the coastal region surrounding Kochi will be inundated. Climate change induced sea level rise will result in widespread salinity affecting the availability and quality of groundwater for drinking and agriculture purposes in Kerala.

The coastal biodiversity of Kerala is also vulnerable to the projected climate change scenarios. Climate change can impact fisheries through multiple pathways. Changes in water temperature, precipitation and oceanographic variables such as wind velocity, wave action and sea level rise, can bring about significant ecological and biological changes in marine and freshwater ecosystem and directly impact people whose livelihood depend on those ecosystems. In addition, climate change strongly influences the distribution and abundance of fishes. The effects of increasing temperature on marine and fresh water ecosystems are already evident.

The increase in Sea Surface Temperature (SST) due to climate change results in change in life history traits of fishes especially the pelagic group of fishes. The resultant increase in temperature leads to faster growth, early maturity thereby decreases in longevity (life span) of fishes. This increase in growth rate is attributed to their increased metabolic rate. Kerala is a traditional home for sardines and mackerels, the two species have moved away from local waters and also shifted to deeper waters. Several important species of fish and high-value shrimps too have become rare in the catches, while, puffer fish has become abundant and are seen as a major cause of destruction of fishing nets.

### **Impact on Agriculture**

Agriculture is the mainstay of state economy and provides food and livelihood security to a large proportion of the population. Cultivated land is declining across the state and production is stagnated mostly due to weather aberrations. Maximum and minimum recorded temperatures have shifted from usual trends and has also led to decrease in agricultural productivity. Dry rivers and lowering water tables in summer have led to water scarcity both in urban and rural areas. Climate related hazards like temperature variation, floods, landslides, drought, coastal erosion etc., are common in Kerala. The land use patterns in Kerala have changed drastically over the past 50 years with a shift away from agrarian based economy. Paddy lands which play an important role in ground water recharge has reduced considerably.

With each degree rise in temperature, rice yield would be reduced by 6 %-. The crop maturity period may also get reduced, which might affect the paddy productivity drastically. This would adversely affect the state where rice is the staple food of majority of the population. Widening in temperature range along with deforestation may be detrimental to thermo-sensitive crops like cardamom, coffee, tea, cocoa and black pepper cultivation across the high ranges of Kerala. Any sort of change in climate will have a detrimental effect on the cropping seasons and cropping pattern that has been traditionally practiced in the state. About 72% water in the state is used for agriculture, of which 40% is from ground water. Drought situation was noted in 2017 especially in districts like Wayanad which recorded a decrease in rainfall where 76% people depend on agriculture.

Productivity of animals is being affected due to heat stress; new diseases and change in pattern of existing diseases are observed; lack of sanitation, improper utilization & storage of dung, lack of balance diet for livestock, fodder and pasture land are the main concerns for livestock rearing. Frequency of incidences of mastitis and foot diseases among crossbred cows and other animals with high productivity may increase due to increase in the number of stressful days.

### **Impacts on Forest**

Based on a range of vegetation modelling studies, IPCC (2007) suggests significant forest dieback towards the end of this century and beyond, especially in tropical, boreal and mountain areas. About 75 % of India's forests are projected to change in character irrespective of the nature of change by the end of the century. There are very few studies addressing the impact of climate change on forests in India. Most of the earlier studies were based on GCM models and earlier versions of BIOME model that had limited capacity in categorizing plant functional types. Forests of Kerala state are a huge reservoir of sequestered carbon. Various types of forests that the Western

Ghats of Kerala harbours, its high diversity, and rich density make forests of Kerala state very important in its carbon sequestration potential. Each and every hectare of forest in Kerala, on an average contains 128 tons of carbon. Deforestation and degradation of forests converts the sequestered carbon and release them back to the atmosphere.

A shift in vegetation type boundaries may be expected both along Western Ghats regions of Kerala and along an altitudinal gradient (with species adapted to the warmer, lower elevation migrating to higher altitudes). The mountain regions of the Western Ghats featuring a mixture of evergreen forest and grassland with ecotones are a sensitive indicator of past climate change (Sukumar *et al.*, 1993, 1995). The likely changes to forests due to climate change are as follows:

- Reduction in forest cover, more plants and animals' species become vulnerable and extinct, shifting the forest boundaries, tropical evergreen forest, sholas, mangrove forest etc., are exposed to loss, increased competition from exotics species, increase in forest fires as temperature increases, loss of fragile ecosystem, likely to impact wild life by impacting their habitat, increase the social vulnerability of the tribal people, increasing the incidence man-wild animals' conflict,
- opening of vulnerable colonization by invasive species, impact the quality and quantity of forest products, loss of endangered flora and fauna, encroachment to forest areas, water scarcity become severe in the interiors of forest, loss of wild life due to various extreme events.

### Impact on Health

Higher temperatures and changing rainfall patterns can enhance the spread of existing vector borne diseases and macro parasites, accompanied by the emergence of new livestock diseases. Communicable along with vector borne diseases have been a health issue in Kerala. Malaria, dengue fever, chikungunya, diarrhoeal diseases, COVID and other virus diseases are all major issues. Climate change is linked with rising instances of these diseases in the State, for instance through higher temperatures, water scarcity and flooding.

**Lack of Comprehensive Adaptation Strategy:** Local Self-Governments (LSG) being at the forefront of any climate related disasters needs to be adequately trained and empowered for undertaking local action plan. People's participation is key to building climate resilience – all mitigation and adaptation projects being taken up in the state should be participatory, people-driven with community buy-in and social acceptability. Women and children are most vulnerable to impacts of climate change.

In general, Kerala has many policies, strategies and plans for addressing various climate change related challenges for agriculture, water resources,

forests and ecosystems, and coastal marine environment. However, the policy framework to align human development and climate change response efforts through adaptation is largely lacking in the State.

## **5.2 Local Self Governments and Biodiversity Management**

Biodiversity management committees are mandated with conservation of Biodiversity at local level. Biodiversity can only be preserved through voluntary participation of the society. At the grass root level, the major constraint identified was the lack of awareness among stakeholders about significance of biodiversity and the ecosystem services provided by it. Capacity building trainings and gap assessment needs to be conducted on a regular basis based on which modules and curriculum can be developed. Lack of administrative support, least priority given for biodiversity related matters, lack of sensitisation etc., at local level are some of the major hurdles in the functioning of the BMCs. Mere classroom training is not sufficient and exposure visits can lead to good learning by BMC members. Trainings for BMCs can be arranged in Forest Schools and other State Institutes.

Although PBR has been prepared in all the LSGs it has to be periodically updated. It is necessary to validate and update the contents in all the PBRs and make it dynamic. A comprehensive biodiversity data portal in the public domain, high quality field guides and monographs are necessary. Developing a standardized methodology for rapid biodiversity surveys for PBR preparation and updation is another issue which has been flagged frequently. As part of UNDP – Munnar Landscape project KSBBS had brought out a standardized protocol for biodiversity surveys. Lack of trained, competent taxonomists to identify flora/fauna at species level is an issue to be addressed. PBR is not to be viewed as an end on itself, it should be used as base document for developing Local Biodiversity Action Plan (LBSAP). UN Convention on Biological Diversity encourage local governments to develop and implement LBSAPs in support of NBSAPs. Capacity building for strengthening BMCs for formulation of Local Action Plan for Biodiversity and their implementation and monitoring at Panchayat level is necessary. The LBSAP should have management plan for local bioresource based on availability and sustainability. Based on the Environmental/Biodiversity grama sabhas and PBR, with technical support of regional TSG, BMC can prepare Environmental/ Biodiversity status Report. It can be an entry-point document based on which the second phase of activity commences.

Popularity of certain groups like birds and butterflies amongst amateurs opens up the possibility of crowd sourcing techniques known as citizen science. In Kerala, the possibility of involving citizen scientists and civil society in biodiversity documentation were not fully explored, though opportunities for such an exercise are awesome. Long term biodiversity monitoring studies

and preparation of inventories can be tried by expanding the network of local communities and civil societies, and cooperation with the government departments.

Depositions in the natural history museums and repositories reveal the great natural history and biodiversity of the nation and are a source material for the taxonomists and biotechnologists to pursue their research. The priority therefore should be to prepare a database of type materials available in each of the repository and to simplify the procedure for sharing the data to practicing taxonomists/biodiversity experts.

Lack of information on the status of potential bioresources, domestic consumption and trading, supply chain, quantity of tradable bioresources etc., affect the implementation of ABS provisions. Hence, state level study for assessing the demand and supply of tradable bioresources to be taken up with experts drawn from different disciplines. Biodiversity code of conduct, setting out standards of behaviour for responsible practices to be followed by line departments need to be developed. Lack of cross sectoral linkages of BMC with existing Institutions as JFMC, EDC, Haritha Karma Sena, Water shed committees etc., need to be addressed. As BMCs and JFMs have similar objectives, incorporating the guiding principles of the two institutions can enhance effectiveness of the government initiatives. Kudumbasree, the massive women empowerment program of Kerala can also be declared as the accredited agency for BMC for undertaking Biodiversity conservation activities.

The linkages between conservation with livelihood need to be highlighted. Models on how to make biodiversity conservation an economically viable activity need to be developed so that biodiversity conservation should become a part of the economic development plan of Panchayat.

Women have been the repository of traditional ecological knowledge, particularly with respect to biodiversity and its uses. Steps are required to foster a congenial atmosphere that facilitates participation of women in activities of BMCs.

Although there are legal and policy framework, there is not enough clarity on the mobilization of resources and mechanisms for their implementation. A detailed review of plan fund allocation at LSG level for natural resources conservation/ environmental protection is necessary for identifying the gaps.

## **6) Infrastructure Sector**

### **6.1 Water**

Kerala state is well endowed with water resources through an extensive network of rivers, streams, lakes, ponds, springs, and backwaters. In Kerala,



surface water provides bulk of its fresh water demand. Although the mean annual rainfall in the State is 2948mm, its spatio-temporal distribution is highly uneven, resulting in a water scarcity for about 5 to 6 months. The dams, reservoirs, and canals are considered as one of the key solutions for growing demand of water and electricity. Water resources development, conservation, and optimum use must be considered as part of the biodiversity conservation strategy.

The 54th round of National Sample Survey report on drinking water and sanitation shows that the population covered by piped water supply is merely 11.5% and about 85% households in the State depend on the traditional open wells for their household water needs. Groundwater meets the domestic needs of more than 80% of rural and 50% of the urban population. The current drinking water utilisation in the State is estimated to be 2100 Mm<sup>3</sup> out of which 1500 Mm<sup>3</sup> is from groundwater.

The irrigation efficiency in the studies carried by CWRDM has been found to be as low as 40%. The net irrigation water utilisation in the State is estimated as 3532 Mm<sup>3</sup> and the gross irrigation water utilisation in the State is estimated to be 8830 Mm<sup>3</sup>. This is supplied from both the surface and groundwater sources.

Water scarcity is experienced in the mid lands which cover 40 % (15,400 km<sup>2</sup>) and high lands, which cover 48% (18,480 km<sup>2</sup>) of the total geographical area of the State. The average slope of mid land and high land can be approximated as 6% and 14% respectively. In such sloping terrains, natural water conservation alone is not sufficient to meet various water needs. Below the water table aquifer or weathered rock, impervious granite rock is present in most part of Kerala. This prevents the flow of water to deep aquifers and reduces the potential of deep groundwater. Therefore, artificial percolation augmenting measures are required to improve groundwater storage. Sloping and undulating topography, removal of natural vegetation, construction of buildings, land filling, conversion of water bodies, sand mining, lack of awareness on wise use of water, pollution of streams and rivers, are some of the challenges in this sector. (Kerala State Planning Board, 2017)

## **6.2 Tourism**

Sustainable tourism can help preserve biodiversity that attracts tourists, while providing economic benefits to the local and national economies. The rapid and often uncontrolled growth of tourism, while contributing to economic growth, also has a major impact on the environment and traditional cultures, and put more and more stress on fragile ecosystems.

### Major impacts of Tourism on Biodiversity

- Infrastructure: Tourism development usually demands increased infrastructure including development of connectivity and other infrastructure for hospitality industry, intensive water demand from tourism and extraction of groundwater can result in significant alteration of natural habitats
- The inflow of foreign tourists leads to increased risk of introduction of alien species
- Solid and Liquid pollution is one major threat to biodiversity especially in tourist places like Munnar and Kumarakam. The waste from houseboats consists of solid wastes including food wastes and liquid wastes like sewage. Large quantities of diesel fuel are also being used for propulsion of boats resulting in pollution due to diesel and oil spilled from engines. The deterioration in water quality (freshwater, coastal waters) and sewage pollution leads to eutrophication of water bodies, impacting the flora and fauna.
- Introduction of pathogens; zoonotics, pandemics
- Pollution and production of greenhouse gases, resulting from travel by air, road, rail, or sea, at local, national and global levels. Carbon dioxide emissions from the tourism sector's transport, accommodation and other activities are estimated to account for 4 to 6% of total global emissions
- Increased risk of fires
- Land use change and urbanization
- Overexploitation of natural resources for food, materials, freshwater and recreation

### Positive impact of Tourism on Biodiversity

**Employment and economic development:** According to central statistical organization enterprise under Ministry of Tourism, Government of India, 47.5 % of jobs come from tourism sector. The income and local employment generated by biodiversity-based tourism can create a strong incentive for communities, local authorities and governments to protect and invest in biodiversity. Tourism is a major source of export earnings in many western countries and many island States, where the dominant tourism activities are based on biodiversity and high-quality ecosystem services. Tourism is a major contributor to the economy given the biodiversity richness of Kerala. Tourism contributes more than 10% to the GDP of the State. Foreign exchange earnings from tourism have shown a steady growth over the years. In 2019, Kerala has earned Rs.10271.06 crores as foreign exchange earnings from tourism against Rs.8764.46crores in the year 2018 showing a growth of 17.19 %.

**Income for management of protected areas:** Revenues from entrance and user fees in protected areas and parks provide funds that can be used for their management. Therefore, tourism financial flows have the potential to be a much larger contributor to the management of the State conservation.

**Raising awareness amongst tourists of biodiversity and the need for conservation**

The experience of biodiversity and high-quality environment can increase the understanding of and support for biodiversity conservation amongst tourists.

### **6.3 Energy and Transport**

Power sector is very important for the development of our state, but it also poses several environmental challenges. It is in the global warming scenario the situation gets worse. We need to look at the ways and means the energy conservation, energy efficiency and also look for new and ecofriendly renewable energy sources. The major energy resources available within the state are hydro solar and wind. Other forms of renewable energy resources are also emerging. Solid waste management has become a challenge and technologies to convert solid waste into power is an option but at the same time caution should be taken against the possible pollution issues while burning the solid waste.


In Kerala, we have small hydro power stations with a capacity of 150 megawatts. In addition, there are power stations with less than 25MW capacity. Even while taking up small hydropower stations, detailed EIA should be carried out with support from concerned LSGs & BMCs.

In Kerala, the demand for power varies depending on the seasons and to a very great extent this is influenced by climate conditions. It is estimated that Kerala has a growth rate in power requirements at 4.5% annually, and this could be even 6% or 7% in certain specific periods. However, based on the trends available, we can expect an annual increase of less than 1000 mu over the next 10 years. However, it all depends on the sustainable development models, that we adopt.

There is also a need to generate reliable data on demand needs in consumer areas like domestic, economical, industrial etc. A more meaningful approach towards decentralized power generation and distribution system may also be considered. There is need to make every stakeholder aware that every unit of electricity is precious and use it judiciously.

A few suggestions to strengthen this sector include:

- Reduce the level of power consumption in the commercial sector
- Provide incentives for industries commercial sector, which save energy during the peak periods.

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- Avoid transmission loss through appropriate measures
  - Eco restoration programmes to be implemented in the catchment areas of hydroelectric projects with line department to facilitate inflow of water into the dams and reduce siltation
  - Implement roof top solar plants in domestic .and commercial sectors.

## CHAPTER 4

# Strategies, action plan and monitoring framework through SMART indicators

### VISION AND MISSION

A Vision and Mission statement for KSBB was developed which will guide all subsequent activities of KSBB for the next 10 years and this is also the basis for the SBSAP.

#### Vision

*To protect biodiversity in its own right and ensure its enrichment and sustainable use for the development of Kerala*

#### Mission

*To conserve our rich biodiversity through policy guidelines, legislation and action plans in a participatory mode for the welfare of all living beings of our state*

KSBB is a statutory, regulatory body under the Department of Environment, Government of Kerala, mandated with conservation of biodiversity, promoting sustainable use of biodiversity and fair and equitable sharing of benefits of biodiversity.

KSBB was established during 2005 and the Kerala Biological Diversity Rules were framed during 2008. During the past years KSBB has implemented several

projects on conservation of biodiversity with peoples participation. But even after 17 years of existence, KSBB is not fully self-sufficient in terms of financial and human resources. Probably the situation is the same with regard to other SBBs in the country as well. KSBB is going ahead with various activities in different parts of the State, but the quality of the work is not being ensured due to lack of human resources in monitoring the activities. KSBB has to be structured like the Pollution Control Board with District Offices, in addition the Head Office and with sufficient technical staff. This kind of revamping the Board will also facilitate empowerment of BMCs, which lacks technical support now. This will require a high-level discussion and a policy decision. However, Kerala being a model in many aspects in the implementation of BD Act, should set a model in this regard as well. It is worth mentioning that among the various states in the Country, Kerala has gone much ahead in the decentralized governance with more and more activities, including biodiversity conservation taking place at local level. However, the performance of BMCs is a matter of concern and KSBB has plans to revitalize and empower these local level bodies to a higher level of efficiency. So also, the updation of PBRs is being taken up including digitalizing. In a few panchayats, management plans are also being prepared using the data from the PBR.

Although KSBB has gone ahead with many landmarks over the past years, we are yet to make a mark in the Access and Benefit Sharing (ABS). The attempts are at varying stages and the Board is also now looking for the BD Act Amendments, recently placed in the Parliament to move forward. Similarly, the establishment of Biodiversity Heritage Sites (BHS) is going on at a slow pace. We hope that more BHSs will be established in the coming years.

As mentioned earlier, the first set of Strategies and Action Plans were made during 2007 and it is high time to review and modify to suit to the present context/ environmental scenario, which shall remain in force at least for the next 10 years.

## Kerala Biodiversity Strategy, Action Plan and Monitoring Framework through SMART indicators

### 1. FOREST AND BIODIVERSITY

#### Strategy 1.1: Restoration of degraded ecosystems

Action Plans	Time frame Short term/ Medium term/Long term	Indicators	Imple- menting agency	Remarks
<ol style="list-style-type: none"> <li>1. Develop a landscape level management plan by harnessing various components of ecosystem functions.</li> <li>2. Undertake planting of native species in degraded and denuded forest areas (enrichment planting)</li> <li>3. Change unproductive monoculture plantations to natural forests.</li> <li>4. Take over the expired and unused private lease holdings and revert back to natural forests.</li> <li>5. Stop soil erosion and improve rate of infiltration and percolation</li> <li>6. Eviction of illegal occupation and encroachments in the forest areas.</li> <li>7. Reduce anthropogenic pressure and grazing pressure by educating communities and improving protection measures</li> <li>8. Long term in-depth studies for monitoring ecosystem services from forests.</li> </ol>	Long term	<p>Percentage change in forest cover</p> <p>Percentage change in area coverage of scrub forest</p> <p>Total area covered under different afforestation schemes (in hectare)</p>	KFD/VSS/ KFRI	

Strategy 1.2: Accelerate carbon sink potential of forests	Long term	Percentage change in total carbon stock Percentage change in carbon stock/ hectare	KFD/VSS/R&D
<ol style="list-style-type: none"> <li>1. Soil and water conservation measures to improve regeneration of forest.</li> <li>2. Enrichment planting of ecologically suitable species.</li> <li>3. Implement ecosystem conservation practices in private land-holdings near/ within forest areas.</li> <li>4. Conduct long term climate change impact studies in different forest types.</li> </ol>	Long term	Percentage change in total carbon stock Percentage change in carbon stock/ hectare	KFD/VSS/R&D
<b>Strategy 1.3 Enhance resilience to combat climate extremes such as flood, drought, landslides, forest fire, natural calamities etc.</b>			
<ol style="list-style-type: none"> <li>1. Identification and mapping of vulnerable areas.</li> <li>2. Adopt preventive measures to contain the possible impacts of climatic extremes.</li> <li>3. Enhance the water holding capacity of forests by protecting the vegetation in the catchment areas.</li> <li>4. Implement soil stabilization measures in fragile areas.</li> <li>5. Developmental activities to be permitted based on multi-hazard vulnerability analysis.</li> <li>6. Eco-restoration of impacted areas.</li> <li>7. Discourage plantation activities in the slopy terrain</li> <li>8. Preparation of vulnerability maps,</li> <li>9. Organize firefighting squad with KFD staff/local people to ensure their availability in the fire prone areas.</li> <li>10. Prevent entry of visitors/ use of matches/ burning activities near grasslands and sholas.</li> <li>11. In transboundary areas, constitute an interstate departmental co-ordination group for firefighting.</li> <li>12. Impart training to field level forest staff on modern methods of firefighting including GIS mapping and remote sensing techniques.</li> <li>13. Provision for providing risk allowance/ insurance coverage to field level officials/ local people.</li> </ol>	Medium/ Long term	<p>Number of vulnerability maps generated</p> <p>Percentage change in area of forest under different altitude</p> <p>Percentage change in area under different slope types</p> <p>Number of forest fire alerts recorded</p> <p>Number of users of forest fire alert systems</p> <p>Change in forest fire prone areas</p> <p>Trends in biodiversity-inclusive climate change adaptation and mitigation measures formulated/ implemented</p>	<p>Restoration of degraded areas by planting native species and establishing engineering and bio engineering measures with the support of Panchayat and district administration</p> <p>District administration/DMA/LSGs</p>



**Strategy 1.4: Manage human wildlife conflicts and road kills of wild animals in a participatory mode**

	Short term	Number of road kills/ human wildlife conflicts reported	KFD/VSS/ LSGD
1. Habitat improvement for ensuring food and water within forest areas for wildlife			
2. Identify major wildlife corridors not only for bigger mammals, but also of other fauna and restore in a participatory decentralized manner		Amount of compensation paid	

3. Avoid night traffic in forested areas and prevent anthropogenic activities in the corridors
4. Implement effective early warning and deterrence systems under tribals/local people in the wildlife prone areas
5. Awareness on selective cultivation of crops in the fringes of forests to avoid issues of wild animals
6. Study population attributes and carrying capacity of animals in the vulnerable area of wildlife attacks
7. Implement appropriate methods such as trenches, solar fences, multi layer live bio fencing etc. to prevent entering of wild animals in the human settlements in the forest boundaries.
8. Develop food forest in the forest fringes in order to ensure availability of food for wild herbivores.

**Strategies 1.5: Forest plantation management to enhance wood productivity**

	Medium term	Change in growing stock in Forest and TOF	KFD/VSS/ KFDC/ KFRU/ Plantation industries
1. Ensure proper maintenance and scientific management of existing high value forest plantations			
2. Develop sustainable harvesting protocols, and value addition of forest products at source		Change in productivity and yield/ha/year	
3. Improve market and supply chain of wood/wood products		Change in green bamboo culms in RFA	
4. Develop a barcode-based approach for tracing wood and wood products to reduce loss			
5. Implement soil nutrient management measures to improve health of forest soils			

6. Adopt biological methods of pest/weed management in forest plantations
7. The productivity of teak plantations in the state is extremely low. Take up appropriate ecological valuation methods to increase teak productivity
8. Undertake productivity studies in monoculture plantations and impact of monoculture plantations on the edaphic attributes
9. Take up legal and administrative initiatives to set aside the unproductive plantations to natural forests

#### Strategy 1.6: Eco restoration of riverbanks

1. Adopt protective measures both for watersheds in forests and downstream areas.	Medium term	Percentage area of river basins brought under integrated water resources management	KFD/VSS/LSGD/NGOs
2. River bank stabilization measures preferably by bio-engineering methods, bio shields		Percentage change in wetlands under different classes in Forest	
3. Restoration of riparian buffers in river banks in downstream agricultural landscapes.			
4. Enrichment planting of riparian species and other suitable species including screwpines in the riverbanks			
5. Regulate sand mining in the riparian areas and also lean sand mining during the monsoon.			
6. The River management fund at District level to be utilized for restoration of river/ river banks			

**Strategy 1.7: Regulate unscientific mining and quarrying along the fringes of the forests.**

Short term	Number of license issued/ renewed	KFD/ LSGD/ Geology dept./DMC
<ol style="list-style-type: none"> <li>1. Restrict permission to quarries in critical and hazardous zones proposed by the Kerala State Disaster Management</li> <li>2. Need based assessment should be conducted before granting permission for quarrying and as far as possible to Govt agencies</li> <li>3. Strict enforcement of laws to prevent illegal quarries.</li> <li>4. Bring out clear guidelines for green construction and the building code brought out by the Govt shall be followed.</li> <li>5. Report on EIA by the district level expert committees shall be insisted.</li> <li>6. Public hearing shall be conducted before releasing license to the applicants.</li> </ol>		

**Strategy 1.8: Restoration/ conservation of unique ecosystems such as sacred groves, laterite hillocks, cliff vegetation and fresh water swamps, grasslands etc.**

Medium term	Percentage change in area under mangroves	KFD/ LSGD/ Revenue Dept./ KSBB/ KFR/ JNTBGRI
<ol style="list-style-type: none"> <li>1. Detailed inventory of mangrove areas using GIS and RS</li> <li>2. Afforestation and reforestation of mangrove plants in the degraded habitats/new sites</li> <li>3. Acquisition of mangrove areas/ unique ecosystems from private owners by providing compensation</li> <li>4. Formulate policy guidelines for conservation of sacred groves, laterite hillocks and other unique ecosystems of local level through BMCs/LGSS</li> <li>5. Declaration of unique ecosystems in a LSG as OECM/BHS/ LBHS and their conservation with local participation</li> <li>7. Prevent soil excavation from lateritic hills</li> <li>8. Assessment of vegetation and edaphic attributes of shola grass land ecosystems in the mountains</li> <li>9. Enforcement of new policies and rules to prevent degradation of these unique ecosystems.</li> </ol>	<p>Percentage change in area under mangroves</p> <p>Percentage change in district wise mangrove cover (Very dense, moderately dense and Open)</p> <p>Percentage change in forest cover in hill districts</p> <p>Area declared under OECMS</p> <p>Percentage change in wetland areas within recorded forest areas/ green wash</p>	<p>Financial support to private land owners who maintain these unique ecosystems</p> <p>Revision of existing rules to ensure protection</p>

10. Regulate human activities / interventions to conserve mountain ecosystems
11. Prevent constructions and real estate business in the vulnerable areas of the mountains by making appropriate laws.
12. Take stringent measures to conserve grassland/fresh water swamps to ensure the hydrological functions/ecosystem sources/ biological needs of wild animals
13. Measures to eradicate invasive species from the shola grasslands
14. Reforestation with indigenous local species in the degraded sholas

Strategy 1.9: A landscape approach of conservation in the PAs, wildlife sanctuaries, Biosphere reserves/ community reserves and areas where human -wildlife interact constantly

1. Identification and de-reservation of biodiversity rich areas and gene pools in the reserved forest to form new wildlife Sanctuaries and National parks.	Long term	Protected area as percentage of total geographical area	KFD/ LSGD/ NGS/ KSBB/ KFRI/ JNTBGRI
2. Establish new community reserves in mangroves and other unique ecosystems		Percentage change in forest area under various classes.	
3. Prepare management plan for the community reserves, mangroves and unique ecosystems		Trends in biodiversity and ecosystem services valuation studies	
4. Reservation of adjoining areas of sanctuaries and National parks into buffer zones		Trends in number and coverage of studies -TEEB, NPV relating to biodiversity	
5. Enhancement of carrying capacity of the forest through enrichment planting/reforestation of degraded sites			
6. Studies to assess population status of flora and fauna and their effective management			
7. Protection of existing water holes, ponds and lakes within forest area to ensure availability of water to wildlife.			
8. Evaluation of national projects on tiger and elephant to assess the impact of these projects in the conservation of both species.			

### Strategy 1.10: Documentation of Biodiversity in PAs and Outside PAs

	Medium term/Long term	Number of species observed during rapid assessment of biodiversity Change in forest type looking into wise Shanon wiener index for trees, shrubs, herbs Percentage change in species richness	KFD/ KFRI / KSBB/ JNTBGRI/ ZSI/ NGO's/ Universities
1. Species level enumeration of flora/fauna to assess their present status as per IUCN guidelines.			
2. Detailed survey and documentation of threatened species distributed in various forest ecosystems			
3. Population attributes, Phytosociological analysis of threatened species in various forest ecosystems			
4. Study the impact of habitat degradation on the density, abundance, distribution pattern and regeneration of threatened species.			
5. Encourage R&D centres and local institutions of ZSI, BSI to take up detailed survey and study the threatened status and population dynamics of selected endemic species /keystone species			
6. Give incentives/fellowships to taxonomic studies			
7. Take up studies on physical, physiological and reproductive changes on endemic species due to climate change			
8. Enumeration and documentation of keystone species in various forest ecosystems.			
9. Study the impact of climate change on bird migration			
10. Networking on studies related to RET Species			
11. Use of molecular methods in identify population at risk			
12. Identification of biodiversity hotspots for conservation			

### Strategy 1.11: Documentation and conservation of NTFP/medicinal plants

	Medium/Long term	Number of species notified under schedule list Number of species notified under Biological Diversity Act Number of training programs conducted to tribals Number of Forest Rights act implemented Percentage change in NWFP collected Percentage change in area of bamboos under different classes in RFA Trends in proportion of products derived from sustainable sources	KFD/VSS/ EDC/JNTBGRI/ KFR/ KSBB/University Departments/Tribal Co-operative Societies and SC, ST Federation/ Oushadi. Medicinal plant board and Ayush	NTFP working circle in working plans Strengthening tribal co-operative societies/ SC and ST corporation for collection and trade of NTFPs
1. Survey and documentation of current status of NTFPs in various forest ecosystems				
2. Assessment of resource base of major NTFPs of different forest types				
3. Study the impact of habitat degradation on the density and abundance of major NTFPs				
4. Make detailed studies on the demand and supply of major NTFPs and regulate its trade				
5. Train tribals in scientific collection, storage and processing of marketable NTFPs.				
6. Documentation of wild edible plants traditionally consumed and marketed by tribals				
7. Impart training to tribals in the processing and value addition of underutilized wild edible fruits				
8. Sustainable collection and processing of canes and bamboos				
9. Improve the regeneration potential of major NTFPs by 'Assisting Regeneration Programme' envisaged by KFD				
10. Inventory and threat status documentation of medicinal plants in various forest ecosystems				
11. Generate data on resource base and regeneration status of medicinal plants to the collectors				
12. Impart training to the collectors on sustainable harvesting techniques of medicinal plants to the collectors				
13. Scientific evaluation of traditionally known medicinal plants for developing new drugs, as per the ABS principle under Biodiversity Act 2002				
14. Encourage cultivation of medicinal plants in the degraded forests to ensure their availability and reduce pressure from the wild				

15. Strengthening the markets of NTFPs and medicinal plants by reorganising the structure and function of tribal co-operative societies and also implement Forest Right Act in order to give maximum benefits to the tribal community thereby protecting their rights
16. Assessment of resource base, sustainable harvest, processing and value addition of NTFPs and medicinal plants should be a key activity to be discussed in the working plan.
17. Initiate medicinal plant trade from informal sector to formal organised sector.
18. Promote studies to standardise cultivation practices of major medicinal plants, their habitat requirements and marketing
19. Popularise good conservation practices by establishing gene banks of medicinal plants at village level
20. Introduce a licence system for marketing genuine raw drugs to the dealers/ sellers
21. Ensure levy for collecting NWFPs leading to conservation activities by BMCs.
22. Conduct studies on supply chain and value addition of NW-FPs.

#### Strategy 1.12: Conservation of biodiversity rich areas outside protected areas

1. Demarcate the BD rich areas outside PAs and take up effective protection measures and manage as BD hotspot areas.	Short term/ Long term	Percentage change in TOF	KFD/VSS/ KSBB/ LSG/BMC
2. Identify the borders of BD rich areas outside protected areas and designate them as ecologically sensitive zones		Number of community reserves/ BHS/LBHS/ OECMs Important Bird areas declared	
3. Optimise the land use, cultivation of edible crops/animal husbandry to enable buffering between protected areas and agricultural landscapes to reduce wildlife crop raiding			

<p>4. Facilitate the declaration of additional area and number of corridors as BHS/OECM/LBHS to establish connectivity between wider landscapes is restored</p> <p>5. Restrict species movements and dispersal within the framework of changing land uses, climate and habitat loss</p> <p>6. Prepare Red List Index (species used for food, medicine, health and livelihood value; pollinating species) and Species-Habitat index (species that provide essential services) in the BD rich areas outside protected areas (OPA)</p> <p>7. Involve BMCs located around PAs and forest in activities related to BD conservation outside the protected areas</p> <p>8. In case, there is unique BD areas, outside PAs, designate them as BHS through BMCs</p> <p>9. Involve local community NGOs, students etc to document BD in the outside protect areas and build up local experts in BD</p>	<p>Area under green spaces in urban centres</p>
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**Strategy 1.13: Ex-situ conservation of threatened /endemic species/key stone species**

<p>1. Prepare species wise strategy and action plan for ex-situ conservation of threatened/endemic /key stone species.</p> <p>2. Establish a genetic reserve for a target taxon, or a group of target taxa and for each target taxa, the effective population size must be estimated.</p> <p>3. Provide incentives to farmers who take up ex-situ conservation of threatened species</p> <p>4. Establishment of arboretum, botanical gardens, bio- resource parks to conserve threatened, endemic and nearly extinct species outside their original habitat.</p> <p>5. Promote studies on growth attributes, physiology and reproductive behaviour of target taxa conserved ex-situ.</p>	<p>Number of Pachahuruthu/ Biodiversity parks etc established</p> <p>Status of selected indicator species</p> <p>Number of medicinal plants conservation areas (MPCAs) established</p> <p>Medium term</p> <p>KFD/VSS/LSGD/Universities/NGOs/KFRI/KSBB/JNTBGRI</p>
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**Strategy 1.14: Conservation of traditional knowledge associated with biodiversity, patent and benefit sharing**

	Short term / medium term	Forest cover change in Tribal districts	KFD/VSS/LSGD/JNTBGR/KFRI/University Departments/Ayush/NGOs/Pharmaceutical industries/KSBB/BMC's	Communities will be benefited under ABS system and improvement of their livelihood opportunities.
1. Documenting traditional knowledge associated with BD in a standardised format				
2. Evaluate the traditional practices and test their usefulness under existing BD Actand Rules		Number of patents and ABS based on TK derived from folk knowledge		
3. Create awareness among people on traditional systems of medicine and food resources and their importance.		Number of benefits sharing agreements signed		
4. Generate data on food resource from tribal communities.		Percentage change in collection of fuelwood/fodder/ bamboo/ NWFP by tribals		
5. Traditional knowledge related to BDs to be used in the management of bioresources in forest and outside PAs		Dependence of people living in forest fringe areas		
6. Identify the importance of traditional languages and integrate in forest management; and ensure effective participation of tribal communities in the implementation of the NBSAP/LBSAPs.		Percentage of relative abundance of major NTFP		
7. Document innovations and practices of traditional and local communities relevant for the conservation and sustainable use of biodiversity.		Trends in number of cases seeking approval to bio-resources and associated traditional knowledge for commercial utilization		
8. Ensure sustained availability of raw materials for indigenous food and medicines by tribals/forest dwellers		Number of traditional herbs formulations documented from codified systems of Indian medicine		
9. Create awareness among the people about the provisions of convention on Biological Diversity for protecting IPR and the need for documenting traditional knowledge.				
10. Take up actions for a legislation for preservation and promotion of TK				
11. Provide benefit sharing mechanism at different levels right from the disclosure of safeguard knowledge to product development technology transfer and marketing through SBB/BMC				
12. Standardize all the raw material trade and enact legislation to prevent bio piracy – transfer of live / dry plants/ animals/ microbes to unknown outside agencies outside the state/country				

13. Appoint a committee on IPR with experts and state holders to review the existing policy and to protect the interest of Kerala.

Number of folk uses of medicinal plants documented from PBRs prepared by BMCs

Strategy 1.15 Documentation and eradication of invasive/alien species within and outside forest

	Medium term/Long term	Percentage change in prevention and control of invasive alien species	KFD/VSS/LSGD/KFRI/Universities/JNTBGRI/KSBB
1. Detailed studies on origin, distribution, ecology and risk in term of impact on BD and control measures to be taken up			
2. Generate state wide invasive species database and a monitoring system with the support of scientific institution/LSGs			
3. Impart training to MGNREGS workers for detection and management of invasive weeds and animals in the fringe areas of forest			
4. Impact of invasive species on regeneration of native species within and outside forest area.			
5. Impact of invasive/alien species on native biodiversity/ food source of herbivores in forests			
6. Enforcement of quarantine rules and regulations to prevent introduction and sale of invasive or alien species in the dry/live form.			
7. Develop biocontrol measures of invasive alien species in the forest ecosystem			
8. Develop techniques for value addition of useful invasive species, Encourage R&D on alternative uses/ value addition of IAS			

Strategy 1.16: Development of urban forest and reduce urban heat island effect

	Medium term	Number of social forestry schemes implemented	KFD/VSS/LSG/KSBB/NGO's/BMC
1. Preparation of green city project to transform the green space available in the metropolitan cities by planting appropriate tree species			
2. Survey of open urban area for identifying space available for planting.			
3. Management plan with irrigation during summer and control of pest and diseases should be prepared for urban forest projects and implement through LSGs/BMCs / Housing society and students			
4. Health of trees, their pruning required etc. to be monitored at local level			
5. Articulate urban space by establishing bio- resource parks, botanical gardens, butterfly gardens, arboretum etc.			
6. Practice living filter concept for utilizing urban affluent through a stretch of trees planted in the polluted sites.			
7. Abating noise and dust pollution by planting multiple layers of trees and shrubs along the roadside, wherever possible			
8. Ensure local community participation under the auspices of decentralized governance, for promotion and conservation of private green spaces, urban and peri-urban areas.			
9. Development of city biodiversity index for preparing green city management plan.			

Strategy 1.17: Prevent depletion and degradation of wild biodiversity resources

	Medium term/ Long term	Number of developmental projects implemented in forest areas	KFD/LSGD/Revenue department
1. Avoid mega developmental projects in biodiversity rich areas of forests			
2. Ensure that the existing forests shall not be de-notified for any activity			
3. Follow enforcement of law and associated rules to avoid encroachment of forest by fringe area residents.			
4. Restrict the allotment of title deeds to the unauthorized occupants of forest land.			
5. Ban further felling of trees on the Pattaya land released to the occupants.			
6. No permission shall be given to quarries in critical/land slide prone areas as identified by Kerala state disaster management authority			
7. EIA should be carried out for all mining activities with special emphasis on biodiversity loss.			
8. Ensure one third (1/3) of the land area of the state is kept under forests (excluding plantations) as envisaged in the National Forest policy 1988			
9. Generally loss due to forest fire is estimated merely on the loss of wood. A more realistic evaluation as the loss of biodiversity/ ecosystem services due to forest fire to be included.			
10. EIA/BIA should be made compulsory for any developmental projects in and around forest areas			
11. Prevent excessive use of chemical fertilizers /pesticides in the plantations like cardamom/tea/coffee etc adjacent to forest areas			

Strategy 1.18: Conservation of below ground biodiversity including microbes				
	Long term	Availability of data base for microbial diversity	Research institutions/ Universities and colleges KFD/VSS/ NGOs	Microbial repositories, reference collections and gene banks to be established.
1. Document taxonomic database from sources like reports, thesis, journals and miscellaneous publications from various research organizations and universities of Kerala on below ground biodiversity including microbes				
2. Train more young scientists on taxonomy of fungi/ bacteria/ virus and also other soil biota. Also include in detail the microbial taxonomy in the curriculum and at university level.		Number of specimens deposited in national repositories		
3. Strengthening molecular taxonomy along with classical taxonomy of microbes				
4. Encourage taxonomic studies on microbes and lesser-known soil biodata.				
5. Explore the use of microbes in sewage/effluent treatment, medicine, biotechnology and industries.				
6. Networking of researchers / Institutes undertaking research on microbes				

Strategy 1.19: Strengthening implementation of policy, legislative and administrative measures for biodiversity conservation and management			
	Medium term/ Long term	Number of cases registered under the Wildlife Protection Act, 1972	KFD/ KSBB/ LSGD/ Line departments
1. Activate the present forest tribunals and establish more if necessary.			
2. Implementation of Forest Rights Act 2006 in its full spirit with emphasis on community rights			
3. Conduct detailed EIA and more transparent and sensitised public hearing for development projects in forest/biodiversity rich areas		Number of cases registered under Biological Diversity Act	
4. Establish legal literacy missions for biodiversity conservation		Trends in number of Joint Forest Management Committees (JFMCs) constituted/operationalized	
5. Translate documents into the local language			
6. Create Lawyer's Forum for environmental awareness and popularise the existing remedies available at local level			

7. Explore role of panchayats / LGSs in the management of forests
8. Appoint local tribal/forest dwellers in forestry sector
9. Organize multi-level trainers' training programs to provide sufficient resource persons for imparting training to different section of the society on biodiversity conservation.
10. Create a corpus fund for biodiversity conservation at the level of SBB/BMC

Trends in financial resources made available for implementing State Biodiversity Targets

#### Strategy 1.20: Adopt agroforestry to achieve food security and for accelerating restoration of local biodiversity

	Medium terms	KFD/LSGD/ and Agriculture department
1. Survey and documentation of trees and crop diversity of home gardens in different agro climatic zones	Change in tree cover as percentage of total geographical area	Percentage change of forest cover inside and outside recorded forest area/green wash area
2. Develop agroforestry models for seasonal food and biodiversity conservation.		
3. Ensure planting of indigenous tree species outside the forest (TOF) and ensure conservation.		
4. Plan agroforestry on sloping agricultural land, stabilizing agricultural production and generate additional income to improve rural people's livelihood.		
5. Build windbreak forest belts on plateaus and along the eastern and western coastlines, ensuring safe agricultural production.		
6. Develop rural residential areas and urban cities with agro-forest, gardens and orchards, to increase food availability and income generation.		
7. Develop various agroforestry models suitable for improving socio-economic condition and ecological characteristics of each region.		
8. Evaluate planting of bamboos under agroforestry and also in open space / public spaces		

9. Implement integrated pest control methods in agroforestry ecosystem
10. Incentivizing retention of large trees / heritage trees.
11. Impart training on decentralized nursery practices at the local body level through BMC for RET plants
12. Amend, supplement and improve relevant rules and regulations, providing a stronger legal foundation for agroforestry and develop standards and certification
13. Development of an institutional mechanism for trees outside forest through BMCs
14. Improve below ground biodiversity of the soil in Agroforestry ecosystem and maintain the quality of soil

Strategy 1.21: Prevention of zoonotic diseases/ disease spread to humans/ domestic animals through wild animals

- |   |   |   |
|---|---|---|
| <ol style="list-style-type: none"> <li>1. Conserve habitats and biodiversity of wild animals so as to limit interactions between wild animals and human habitats</li> <li>2. Awareness creation to avoid consumption of wild meat/ fallen fruits eaten by bats and other animals</li> <li>3. Periodic health check-up at local level for rural people, including tribal colonies</li> </ol> | <p>Number of zoonotic diseases reported</p> | <p>Health Department/<br/>Veterinary department</p> |
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## 2. COASTAL AND INLAND BIODIVERSITY

### Strategy 2.1: Conservation of mangrove ecosystems

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Assessing current distributional pattern and spread area (mapping) of mangroves</li> <li>2. Assessing diversity of mangroves and associates and its extent</li> <li>3. Assess natural and anthropogenic factors causing damage to mangrove ecosystem</li> <li>4. Publication of printed / short film on mangroves, success stories.</li> </ol>	Short term	Percentage change in area under mangroves	TBGRI, KFRI, Universities and Academic institutions, KFD	Documents on previous studies- India State of Forest Report
<ol style="list-style-type: none"> <li>1. Assessment of ecosystem services of mangroves and mangrove associates for the benefit of human beings and other biota</li> <li>2. Economic valuation of products and by products from mangroves</li> <li>3. Conducting hands on training for mangrove bio-resource utilization</li> <li>4. Encourage ecotourism in mangrove areas/ mangrove circuits</li> </ol>	Medium and long term	Number of studies/undertaken completed	TBGRI, KFRI, KSBB, KFD, NGO's	Documents on previous studies



	Long term	Percentage change in area under mangroves	Kerala Forest Department, Universities, ICAR Institutions, TB-GRI, KFRI, NGOs, KSBB
<ol style="list-style-type: none"> <li>Determine species that need special attention for conservation</li> <li>Determine the possible areas to which mangroves can be spread</li> <li>Promote Mangroves in suitable areas for augmenting fish production</li> <li>Conservation of mangroves in identified areas in lieu of climate change</li> <li>Actions for coastal protection activities in identified areas by bio-engineering methods (bio-shield)</li> <li>Community based restoration programmes of mangroves</li> </ol>	Long term		
<ol style="list-style-type: none"> <li>Take up studies on management methods, the ecology of mangroves, flora and fauna, their microbiology and the biochemistry of organic matter and sediments.</li> <li>Take up studies on carbon sequestration potential of mangroves</li> <li>Encourage research for development of new product (timber, honey, perfumes, bio-active substances. and extraction of bioactive compounds from mangroves</li> </ol>	Long term	Allocation of budget resources for R and D	Universities, TB-GRI, KFRI, ICAR Institutions
<ol style="list-style-type: none"> <li>Notify areas where damage is extreme, as community mangrove protected areas</li> <li>Mainstream the sustainable management of mangroves into the forestry sector</li> </ol>	Long term	Number of locations notified	KFD, KSBB

(Short term : 0-1 yr; medium term : 0-5 yrs; long term : 0-10 yrs)

## Suggestions

Mangroves are highly productive areas. So far India lost 40 per cent or more mangrove areas and is true for Kerala also. Humans have put great pressure on mangroves for timber, fuel wood, fodder, honey and other non-wood forest products (NWFPs). Private land owners have destroyed the mangroves in many places. Management of mangrove ecosystem is highly essential in order to ensure the conservation of mangroves for environmental benefits, together with a sustainable supply of various forest and other products to meet the day-to-day requirements of local people. Management can also open new avenues for self-employment such as ecotourism, fishing, beekeeping and cottage industries based on mangrove forest products, helping to improve the socio-economic conditions of the local communities. Threats identified are : Agriculture, Prawn Seed Collection, Freshwater Flow Reduction, Calamities, Tourism Development Encroachment, Developmental Activities, Coral Reef Degradation, Over Exploitation, Tree Felling, Pollution.

The following suggestions will help to conserve mangroves –

- People's involvement in mangrove management on public lands and related benefits;
- Programmes to raise people's awareness of the importance of mangroves, e.g. through films, exhibitions, newspapers, magazines, posters, stickers, brochures, banners, seminars, nature camps, birdwatching, study tours in the mangrove forests, establishment of mangrove parks in the mangrove areas close to towns, and the celebration of Mangrove Conservation Day, with essay competitions, debates and drawing competitions;
- Incentives for sustainable management of mangroves on private and village community land;

### Strategy 2.2 : Eco restoration of riparian vegetation

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Assessing current distributional pattern and spread area (mapping)</li> <li>2. Locally specific data on species available and its extent</li> <li>3. Assess damages due to natural calamities and human factors</li> <li>4. Awareness creation through pamphlets/ short videos etc.</li> </ol>	Short term	Maps generated	TBGRI, Universities, KFRI	
<ol style="list-style-type: none"> <li>5. Assess ecosystem services provided by riparian ecosystems</li> <li>6. Economic valuation of products and by products from river bank plants</li> <li>7. Management of riparian vegetation for bund strengthening, products development</li> </ol>	Medium and Long term		TBGRI, KFRI, Universities, Government agencies, NGOs	
<ol style="list-style-type: none"> <li>8. List out species specially to be considered for conservation of river bank protection and restocking of degraded areas</li> <li>9. Identify selected areas along river bank and establish parks through community-based restoration programmes</li> </ol>	Long term	Database of riparian vegetation	Forest Department, Universities, ICAR Institutions, TBGRI, KFRI, NGOs	
<p><b>Policies</b>            Notify areas where damage is extreme as BHS/ LBHS/ Community conserved areas            Make a policy to utilize funds under river management fund for eco restoration of riparian ecosystem through BMCs</p>	Short term	Number of locations notified; bank protected No: of projects funded under River management fund	Government agencies	

(Short term: 0-1 yr; medium term: 0-5 yrs.; long term: 0-10 yrs.)

River bank protection is prime importance for water storage, free flow and avoiding pollution threats to a major extent. The proven methodology is by using natural vegetation. It also yields revenue from plants like bamboo, Pandanus, medicinal plants etc. etc. In some places other methods such as rip rap hard armouring and / or geotextile bags. Sometimes combination of these is also adopted.

### Strategy 2.3: Protection and sustenance of coastal habitat for biodiversity conservation

Action Plan	Time frame Short, medium and long term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Generation of baseline data on coastal habitat and morphology</li> <li>2. Documentation of sandy beach with respect to its width</li> <li>3. Documentation of coastal landforms such as cliffs, headlands, tidal inlet (azhi, pozhi, arappa), sand dunes and status with respect to land use</li> <li>4. Documentation of endemic vegetation on sandy beaches, sand dunes, cliffs and headlands</li> <li>5. Documentation of endemic vegetation on the banks of rivulets forming arappa (small tidal inlets)</li> <li>6. Documentation of changes in biodiversity and landform with the conversion of seasonal tidal inlets (pozhi) into permanently open tidal inlets through construction of fishing harbours and training walls</li> <li>7. Documentation of mudbank occurrence and its deviations, migration and impacts</li> <li>8. Documentation impacts of hard constructions</li> <li>9. Documentation of impacts of bio-engineering methods adopted in beaches</li> <li>10. Document changes in fishing methods, increase in destructive fishing methods, changes in estuarine biodiversity</li> </ol>	Short term	Documented data as reports and research papers on coastal habitat and morphology List (as reports) of coastal areas suited for ecosystem based coastal management	Universities, KFRI, CWRDM, Fisheries Department, Irrigation Dept, Harbour Engineering Dept, KSCADC, NCESS, CM-FRI	Provides baseline data for protection of coastal habitats, coastal biodiversity and ecosystems

11. Identification and development of vegetation suited for low, medium and high energy sandy coast; cliff and cliff slope; rivulets and arappa	Medium term	No of projects undertaken	KFRI, Universities Fisheries Dept, DOECC, Irrigation Dept, KSCADC	Helps to plan bio-shield for coastal protection and biodiversity enrichment, Provides coastal protection along with biodiversity enrichment
12. Planting and development of sea grass bed and sand dune vegetation in identified coastal stretches				
13. Planting of endemic species along the banks of rivulets and arappas after desiltation and cleaning				
14. Revive mud banks in traditional mud bank areas from where mud banks disappeared				
15. Notification of identified cliffs as Areas of Outstanding Natural Beauty (AONB)/ BHS	Medium term	Number of notified AONBs	DOECC, KFRI, KSBB	Helps to protect unique cliffs ecosystem and its biodiversity
16. Promotion of participatory approach to protect and sustain turtle breeding/nesting grounds	Medium term	Number of turtle breeding/nesting grounds conserved	KSBB, Fisheries Dept., Universities, KFRI, Forest Dept	
17. Proper Settlement and resettlement plans for fishing villages	Long term	Number of fishing villages for which settlement plans are prepared	Fisheries Dept., Town Planning Dept, LSGD institutions, KSCADC, Disaster Management Dept.	Helps to sustain beach, intertidal ecosystem
18. Development of tourism as an alternate employment and source of income for traditional communities;				

19. Consider rehabilitation of fishermen community outside the “no development zone area” with adequate facilities.	Long term	Assistance provided to fishermen	LSGD, LSG Institutions, Town Planning Dept., Fisheries Dept., DEandCC	Helps sustain coastal habitats and ecosystems
20. Development of eco-friendly methods of waste management	Long term	Waste treatment plants established in coastal areas	Fisheries Department, Pollution Control Board	Monitoring
21. Strict Implementation of rules and regulations such as Wetland Act, CRZ notification, Kerala Biodiversity Rules, Kerala Marine Fishery Act, Kerala Inland Fisheries and Aquaculture Act, Kerala Fish Seed Act in the coastal zone to prevent reclamation of coastal wetlands.	Long term	No: of policy guidelines issued	Fisheries Dept., KSBB, DOECC, LSGD institutions	
22. Implement coastal zone-specific land use rules and building rules in tune with CRZ and other relevant Acts.			Central Water Commission, Irrigation Dept., Harbour Engineering Dept., KSCADC, LSGD	
23. Development and adaptation of minimum beach width and minimum beach elevation for coastal constructions				
24. Development of guidelines for developing and running homestay facilities in coastal zone by traditional coastal communities				
25. Bring out guidelines on mining of heavy minerals like black sand (aluminite) and white sand (silicates)				

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Strategy 2.4: Conservation of freshwater biodiversity**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Assessment of current distributional pattern and spread area (mapping), species diversity and environmental factors affecting aquatic bioresources</li> <li>2. Documentation of fresh water resources commercially utilized and prevent over exploitation of fish resources</li> </ol>	Short term	Inclusion of statistics of fish resources collected from wild in fisheries statistics	Universities, KSBB, Fisheries dept.	
<ol style="list-style-type: none"> <li>3. Valuing services of freshwater organisms, products and by products from aquatic organisms for the benefit of human beings and other biota and environment</li> <li>4. Utilization of fish resources for various services like aquaculture, ornamental fish trade, removal of organic wastes, for mosquito larval control to ensure health of human being</li> </ol>	Medium and Long term	Products and services from aquatic organisms	Fisheries dept, NGO's	
<ol style="list-style-type: none"> <li>5. Assess the carrying capacity of fishing boats and also ensure registration for mechanized boats.</li> <li>6. Eliminating invasive alien fishes like African muzhi (<i>Clarias gariepinus</i>) and tilapia (<i>Oreochromis mossambicus</i>) from reservoirs</li> <li>7. Enforce fishing holidays (catch ban) during breeding season</li> <li>8. Fixation of minimum size for priority species for capture from wild</li> <li>9. Ban on brood fish capture during monsoon seasons</li> </ol>	Long term	Policy guidelines developed No: of carrying capacity studies conducted	Universities, ICAR Institutions, Fisheries Dept.	

10. Find out species which need special attention for conservation	Long term	Areas notified	KFD, Universities, ICAR Institutions, KFRI, Fisheries Dept., KSBB	Sustenance of aquatic flora and fauna
11. Declaration of protected areas as conservation zones				
12. Research on breeding biology of selected species for conservation				
13. Study of management methods, the ecology of aquatic flora and fauna, their microbiology and the biochemistry of organic matter and sediments.	Long term	Allocation of budget re-sources for R and D	Universities, TB-GRI, KFRI, ICAR Institutions	
14. Research components for new product development (candidate species for aquaculture, ornamental fish trade etc.)				

(Short term : 0-1 yr; medium term : 0-5 yrs; long term : 0-10 yrs)

**Note :**

There are about 190 species of fishes (including subterranean species), 17 species of freshwater prawns, 17 species of freshwater shrimps, 41 species of crabs have been reported from freshwater regions of Kerala. These species support good capture fisheries, many species have aquaculture potentials and large number of them have ornamental value. Species possessing aquaculture potential include : *Batasio travancoria*, *Clarias dussumieri*, *Horabagrus nigrigollaris*, *Hypselobarbus jerdoni*, *Hypselobarbus periyarensis*, *Hypselobarbus kolus*, *Hypselobarbus kurali*, *Hypselobarbus thomassi*, *Neolissochilus wynaadensis*, *Ompok malabaricus*, *Osteochilichthys longidorsalis*, *Osteochilichthys nashi*, *Osteochilichthys thomassi*, *Pterocryptis wynaadensis*, *Tor khudree*, *Tor malabaricus*, *Tor remadeviae*, *Epinephelus malabaricus*, *Heteropneustes fossilis*, *Labeo dussumieri*, *Eetroplus suratensis*, *Channa diplogramma*, *Channa pseudomarulius*, *Channa striata*, *Anabas testudineus*. Many of the above species are currently utilized for aquaculture.

The species of conservation value include: Fishes: *Balitora jalpalli*, *Batasio travancoria*, *Garra menoni*, *Garra periyarensis*, *Ghatsa Montana*, *Horabagrus nigrigollaris*, *Hypselobarbus periyarensis*, *Hypselobarbus thomassi*, *Lepidopygopsis typus*, *Neolissochilus wynaadensis*, *Osteochilichthys longidorsalis*, *Osteochilichthys thomassi*, *Sahyadria chalakkudiensis*, *Sahyadria denisonii*, *Tor remadeviae*,



*Travancoria elongate*, *Travancoria jonesi*; Freshwater prawns: *Palaemon concinnus*, *Macrobrachium elatum*, *Macrobrachium indicum*, *Macrobrachium aemulum*, *Macrobrachium idea*, *Macrobrachium josephii*, *Macrobrachium velense*, *Macrobrachium madhusoodanani*;

Freshwater shrimps: *Caridina jalihali*, *Caridina gracilirostris*, *Caridina vithuraensis*, *Caridina carli*, *Eurindicus bhugarbha*; Mollusca :

*Lamellidens branchialis*, *Pila globosa*.

Invasive alien fishes such as African muzhi (*Clarias gariepinus*) and tilapia (*Oreochromis mossambicus*) have been reported from reservoirs. These species cause great threat to natural populations in reservoirs and also downstream and is sufficient enough to upset the ecosystem balance. Therefore, urgent measures are necessary to mitigate the threat of invasive species.

#### Strategy 2.5: Marine biodiversity, conservation and sustainable utilization

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Consolidation of qualitative and quantitative data base of marine living resources for framing management plans	Short term	Database generated	CMFRI, Universities, Fisheries Depts.	
2. Permit multiday trawling beyond territorial waters	Long term			
3. Impose minimum legal mesh size for fishing and strict enforcement of by-catch reduction methods				
4. Appropriate regulation of stake nets in backwaters				
5. Adopt eco-friendly aquaculture models in coastal waters with the involvement of fisherfolk				

6. Trawl ban effect should be assessed regularly and renewed on scientific basis			
7. Sea ranching programmes are to be adopted in cases of depleted stocks			
8. Report of vannamei stock (though minimum numbers at present) has to be taken as priority			
9. Marine ornamentals are to be carefully domesticated and encourage seed production and encourage repopulation and also make way for income generation for fisherfolk			
10. Marine protected areas are to be notified based on scientific assessment	Long term	No: of areas Notified	
11. Deviation of mud banks are to be seriously studied	Medium term		
12. Empowerment by skill development of fish and fishery products	Medium term		NIFPHATT, ICAR, Universities
13. Encourage use of low carbon and eco-friendly technologies in marine ecosystems	Long term		Fisheries Dept., Tourism Dept.
14. Formulate guidelines for fishing beyond 12 nautical miles and also for enabling fishing in areas beyond national jurisdiction (ABNJ)	Long term		
15. Evolve policies for floor price to fishermen for their catch and establish adequate storage facilities. Policy should also bring in how the supply chain works	Long term		

- 16. Developing overall mariculture policy covering all aspects
- 17. Developing tourism policy for marine tourism
- 18. Evolve as system for a separate training and certification of fishermen who goes into the sea for fishing in safe navigation, responsible fishing, log keeping etc.

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

- Many species of fishes, prawns, shrimps and other small sized organisms have great potential for utilization as new candidate species for aquaculture and ornamental fishes
- Breeding biology of many species are yet to be studied and methods developed

**Strategy 2.6 : Sustainable utilization of Aquatic Bioresources/ fishes**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Assessing the potential for utilization of suitable species for aquaculture, ornamental fish culture, live feed culture etc.	Long term		Universities, ICAR institutes, Fisheries Department	
2. Assess the population structure of the species for capture				
3. Assess the ecosystem services provided by marine/aquatic ecosystem	Medium and long term		KFRI, Universities, KSBB	Documents on previous studies
4. Actions for conserving vulnerable species from over exploitation	Long term	Species conserved	Forest Department, Univer- sities, ICAR Institutions, Fisheries Dept.	New studies

<p>5. Utilize the TK and other skills of marine fishers for Biodiversity conservation, climate change, adaptation and also for disaster management activities</p>	<p>Universities, ICAR Institutions, KSBB</p>	<p>Long term</p>	<p>Universities, ICAR Institutions, KSGRI, KFRI, R and D</p>
<p>6. Domestication and breeding at captivity of selected species</p>	<p>Universities, TBGRI, KFRI, ICAR Institutions</p>	<p>Long term</p>	<p>R and D</p>
<p>7. Repopulating the water bodies with seeds from where the species has been collected</p>			
<p>8. Empower the women workforce in the fish processing units</p>			

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Suggestions:**

Species of ornamental value include : *Macrobrachium latimanus*, *Macrobrachium indicum*, *Macrobrachium gurudeve*, *Macrobrachium ornatus*, *Macrobrachium canarae*, *Macrobrachium sulcatum*, *Macrobrachium equidens*, *Caridina vithuraensis*, *Caridina babaulti*, *Caridina jalihali*, *Caridina pseudogracilirostris*, *Caridina gracilirostris*, *Caridina gurneyi*, *Sahyadria denisonii*, *Dawkinsia filamentosus*, *Dawkinsia assimilis*, *Halduria fasciatus*, *Carinotetraodon travancoricus*, *Barilius bakeri*, *Schistura denisonii*, *Mesonoemacheilus traingularis*, *Mesonoemacheilus guentheri*, *Etropus suratensis*, *Horabagrus brachysoma*, *Barilius canaresis*, *Mystus malabaricus*, *Botia striata*, *Puntius sahyadrensis*, *Hyphessobrycon jerdoni*, *Puntius tambraparnai*, *Sicyopterus griseus*, *Pethis setnai*. Algae and Copepods can be utilized for live feed culture.

Fishes of aquacultural importance: *Batasio travancoria*, *Clarias dussumieri*, *Horabagrus nigricoloris*, *Hyphessobrycon jerdoni*, *Hyphessobrycon periyarensis*, *Hyphessobrycon kolus*, *Hyphessobrycon kurali*, *Hyphessobrycon thomasi*, *Neolissochilus wynaadensis*, *Ompok malabaricus*, *Osteochilichthys longidorsalis*, *Osteochilichthys thomasi*, *Pterocryptis wynaadensis*, *Tor khudree*, *Tor malabaricus*, *Tor remadevii*

### Strategy 2.7: Conservation of wetland for water security and food

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Assessing status of wetlands of Kerala (mapping)</li> <li>2. Assessing the pattern of current use of wetlands of Kerala</li> <li>3. Assessing the run off and percolation pattern of water in different terrain of Kerala</li> <li>4. Assessing the duration of water availability in different water bodies</li> <li>5. Generation of data base for capture fisheries</li> <li>6. New candidate species for aquaculture, ornamental fish culture</li> </ol>	Short term	Percentage change in wetlands	Fisheries department, Universities, CWRDM	
<ol style="list-style-type: none"> <li>7. Periodic checking of water quality of water bodies</li> </ol>	Short and medium term	Percentage change in water quality	Universities, CWRDM, Pollution Control Board, NGO's	
<ol style="list-style-type: none"> <li>8. Promote schemes for conversion the water hyacinth to value added products</li> <li>9. Implement programmes for controlling salt water incursion sp.</li> <li>10. Prevention of reclamation of wetlands and protection through planting of suitable plants and to plan programmes for income generation (e.g., Pandanus and production of various curios items for tourism and regular domestic purposes)</li> <li>11. Strict implementation of laws on sand mining and its monitoring</li> <li>12. Take preventive measures against industrial pollution in water bodies</li> </ol>	Medium and Long term		Universities, CWRDM, Government agencies, NGOs,	

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

Most of the water bodies of the state are under great threat of deterioration. Ground water recharge is getting reduced and may result in water shortage and this can adversely affect biodiversity. Subterranean system will be most affected. Most of the river systems are polluted. This will result in the damage to flora and fauna and this in turn will affect the health of human beings. From freshwater ecosystems about 196 fishes, 20 freshwater prawns, 17 shrimps, a large number of mollusks (excluding other organisms) have been reported from Kerala waters. Around 13-16 species are over exploited and are facing serious threat of decline. The ecology for breeding and domestication of majority of species is not known. Many species are important either for aquaculture and ornamental purposes. From the data, a few species are to be included under prioritized species: *Macrobrachium josephi*, *Macrobrachium elatum*, *Macrobrachium veliense*, *Macrobrachium ornatus*, *Macrobrachium idae*, *Leptocarpus kempfi*, *Caridina jalahali*, *Caridina gracilirostre*, *Lamallidens branchialis*, *Tor ramadavii*, *Aenigmachanna gollum*, *Kryptoglanis shajii*, *Horaglanis krishnai*, *Horaglanis alikunhi*, *Horaglanis abdulkamai*, *Rakthamichthys digressus*, *Rakthamichthys indicus*, *Rakthamichthys roseni*. Critically endangered fishes include: *Garra arunachalami*, *Hemibagrus punctatus*, *Hypselobarbus thomasi*, *Mesonoemachilus herrei*, *Neolissochilus wynaadensis*, *Pethia pookoensis*, *Tor ramadevi*, *Clarias dayi*. Critically endangered shell fishes include: *Macrobrachium josephi*, *Macrobrachium ornatus*, *Macrobrachium idae*, *Macrobrachium elatum*, *Macrobrachium veliense*, *Caridina jalahali*, *Caridina gracilirostre*, *Leptocarpus kempfi*, *Lamallidens branchialis*. It is reported that 31 and 14 species of fishes are Endangered and Vulnerable.

#### Strategy 2.8: Conservation of aquatic subterranean biodiversity

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Assessing current distributional pattern of subterranean fauna (mapping)	Medium term	Extent of subterranean fauna of Kerala	Universities, KFRI, NGOs	
2. Assessing total species available and its extent				

3. Valuing services of subterranean fauna for the water quality maintenance in this peculiar environment	Medium and Long term	KFRI, Universities, Government agencies, NGOs
4. Assess species components of subterranean environment and dietary requirements	Medium and long term	Universities, Government Agencies, NGOs
5. Assess losses caused by natural calamities on subterranean aquatic organisms	Long term	Universities, ICAR Institutions, Government Agencies, NGOs
6. Determine the extent and periodicity of damages		
7. Assess groundwater reduction and consequent changes in subterranean habitat		
8. Evolve special programs for conservation of Subterranean organisms	Long term	Forest Department, Universities, ICAR Institutions, KFRI, NGOs
9. Study of adaptations of subterranean fauna at belowground environment	Long term	Universities, KFRI, ICAR Institutions
10. Computer assisted species localization		

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Note:** Subterranean environments are peculiar because of continuous darkness, complete isolation, practically very low variability in abiotic conditions such as water chemistry, dissolved gases, bare minimum food production and very poor predator threat. This environment is significantly energy-limited. Owing to these conditions, the fauna is highly adapted both morphologically, ecologically, physiologically, behaviourably and genetically. Kathrin Hüssop (2012) has given a meaningful illustration for factors concerning adaptation to food scarcity in caves (Encyclopedia in Caves, 2nd edition) is reproduced below (References: Barnes, R. S. K. and K. H. Mann, (Eds.) 1980. Fundamentals of Aquatic Ecosystem. Blackwell Scientific Publications, Oxford. Pp 229; Bock, W. J., 1988. The nature of explanations in morphologie. Amer. Zool., 28: 205-215; Jayachandran, K. V., 2001.

**Strategy 2.9: Fish processing and Products**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Develop marketing strategies for fish products</li> <li>2. Ensure hygienic production of fish products</li> <li>3. Action required to preserve the raw fish hygienically and supply without delay for which huge fish preservation facilities like cold storages are to be set up at each landing centres</li> <li>Awareness programmes on nutritive value of fish products</li> <li>4. Make available well-preserved fish for processing</li> <li>5. Set up outlets for rural people</li> <li>6. Periodic quality check and food safety preparation assurance mechanism as per the food safety laws</li> <li>7. Proper trainings for rural people for product preparation</li> <li>8. New technologies developed for Hygienic fish drying</li> <li>9. Supply chains are to be conceptualized in such a way as to get the maximum benefits to the local persons</li> <li>10. Steps to be taken for procurement of fish and supply for product enterprises</li> <li>11. Improve the package of products in an attractive manner</li> </ol>	Short term	Number of Products in the market	Fisheries Dept., Universities, ICAR Institutes, Kudumbasree	



12. Generate more job opportunities for fisherfolk and income generation	Long term	Number of new start-ups augmenting income for rural people	Fisheries Dept., NGOs
13. Fish waste are to be utilized for wealth from waste programme	Long term	Number of new start-ups and augmenting income for rural people	Universities, ICAR Institutions, Government Agencies, NGOs
14. Establish scientifically nutritive value of each product	Long term	New product development	Universities, ICAR Institutions
15. New products to be developed by incorporating traditional knowledge			
16. Publication of printed / short film on processing and product development	Medium term	Publication of documents	Universities, ICAR Institutions

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Note:**

Fish is a highly perishable commodity. No assurance whether fish is available on a particular day and at the same time whether the fish captured are sold out at reasonably good price. Hence the fisher folk are facing serious difficulties and often their lives remain miserable. Therefore, fixing floor price for fish and awarding money at the landing centre itself will be a welcome initiative. Value added products development is an adoptable method of fish utilization

**Fish processing and products:** Chilled fish, frozen fish fillets,

**Speciality products:** stretched shrimp (Nobashi), Barbecue, Sushi (Cooked butterfly shrimp), skewed shrimp, shrimp head-on (centre peeled), shrimp head-on cooked (centre peeled)

**Battered and breaded fish products:** (Portioning/ forming, predusting, battering, breading, pre-frying, freezing) – fish finger or fish portion, fish fillets, shrimp products, squid products, clam products, fish cutlets, fish balls, crab claw balls, minced based products, ready to serve fish products in reportable pouch, extruded products, intermediate moisture products (IMF), seaweed products/ seaweed incorporated products, fish caviar substitutes

**Other products:** pickled products, fish soup powder, fish flakes and wafers, fish paste, fish noodles.

**Fish drying:** sun drying, electric drying

**Strategy 2.10: Nutraceuticals, bioactive compounds and microbial products**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Document the present extraction of nutraceuticals, bioactive compounds and microbial products from aquatic resources</li> <li>2. Assessing efficacy of the products for commercial production</li> <li>3. Assessing market possibilities and supply chain</li> <li>4. Assess negative impacts/ if any.</li> </ol>	Short term	No: of nutraceutical products developed	NCAAH, Universities, CSIR NIO, ICAR CMFRI, ICAR CIFT, CSIR NIIST	
<ol style="list-style-type: none"> <li>5. Develop sustainable mode of extraction of biota for commercial utilization.</li> </ol>	Long term		NCAAH, Universities, CSIR NIO, ICAR CMFRI, ICAR CIFT, CSIR NIIST	
<ol style="list-style-type: none"> <li>6. R and D to be strengthened for marine product development.</li> </ol>	Long term	Budgetary resources for RandD	NCAAH, Universities, CSIR NIO, ICAR CMFRI, ICAR CIFT, CSIR NIIST	

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

### Nutraceuticals developed by ICAR-CMFRI

- 1) Cadalmin™ Green Mussel extract (Cadalmin™ GMe) to combat joint pain and **rheumatoid arthritis**
- 2) Cadalmin™ Green Algal extract (Cadalmin™ GAe) to combat **rheumatic arthritic pains**
- 3) Cadalmin™ Antidiabetic extract (Cadalmin™ ADe) for use against Type II diabetes
- 4) Cadalmin™ Antihypercholesterolemic extract (Cadalmin™ ACe) for dyslipidemia
- 5) Cadalmin™ Antihypothyroidism extract (Cadalmin™ ATe) to combat hypothyroid disorders
- 6) Cadalmin™ Antihypertensive extract (Cadalmin™ AHe) for use against hypertension
- 7) Cadalmin™ Antiosteoporotic extract (Cadalmin™ AOe) to treat osteoporosis
- 8) Cadalmin™ Immunoboost extract (Cadalmin™ IBe) to boost innate immunity

### Strategy 2.11: Generate income from fish waste

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Develop beneficial utilization of fish waste at local level	Long term	Number of products developed	Universities, ICAR Institutions Govt. Departments	
2. Valuing services offered to ecosystems (environment) by utilizing waste for production of useful products	Medium and Long term		Universities, Government agencies, NGOs, ICAR Institutions	
3. Develop start-up initiatives using fish waste for unemployed educated youth	Medium and long term	Number of start-ups initiated	Universities, ICAR Institutions, Government Agencies, NGOs	
4. Encourage new product development from fish waste	Long term		Universities, ICAR Institutions	

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Note:** Huge quantities of fish and prawn waste are accumulated during processing. From prawns 60% and from fish 25-30% wastes are being generated. If these wastes are not utilized properly environmental contamination will result and consequent health problems for humans and other biota. Therefore, programmes and planning to wealth generation from waste is a possibility.

The Wealth that can be generated from waste are given below -

#### Sources of fishery wastes

1. From prawns, squilla, crabs, lobsters: products - chitin and chitosan production, carotenoid pigments
2. From fish:
  - a. Animal feed supplement: Fish meal, Fish soluble, Fish silage and foliar spray, Fish manure/ guano/ compost
  - b. Products from meat of fish waste/ underutilized fish: Fish protein concentrate (FPC), Fish protein hydrolysate, pet food
  - c. Fish oil products: Fish body oil (eicosapentaenoic acid EPA; docosahexaenoic acid DHA), Fish liver oil, squalene
  - d. Products from fish skin and scales: Leather, collagen peptides, gelatine, fish glue, pearl essence, ornamental products, shagreen
  - e. Products from fish fin: shark fin rays
  - f. Products from fish bone: Calcium phosphate, Hydroxyapatite (HAp), fish bone meal, shark cartilage & Chondroin sulphate, ornamental products and pigments
  - g. Products from air bladder: Fish maws and Isinglass, gelatin
  - h. Products from fish viscera: Insulin, surgical suture, enzymes (various)
3. From Mollusca: products – calcium carbonate, cuttle bone, cephalopod ink

### Strategy 2.12: Implement responsible tourism guidelines

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Assessing areas suitable for aquatic tourism (mapping) acceptance on the tourism projects, any heritage issues etc</li> <li>2. Assess socio-economic aspects of local people in coastal/marine areas with tourism potential</li> </ol>	Short term		Tourism, environment department, TBGRI, KFRI, Universities, NGOs	
<ol style="list-style-type: none"> <li>3. Undertake carrying capacity studies in major tourist spots and number of house boats in backwaters to be permitted based on carrying capacity studies</li> </ol>	Medium and Long term	Number of studies undertaken	TBGRI, KFRI, Universities, KSBB, NGOs	
<ol style="list-style-type: none"> <li>4. Take steps to see that all house boats are fitted with non-conventional energy sources and bio-toilets</li> </ol>	Short and medium term		TBGRI, KFRI, Universities, Government agencies, NGOs	
<ol style="list-style-type: none"> <li>5. Link tourism with more employment generation of local unemployed youth such as tourist guides, scuba diving guides etc.</li> <li>6. Any general facility like healthcare/ communication network developed for tourism in an area shall be open to local people as well</li> </ol>	Long term		Universities, TBGRI, KFRI, trained and registered agencies for offering swimming and scuba diving	
<ol style="list-style-type: none"> <li>7. A share of the income from tourism shall be committed for conservation of coastal/ marine biodiversity / livelihood improvement of local community</li> </ol>				

8. All constructions in the coastal/ marine areas shall be as per the CRZ notification and other relevant state rules.

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Strategy 2.13: Prevent pollution of water bodies to conserve biodiversity**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Assess industrial, domestic, sewage pollution affecting wet land systems including coastal waters.	Short term	Percentage change in water quality	Universities, Pollution control Board, NGOs, Government Departments	
2. Urgent actions to be taken for locating, collection, analysing, treatment and final disposal facility of the waste materials	Long term		Government	
3. Action to be taken for establishing solid waste disposal, recycling and reuse mechanisms at local self-governance level			Local self-governments	
4. Upgrading cleaning measures at beaches, harbours, fish landing centres for proper management	Long term		Local self-governments	
5. Develop appropriate disposal mechanisms for marine waste, like discards of crafts and gears, plastic waste and other debris at beaches			Government, Pollution Control Board	
6. Pollution pressures due to tourism at beaches and backwaters are to be restricted				

7. Awareness on pollution to local people and entrust them to safeguard the coasts
8. Immediate adoption of modern technologies for husk retting without causing any damage to natural waterbodies
9. Prevent dumping of plastic waste to aquatic ecosystem, as it can affect the planktons, primary producers both in the marine and fresh water ecosystems.

Universities, Government

Government, industries Dept., Pollution control board

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

#### Strategy 2.14: Ensure the socio economic and livelihood security of fisherfolk

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Set up of fishermen cooperative societies under the aegis of Matsyafed in each fishermen village to improve the socio-economic aspects of fishermen community.</li> <li>2. Develop proper monitoring system on the fund use for the welfare measures of fisherfolk.</li> <li>3. Implement an education and skill development program among the fisherman community to equip the new generation of fishers to find alternate vocation.</li> <li>4. Provide alternate livelihood options to fishermen during trawl ban period</li> <li>5. Provide better facilities in the landing centres for storage of fish under government control to avoid the middlemen.</li> <li>6. Prevent use of formalin and such preservatives to ensure that the public get quality fish</li> </ol>	Long term	No: of societies set up	Government	Improvement in the socio-economic aspects

7. For getting better price for catch, fish vending in prime locations in towns and cities should be promoted through the fishermen SHGs.
8. Floor price has to be fixed and the price has to be distributed without any delay so that they are assured of getting good price (Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Strategy 2.15: Managing Invasive Alien Species in water bodies**

Action Plan	Time frame Short, medium and short term	Indicators	Implementing agency	Remarks
1. Assess alien and invasive species in Kerala waters (mapping)	Short term	Data base of alien species	Universities, Government Depts.	
2. Assessing impact to environment and biota	Medium term		Universities and Government Depts.	
3. Develop data base of beneficial and non-beneficial species and strategies for their management	Long term		Universities, Government Depts.	
4. Elimination of alien species from water bodies like the attempt made in Periyar in Kerala	Long term		Government Depts.	
5. Adopt strict quarantine methods to prevent introduction of alien species	Long term		Government Depts.	
6. Develop data base of diseases which alien species spread in waters	Long term		Universities, Government Depts.	

(Short term: 0-1 yr.; medium term: 0-5 yrs.; long term: 0-10 yrs.)

**Note:** Alien species in Kerala are presented in Annexure 20. A few species are important for aquaculture and a large number of them are important in ornamental trade.



### 3. AGRO- BIODIVERSITY AND ANIMAL HUSBANDRY

#### 3.1: AGRO- BIODIVERSITY

##### Strategy 3.1.1: Documentation of crop diversity and varietal diversity for developing database on agro-biodiversity

Action Plans	Time frame	Indicators	Implementing agency	Remarks
1. Prepare district/Agro ecological unit wise crop diversity and varietal diversity including new and extant cultivars, improved cultivars, HYVs, unique land races and crop wild relatives of major crops.	Medium term	Updated Peoples' Biodiversity Registers, data base of agro-biodiversity in each district.	Dept. of Agri. Development and Farmers' Welfare, BMCs, KAU, R & D institutions, NGOs.	Updation of Peoples' Biodiversity Registers can very well support this action plan.
2. Documentation of agrobiodiversity of under- utilised crops including tuber crops, leafy vegetables, fruits, medicinal plants etc. useful for creating food diversity and nutritional security.	Medium term	List of tuber crops, leafy vegetables, under-utilised fruit crops, medicinal plants prepared.	BMCs, NGOs, R & D institutions	Underutilised crops that are beneficial for food diversity, health security and nutritional security are to be documented and protected.
3. Identification of areas suited for in-situ/on- farm conservation of major crops in each district.	Short term	Number. of sites identified.	Agriculture departments, KAU	

<p>4. Generate data on individuals, communities, societies, genome saviours, eco-clubs and NGOs engaged in agro-biodiversity conservation.</p>	<p>Short term</p>	<p>Number of farmers identified, and documents prepared.</p>	<p>KAU, NGOs, BMCs, R &amp; D institutions</p> <p>Many individual farmers, communities, societies, eco-clubs and genome saviours in Kerala are actively engaged in agro-biodiversity conservation. These efforts are to be documented and encouraged.</p>
<p>5. Collect traditional knowledge, tribal languages, tribal vocabulary, food culture and ethnic culture related to agrobiodiversity including medicinal and nutritional uses of plants, practised and propagated by tribes and ethnic groups which are non-documented and practised over generations, under strict compliance of existing Act and Rules</p>	<p>Medium term</p>	<p>Documents prepared</p>	<p>RandD institutions and KSBB, KIRTADS</p> <p>Orally propagated knowledge of tribal communities including food habits is to be documented and protected. Otherwise in due course such oral literature will be lost for ever.</p>
<p>6. Documentation and evaluation of Functional Agro Biodiversity that can improve soil and water conservation, soil and water quality, crop pollination, biocontrol of pests and diseases, regulation of microclimate, and recreational and aesthetic uses.</p>	<p>Medium term</p>	<p>Documents prepared</p>	<p>KSBB, RandD institutions</p>
<p>7. Study of impact of alien species on native crop diversity and ecosystems.</p>	<p>Medium term</p>	<p>Data base developed</p>	<p>KSBB, NGOs, BMCs, academic institutions. Such as KAU</p>

- Notes.
1. Emphasis is to be given for crops like rice, vegetables, coconut, fruit trees like banana, jack fruit and mango, spices such as pepper, cardamom, and nutmeg, cinnamon clove, ginger and other major crops of each district.
  2. Varieties and related TK for overcoming biotic and abiotic stresses including flood, salinity, heat, drought, pests, diseases etc. and with better food quality, taste, medicinal values and that can be used in home medicine. are to be specifically documented.
  3. Many including tribal communities are using green leafy vegetables, wild tubers and wild relatives in their diet for nutritional security, food safety and health benefits. This culture is gradually diminishing as communities are currently depending on rice and other staple food crops leading to nutritional problems. Use of underutilised crops, tubers and leafy vegetables is to be documented and promoted.
  4. On- farm conservation sites for rice, spices [pepper, nutmeg, cardamom], jackfruit, mango, banana, coconut, tuber crops and vegetables can be established in each district.

**Strategy 3.1.2 . Incentivising conservators/ custodian farmers**

- |   |            |   |   |
|---|------------|---|---|
| 1. Instituting awards and recognitions for custodian farmers.   | Short term | Number of awards/rewards instituted;<br>Number of farmers receiving awards. | KSBB, KAU, ICAR institutes, Agri departments      |
| 2. Provide technical support to custodian farmers / BMCs to get rewards/ awards / recognitions instituted by different national and state agencies/ institutions. | Short term | Number of awards/rewards received by Kerala farmers                         | KSBB, BMCs Agrl. Universities, RandD institutions |

**Strategy 3.1.3. Promote maximum crop and varietal diversity among farming community as part of land use strategy**

- |  |           |  |   |
|--|-----------|--|---|
| 1. Setting up community seed banks/ propagation material at local level for the benefit of farmers | Long term | Number of seed banks established and efficiency of seed distribution system. | KSBB/BMCs/ Dept. of Agri. Development and Farmers' Welfare. |
|--|-----------|--|---|

2. Establishment of regional agro biodiversity conservation centres in biodiversity hot spot areas.	Medium term/long term	Number of centres established	RandD institutions, BMCs, KSBB, Dept. of Agri. Development and Farmers' Welfare.	Such centres can conserve endangered and extant varieties and land races of economically important crops of Kerala and can provide seeds/planting material to interested farmers. Create seed banks of paddy seeds of Thanal
3. Promotion of deposition of seeds of conserved varieties in farmers land, national and local gene banks.	Short term	Number of accessions added to germplasm collections of different institutions	NBPGR, KAU	A certificate to the effect can be issued by gene banks to contributing farmers.
4. Organise seed exchange/ seed festival programmes in each district.	short term	Number of seed exchange melas /seed festivals organised	KSBB, BMCs, NGOs, RandD institutions.	Such festivals can provide better and local access to seed /planting material of traditional varieties and land races.
5. Networking of Genome Saviors and custodian farmers of Kerala for conservation and exchange of ideas	Short term	Network established	KSBB, Agri. Dept., NGOs, RandD institutions	Such network can provide information and easy access to seeds and planting material of traditional varieties.
6. Promotion and revival of homestead gardens with unique and nutritionally rich diversified crops and cropping systems with indigenous varieties	Short term	Number of home gardens developed	BMCs, women self-groups, Kudumbasree units	

7. Promotion of terrace cultivation in urban houses with land races/ medicinal plants and nutritionally important plants for domestic use and for promotion of urban agro biodiversity.	Short term	Number of terrace gardens established	KSBB/BMCs/Agri. Dept., KAU, resident associations
8. Establishing incentives for agro-biodiversity conservation, ecosystem restoration and protection.	Short term	Incentives developed and distributed.	KSBB, Line departments
9. Promote food forests and other farmer initiatives like “plavu gramam” and “nattu manchottil” aiming crop specific conservation.	Medium term	Number of conservation sites established.	BMCs, women self-help groups, Kudumbasree units, eco-clubs, student groups, resident associations, NSS units, KSBB, farmer communities and even individual farmers.
10. Provide conservation units for forage and fodder crops, and green manure crops.	Short term	Number of units established	Dept. of Agri. Development and Farmers’ Welfare.
11. Encourage cultivation of crop plants like “elavazha” and other trees useful for packing food to replace plastics	Short term		BMCs and Kudumbasree units

12. Promote apiculture for enhancing pollination through bee keeping	Short term	Number of Apiculture units established and stingless bee hives distributed to school/college students	Dept. of Agri. Development and Farmers' Welfare.	This also supports production of good quality honey for health care.
13. Linking biodiversity with responsible tourism, farm tourism and GI tourism by arranging conducted tours / visits to biodiversity rich areas/farms/ heritage sites/ locations of GIs and homesteads of custodian farmers	Short term	Number of visits organised/ development of farm tourism	Responsible Tourism Mission and Tourism dept., tour operators	
<p>Notes. 1. This strategy can be implemented with emphasis on diversity of crops like tuber crops, rice, cereals, millets, vegetables, jack-fruit, mango, banana and other fruit crops, medicinal plants, spices and under-utilised crops. Seed banks through BMC are also to be promoted based on this. A directory of such district wise, custodian farmers and BMCs should be readily available to public through BMCs.</p> <p>Examples can be</p> <ol style="list-style-type: none"> <li>1. Establishment of seed bank for conserving indigenous millets and red gram in Attapadi in Palakkad district Marayoor near Munnar.</li> <li>2. Establishment of seed bank for indigenous rice varieties in Wayanad Dst., Palakkad Dst, Kuttanad region and Onattukara.</li> <li>3. Establishment of seed bank for indigenous mango varieties at Palakkad [Muthalamada area] and Kannur (Kannapuram area).</li> <li>4. Establishment of germplasm of banana in Thrissur Dst.( Kannara area) and Thiruvananthapuram Dst.</li> <li>5. Establishment of Seed bank for sesame at Onattukara tract.</li> <li>6. Establishment for seed bank for spices in Idukki district.</li> </ol>				
<p><b>Strategy 3.1.4. Promote Sustainable utilisation of agro -biodiversity</b></p>				
1. Promote activities of FPOs and start-ups in terms of effective and sustainable utilization of agrobiodiversity, value addition and income generation.	Medium term	FPOs and start-ups formed for sustainable utilisation of agrobiodiversity, success stories.	NABARD. KAU KVKs. VFCK.	

2. Value addition and minimal processing for underutilized nutrient rich-tubers, vegetables and fruits.	Medium term	Methods developed for value addition and processing.	KAU, R & D institutions, women self-help groups, Kudumbasree units, start ups
3. Promote cultivation and marketing of typical traditional crop items of Kerala, like Navara, Pokkali, Kaipad and other rice varieties and other vegetables and medicinal plants.	Short term	Number of Promotion activities	Dept. of Agricultural Development and Farmers Welfare, Medicinal Plant Board

### Strategy 3.1.5. Strengthening research needs on agro-biodiversity

1. Develop stress [biotic and abiotic] tolerant new crop varieties.	Medium term	Number of varieties developed	KAU and other R&D institutions	Resistant varieties for pests/diseases/ heat/salinity/drought, flood and climate resilient varieties can be developed by adopting different breeding strategies.
2. Evaluation and salinity, characterisation of traditional varieties/ farmer varieties especially that of rice, millets, fruit crops, spices, tuber crops and vegetables.		Number of varieties evaluated	KAU, R&D institutes	Traditional varieties are to be evaluated for resistance / tolerance for biotic and abiotic stresses. Many traditional paddy and vegetable varieties have precious genes to tolerate biotic and abiotic stresses including drought, flood, heat, drought, salinity, pest and disease attack.

3. Documentation and validation of resilient agricultural practices including varietal spectrum/mixtures adopted by farmers to overcome issues of climate change related	Medium term	Data base of resilient varieties and management practices	KSBB, BMCS, Reputed NGOs.	Farmers adopt different crop management practices and different varieties to overcome climate change. These practices are to be documented for scientific studies, validation and popularisation.
4. Organise open days in R&D institutions to showcase biodiversity of crop plants and distribution of planting material/seeds to interested farmers and students.	Short term	Number of field days organised	R&D institutions	
5. GIS mapping of endangered crop species	Medium term	Locations identified	KSBB, research institutions	
6. Preparation of passport data for not so common crop plants	Medium term	Passport data prepared	KSBB/KAU/Colleges, Research Institutions	
7. Initiatives to make the agricultural practises climate smart and resilient		Trends in Climate resilient farming practises developed	DOECC, R&D institutions	
8. Evaluation of “ecosystem services” of agrobiodiversity components and documentation of successful models.	Medium term	Trends in biodiversity and ecosystem services valuation studies Trends in number and coverage of studies -TEEB, NPV relating to biodiversity	Academic and research institutions	



### Strategy 3.1.6. Protect IPR on crop diversity

- |  |             |  |   |
|--|-------------|--|---|
| 2. Protection of unique crop products of Kerala as GIs.  | Medium term | Number of products registered as GIs     | KAU and other research institutions in collaboration with farmer groups                                 |
| 3. Registration of extant and farmer varieties and new varieties of crops under PPV and FR Act, 2001 for IP protection and benefit sharing | Medium term | Number of varieties registered           | KAU and R&D institutions<br><br>This will help to protect breeders' and farmers right on crop varieties |
| 4. Awareness creation on IPR protection for agro biodiversity among farmers, different stake holders and authorities.                      | Short term  | Number of awareness programmes organised | KSBB, KILA, R&D institutions.   |

## 3.2 ANIMAL HUSBANDRY

### Strategy 3.2.1. Documentation of population structure and morphological traits of indigenous specious

- |   |             |   |             |
|---|-------------|---|-------------|
| 1. Conduct surveys to identify different genetic groups of domestic animals     | Short term  | Breed / genetic group wise information indigenous animals | KVASU       |
| 2. Identification of animals of each genetic group by application of microchips | Medium term | Number of animals identified                              | KVASU / AHD |

Note: There are many indigenous domestic native breeds in Kerala like Vechur cattle, Kasargod cattle, Vatakara cattle, Vilwadi cattle, Wayanad cattle, Kuttampuzha dwarf (Periyar cattle), Cheruvally cattle, Highrange dwarf cattle, Kuttanad buffaloes, Ankamaly pigs, Malabari goats, Attappady Black goats and some other non-described domestic animal groups. In the avian group, Tellichery chicken, Chara and Chempally ducks and other types of indigenous poultry are reared by the farmers. The population data on Vechur cow alone is available through 20th Livestock Census. Physical characters of Vechur, Kasargod, High range Dwarf and Vatakara cattle with breed descriptors are published. Molecular characterization of some of these groups is already done by NBAGR / KVASU. There are some publications on Tellichery chicken, Ankamaly pigs and Wayanad cattle. Hence there is a need to define these genetic groups and to compare their characters and similarities at physical and molecular genetic level. Information about population structure is to be developed.

#### Strategy 3.2.2 . Recognition of genetic groups of livestock and poultry as breed

1. Document flora and fauna of the breeding tract of different indigenous domestic animal resources	Short term	Information gathered	KVASU
2. Undertake formalities required to get recognition as specific breeds	Medium term	Genetic groups of animals recognised as a 'breed'	KVASU/ AHD/ NGOs
3. Establish herd books for each breed	Medium term	Number of herd books started	KVASU/ AHD

#### Strategy 3.2.3. Identify unique specialities and alternative uses of indigenous animal genetic groups

1. Characterisation of animals /birds and their produce	Long term	Number of Projects, Number of Research / popular publications,	KVASU
2. Research for finding out uniqueness of indigenous resources	Medium term and long term	Uniqueness and specific uses identified	NGOs/ KVASU/ AHD
3. Training for the farmers and interested persons to manufacture unique products from the produce of indigenous animal / birds	Short term and long term	Number of trainings conducted	KVASU/ LSGD

Note: Many of the domestic native animals were bred for specific purposes by the keepers. These purposes include the specialized working conditions for draft animals, composition of milk with its unique flavour or characters, specialties of meat like its texture and flavour, qualities of egg in poultry, acclimatization to climatic conditions and other attributes. In the era of changing climate, agricultural practices and consumer preferences for animal products, the relevance of many of these genetic resources are lost. Hence to prevent the genetic erosion and loss of indigenous genetic resources steps are urgently needed.

#### Strategy 3.2.4. Incentivize farmers who maintain Indigenous animal genetic resources

- |  |             |  |                        |
|--|-------------|--|------------------------|
| 1. Financial support and technical advice to farmer who conserve indigenous domestic animal resources                          | Short term  | Number of farmers receiving the assistance | AHD/ LSGD              |
| 2. Identification of custodian famers for indigenous breeds and declare as in-situ conservation centres in their native tracts | Medium term | Number of custodian farmers identified     | AHD/ KVASU/ LSGD, KSBB |
| 3. Honour the animal breed conservators and individuals who conserve indigenous genetic resources                              | Short term  | Number of awards instituted                | KSBB                   |

Note: Most of the indigenous genetic resources of the State except Vechur, Kasargode, Attappady Black, Ankamaly pigs and Malabari goats do not have institutional farms or units for their conservation. Even the units available are not having sufficient numbers and facilities to ensure survival of these indigenous genetic groups.

#### Strategy 3.2.5. Registration of Geographical Indications and variety protection tag

- |   |             |                                  |       |
|---|-------------|----------------------------------|-------|
| 1. Take up registration of Geographical Indication for unique animal products or variety protection tag | Medium term | Number of applications submitted | KVASU |
|---|-------------|----------------------------------|-------|

Note. Products from indigenous breeds can be registered as GIs, as done in the case of Kadaknath black chicken meat from MP.

### Strategy 3.2.6. Maintain healthy and productive populations of indigenous breeds for distribution

- |  |                                       |  |  |
|--|---------------------------------------|--|--|
| 1. Establishment of at least one bull station for each indigenous genetic group of animals                   | Medium term and long term             | Number of bull stations established  | AHD/ KLDB/ LSGD/ NGO/KVASU                   |
| 2. Organise breeders associations and encourage them to maintain breeding bulls                              | Medium term and long term             | Number of breeding bulls kept by breeders' associations and number of breeding bulls certified | NGO/ KLDB/ LSGD                              |
| 3. Provide specific registration and certification of breeding bulls, semen and other breeding materials     | Medium term and long term             | Number of points where semen is available  | AHD  |
| 4. Identification and certification of breeders / satellite units for supply of indigenous genetic resources | Short term, medium term and long term | Number of identified breeders  | AHD/ KLDB / KVASU/ NGOs/ Progressive farmers |

Note: One of the major complaints raised by keepers of indigenous genetic resources is difficulties in getting semen for insemination of their cattle and buffaloes. Furthermore, there is no mechanism to make sure that the semen supplied is that of good quality bulls. As the bull stations for supply of semen to farmers requires certification, which may not be possible for small scale units, maintenance of breeding bull has to be taken as an alternative. In many states multiplication and supply of genetic resources are done through certified satellite units where the quality of the resources is maintained by certification process.

### Strategy 3.2.7. Formation of farmer producer companies for multiplication and sale of indigenous genetic resources

- |   |                      |                            |                  |
|---|----------------------|----------------------------|------------------|
| Establishment of farmer producer companies for marketing of the germplasm and produce from indigenous domestic animal resources | Medium and long term | Number of companies formed | AHD/ KVASU/ KLDB |
|---|----------------------|----------------------------|------------------|

## 4. STRATEGY AND ACTION PLAN FOR SOCIAL SECTOR

### 4.1. TRADITIONAL KNOWLEDGE AND TRIBAL DEVELOPMENT

#### Strategy 4.1.1: Documentation of TK/Folk practices associated with Bioresources

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>1. Systematic documentation and preparation of database based on the Traditional Knowledge (TK), associated with Biodiversity after obtaining the Prior Informed Consent (PIC) and Mutually Agreed Terms as per BD Act</li> <li>2. Video documentation of TK of Kerala based on case studies</li> <li>3. Protection of TK associated with biodiversity under sui generic system</li> <li>4. Establish Panchayat TK Trust in every panchayat with elected representatives of communities holding TK</li> <li>5. Develop gene pool conservation areas in the forest/ forest fringe area of tribal settlements with the support of FDA/ VSS/EDC/Oorukootam by ensuring the in-situ, and ex-situ conservation of local biodiversity</li> </ol>	Short term, Medium term and Long term	No. of conservation areas established	BMC, LSG, Line departments/ Forest Departments, RTSG, KFRI, MBGIPS, JNTBGRI, RGC, KSBB

#### Strategy 4.1.2: Sustainable Collection of Non-Wood Forest Produce (NWFP)

Action Plan	Time frame	Indicators	Implementing agency
Develop a scientifically designed data base format for division wise collection of NWFP and checklist of other forest bio resources of Kerala through participatory approach.	Long term	Number of training programs conducted Database developed	BMC, LSG, Line departments/ Forest Departments, TSG, KFRI, MBGIPS, KFRI, RGC, JNTBGRI, KSBB/KILA

Conduct an in-depth study and analysis on informal trade of NWFP and other forest bio resources of Kerala. Training and capacity building programs shall be extended exclusively to tribal communities, for the scientific collection of NWFP and other tradable forest bioresources.

**Strategy 4.1.3: Supply Chain and Value Chain analysis of Tradable Bio resources**

Action Plan	Time frame	Indicators	Implementing agency
Systematic documentation of current status of supply chain and value chain of NWFP and other tradable forest bio resources of Kerala. Impart training for diverse income generation activities from bio-resources such as value-added products from bamboo, medicinal and aromatic plants.	Short term	Number of studies on supply chains/ value chains conducted	BMC, LSG, Line departments/Forest Departments, TSG, KILA, KFRI, MBGIPS, JNTBGRI, RGCB, KSBB

**Strategy 4.1.4. Permanent revolving fund exclusively for the tribal communities**

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>Allotment of permanent revolving fund to sustain the livelihood of tribal communities. (It is to be noted that during the primary collection, they do not get proper price and spot payment for the collection of raw materials.</li> <li>Introduce minimum support price for plants collected under NWFP and other tradable forest bio-resources to avoid fluctuation of prices</li> <li>Strengthen the existing marketing network of diverse value-added products produced from bio resources</li> </ol>	Long term	Amount allotted as revolving fund	BMC, LSG, Line departments/Forest Departments, TSG, RTSG, KILA, KFRI, MBGIPS, RGCB, JNTBGRI

### Strategy 4.1.5. Development of entrepreneurship programme among tribal communities of Kerala

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>1. Systematic and scientific training shall be extended among tribal communities of Kerala for semi processed /value added products/home remedies etc, based on NWFP and other tradable bio resources</li> <li>2. A special package programme on conservation and cultivation practice shall be formulated and implemented among tribal communities of Kerala through BMC and LSG</li> <li>3. Need based assessment to support housing, land distribution, effective land use and development, agriculture, animal husbandry aspects, installation of non-conventional source of energy and other rights as per Forest Rights Act</li> <li>4. Training on value addition and bio-prospecting for income generation (essential oils, extracts, oleoresins, and other value-added products)</li> <li>5. Introduce Green Pharmacy Concept among the tribal communities for their primary health care with the support of AYUSH department.</li> <li>6. Document TK with the tribal people on availability of specific bioresource (NWFP) in different seasons/ climate change impacts</li> </ol>	Long term	Number of training programs for entrepreneurship conducted	BMC, LSG, Line departments/Forest Departments, TSG, KILA, KFRI, MBGIPS, JNTBGRI, RGC, KSBB

#### Strategy 4.1.6: Scientific validation of selected bio resources and developing novel products

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>1. Project mode study based on traditional knowledge on wild edible leafy vegetables, fruits, grains, nuts, oil and tubers, medicinal plants, spices, aromatic plants with a view to develop simple effective diverse products related to food / medicines and health care.</li> <li>2. Screening of anti-viral properties, activities based on ethno medical leads obtained from plant species used by the tribal communities of Kerala.</li> <li>3. Ensure quality, purity and safety of forest produce through good collection practises, processing, storage, packing.</li> </ol>	Medium term	Number of patents filed	BMC, LSG, Line departments/Forest Departments, TSG, Universities, KFRI, MBGIPS, JNTBGRI, RGCB, KSBB

#### Strategy 4.1.7: Sustainable use of Bioresources for One health

Action plan	Period	Indicators	Agencies
<ol style="list-style-type: none"> <li>1. Preparation of resource inventory of raw drugs at district level</li> <li>2. Make it mandatory for the medicine manufacturing units to declare their annual raw drugs requirement</li> <li>3. Assess the resource, which have become rare or fast depleting.</li> <li>4. Promote cultivation of medicinal plants in waste lands, homesteads, government lands, forest plantations to reduce pressure on wild sources</li> <li>5. Include medicinal plants for raising in “Smirithivanams” in memory of National leaders</li> <li>6. Give training on sustainable harvesting technique to tribals/local field level collectors</li> <li>7. Encourage taxonomy of medicinal plants</li> <li>8. Document traditional knowledge associated with bioresources as per the existing law</li> <li>9. Evaluate the traditional practices and test their usefulness as per the existing law</li> <li>10. Create awareness among people on traditional systems of medicine and food resources and their importance</li> </ol>	Long term	No: of training conducted No: of patents relating to use of bioresources in healthcare Database on raw drugs at district level	R and D Institutions of State and National level



## 4.2. EDUCATION

### Strategy: 4.2.1. Promote Biodiversity education among students and youth

Target	Action plan	Period	Indicators	Agencies
Students Primary, high school, secondary, higher secondary, higher education, education institutes (Colleges and University)	<ol style="list-style-type: none"> <li>1. Review and revise curricula and text books to incorporate environmental / biodiversity components</li> <li>2. Develop monitoring mechanisms to assess the efficacy of biodiversity education</li> <li>3. Environmental and social auditing every year</li> <li>4. Make environmental education mandatory for the entire sphere of education system</li> <li>5. Introduce state biodiversity crops (SBC) like NCC in schools and colleges.</li> <li>6. All eco-clubs and other clubs in schools and colleges to be merged under a convener as Environmental clubs</li> <li>7. Seminar and training programmes on taxonomy to be organized at college level</li> <li>8. As part of non-formal education "PBR as a textbook and Panchayat as classroom" can be implemented in association with Literacy mission</li> <li>9. Develop non-formal teaching and training module for youths</li> <li>10. Identify and honor biodiversity champions / youth leaders at district and state level</li> <li>11. Identify flagship species for each district through participatory mode and undertake monitoring of such species.</li> <li>12. Strengthen citizen science programs and support Nature camp, bird watching camp etc. and involve youth in Biodiversity conservation programs of BMC</li> </ol>	Long term	<p>Number of students opting for higher-level specialization in biological sciences</p> <p>Numbers of schools enrolled in the National Environment Awareness Campaign, National Green Corps-Eco Clubs Programme, Biodiversity clubs, Bhoomita sena clubs, Eco clubs etc</p>	<p>DPI</p> <p>SCERT</p> <p>Universities</p> <p>DCE</p> <p>HEC</p> <p>Technical education</p> <p>DOECC</p>

Strategy 4.2.2: Promote Biodiversity awareness for different stakeholders

Target	Action plan	Period	Indicators	Agencies
Government/Semi Govt. Boards, Corporation, Federations (Forest, agriculture, horticulture, animal husbandry, fisheries, water resource, rural and urban development, cooperative), Media, Public leaders, Judiciary	<ol style="list-style-type: none"> <li>Organize events connected with environmental and biodiversity conservation at BMC levels</li> <li>Ensure better coordination among institutions such as Panchayat, BMC, VFDCs, VFDSs, JFM, local administration, research institutes as well as NGOs</li> <li>Identify training needs that strengthen the role of institutions like Panchayats/BMCs in Biodiversity conservation</li> <li>Awareness drives (workshop, seminar and conference) for sensitization of people's representative's media, judiciary and bureaucracy regarding implementation of BDA, 2002 and other relevant acts and regulations</li> <li>Promote making of short films and documentaries for awareness creation</li> <li>Mainstream biodiversity in the training programs of all line departments</li> <li>Identify and prioritize areas on biodiversity and its conservation requiring research. Mobilize resources and develop adequate manpower and other infrastructure for undertaking research on prioritized areas in a time bound manner.</li> <li>Development of a biodiversity information system under the aegis of KSBB</li> <li>Financial allocation for communication, education and public awareness programmes</li> </ol>	Long term	Trends in visits to protected areas (PAs), natural history museums and exhibitions and zoological/botanical gardens Trends in inclusion of biodiversity in training / orientation programs of line departments	BMC, KSBB, LSGs, press clubs, KILA

## 5. STRATEGY AND ACTION PLAN FOR CROSS CUTTING SECTORS

### 5.1. ENVIRONMENT AND CLIMATE CHANGE

#### Strategy 5.1.1: Acquiring deeper knowledge on the climate change phenomena in Kerala

Action Plan	Time frame Short term/Medium term/Long term	Indicators	Implementing Agency	Remarks
<p>Climate change predictions for Kerala</p> <ol style="list-style-type: none"> <li>1. Study the changing temporal-spatial distribution of rainfall characteristics over Kerala.</li> <li>2. Understand the increasing extreme rainfall events and its link to hydrological hazards.</li> <li>3. Explain the structural changes in the cloud characteristics over Kerala region.</li> <li>4. Study the increasing frequency of extremely severe cyclonic storms over Arabian Sea in response to the galloping warming trend of Arabian sea waters.</li> <li>5. Understand the increasing frequency and timing of compound events over the coastal regions due to monsoon winds, cyclonic storms, storm surges, coastal flooding due to heavy rainfall, and river water runoff on the top of the projected sea level rise.</li> <li>6. Survey the increasing incidence of heat waves and its impacts on human and animal health.</li> <li>7. Survey on climate change impacts on socio-economics aspects like human/animal migration</li> </ol>	Medium term	Allocation of budget resources (Budget Estimates) for Climate change related studies	IMD, CUSAT, KUFOS, DOECC	

<p>Early warning systems Implementation of end-to-end early warning and decision support system. Education and awareness among different communities at local level on the evolving risks under changing climate. Implement mechanism to reach the most vulnerable people and check distant water fishing communities with timely warning. Interpreting the scientific information and translating them to local language, (Malayalam) understandable to stakeholders. Regular testing and updating of Standard operating procedure whenever required in the case of potential cyclogenesis near the coast.</p>	<p>Medium term</p>	<p>No of districts/ LSG with local disaster management plan</p>	<p>KDMA,- DOECC</p>
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### Suggestions

Effective response to potential disasters in future under changing climate is always linked to continuous monitoring. Take this opportunity to develop that capability in-house.

**A “bottom-up-approach” is needed for the implementation of multi-hazard early warning system in which involvement of local communities are essential. People centred early warning systems rely on the direct participation of those most likely to be exposed to hazards.**

The agencies concerned should take the lead role in establishing required Automatic Weather Station (AWS), Lightning sensors, water level gauges, stream gauge and other instruments should be installed and **maintained for easy access to all academic institutions in an open data repository** to facilitate more active research and for citizen collectives. For the time being, there is no formal dissemination and sharing of quality research data collected by various agencies with public money. Some kind of duplication can also be avoided.

Encourage more citizen level joint programs for weather monitoring, data collections and awareness. Both formal and informal education/awareness programs can be conducted.

In-house development of stakeholder specific products may be developed through facilities available in State rather than depending mostly on private agencies.

### Strategy 5.1.1.2: Downscale the global climate change predictions to suit Kerala

Action Plan	Time frame Short term/Medium term/Long term	Indicators	Implementing Agency	Remarks
1. Map the past climate changes and the future climate predictions for Kerala based on IPCC reports	Long term	Updated trend analysis maps generated	IMD, CUSAT, KU-FOS, DOECC	
2. Cadastral mapping on a GIS platform to be done for all locations with historical events of flooding/extreme events and with potential for extreme events.	Long term	Updated Susceptibility to flood, drought, landslide maps generated	Land Survey Dept., LSGD, CUSAT, KSDMA, DOECC	
3. Map the climate change, especially temperature, rainfall, etc, based on climate scenarios applicable to Kerala	Long term	Updated trend analysis maps generated	IMD, CUSAT, KU-FOS, DOECC	
4. Establish more weather stations (at least temperature and rainfall), especially at vulnerable locations with public participation	Short term	No of Weather stations established	IMD, Research Institutions	
5. Workshop for LSGD, Local body members, Kerala Disaster Management Authority and other stakeholders on interpretation of data on predictions	Short term	Number of awareness workshops organized	KSBB, LSGD, KILA, DOECC	
6. Notify locations which are very vulnerable, especially in the districts of Alappuzha, Idukki, Palakkad and Wayanad	Medium term	No. of locations notified	DOECC	

Global Climate Model (GCM) data available at 1° grid scale. Finer scaling is needed to get the data at district level in Kerala. Grids and re-gridding can be done using various computer platforms like Matlab, R profession etc.

Existing hazard zonation maps of KSDMA/NCESS is 1:50,000 scale only. Downscaling not possible from this scale. Identify the

vulnerable zone (high hazard zone) in this map and preference can be given to people inhabited high hazard zone, and then go for detailed field visit in this area and prepare hazard zonation map at cadastral scale (1: 5000). This detailed map (cadastral map) contain the village survey numbers also and will be useful for implementing hazard mitigation and adaptation action programmes.

**Strategy 5.1.3: Conservation, restoration and sustainable management of forest ecosystems (all major ones) to reduce vulnerability to climate hazards such as landslides, floods, drought, etc.**

Action Plan	Time frame	Indicators	Implementing agency	Remarks
A landscape-based mapping for sustainable management of environment with climate adaptation in mind.	Long term	Maps generated	IMD, CUSAT, KU-FOS, DOECC	
Mapping locations with existing quarries and other mining operations. Mapping locations where tourism developments have posed threats to biodiversity. Mapping locations where human-wildlife conflicts are prevalent	Long term	Maps generated	KFD, Geology Dept., LSGD	
Establish monitoring stations at critical ecosystem locations with continuous weather data recording along with soil and forest health monitoring.	Long term	No of weather stations established	IMD, CUSAT, KU-FOS, KFRI, GESS, KFD, etc.	
Implementation of water and soil conservation methods at all levels to conserve different types of biodiversity	Long term	Percentage ground water withdrawal against availability Per capita availability of water (in m3/person)	Soil and water conservation Departments, KFD, LSGD	
Workshop for LSGD, Local body members, Kerala Disaster Management Authority and other stakeholders	Short term	Number of awareness workshops organized	KSBB, LSGD, etc.	

Rehabilitation programmes for the most vulnerable section of the population. Medium term No of schemes implemented Revenue Dept. Mechanism to monitor land use change from cadastral maps especially in vulnerable locations.

#### Strategy 5.1.4: Conservation of Floral and Faunal diversity in response to climate change

Action Plan	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Documentation of available data on the vulnerability-resilience of plant and animal species in Kerala.</li> <li>2. Assess the vulnerability and resilience to climate change of major plant and animal species in Kerala with reference to the future predictions.</li> </ol>	Long term	Research reports	Universities and research Institutes	
<ol style="list-style-type: none"> <li>3. List plant and animal species which need in situ or ex situ conservation from their vulnerability and resilience assessments.</li> <li>4. Recognize the role of each of the plant/animal species in the functioning of the different ecosystem and thereby to ecosystem services in the context of climate change.</li> </ol>	Long term	Species list published Publications on the ecophysiology	Universities and research Institutes	
<ol style="list-style-type: none"> <li>5. Organize seminars on the significance of plant/animal diversity in schools and colleges/ BMC/ LSG especially ecosystem services rendered by them.</li> </ol>	Short term	Number of awareness workshops organized	Universities and research Institutes	
<ol style="list-style-type: none"> <li>6. Enforce strict rules regarding the utilisation of red data book listed species</li> </ol>	Short term	No of cases registered under Wildlife Protection Act. 1972	KFD	

### Strategy 5.1.5: Intensive Conservation of RET plant/animal species in response to climate change

Action Plan	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Compile available research on the vulnerability-resilience of RET plant species in Kerala.</li> <li>2. Assess the vulnerability and resilience to climate change of major RET species of plant and animal species in Kerala with reference to the future climate predictions.</li> </ol>	Long term	Research reports	Universities and research Institutes	
<ol style="list-style-type: none"> <li>3. List RET species which need in situ or ex situ conservation based on their vulnerability and resilience assessments.</li> <li>4. Promote research on the reproductive biology of the RET species to assess the specific stages where intervention is needed.</li> <li>5. Recognize the role of each of the RET species in the functioning of the different ecosystem and thereby to ecosystem services.</li> </ol>	Long term	Species list published Publications on the reproductive biology Publication on the ecophysiology	Universities and research Institutes	
<ol style="list-style-type: none"> <li>6. Field experimentation for RET species which need assisted regeneration in case of plants and captive breeding in case of animals</li> </ol>	Long term	Plots established and animals bred in captivity	Universities and research Institutes + Zoo	
<ol style="list-style-type: none"> <li>7. Bring out informative and attractive publications on RET species and also in website of the KSBB</li> </ol>	Short term	Publications and websites	KSBB	



### Strategy 5.1.6: Conservation of agricultural biodiversity in response to climate change

Action Plan	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Compile available research on the vulnerability-resilience of cultivated plant species in Kerala.</li> <li>2. Assess the vulnerability and resilience to climate change of major crop species in Kerala with reference to the future climate predictions.</li> </ol>	Long term	Research reports	Universities and research Institutes	
<ol style="list-style-type: none"> <li>3. List crop varieties which need in situ or ex situ conservation from their vulnerability and resilience assessments.</li> <li>4. Research work to be done on the reproductive biology of the crop varieties to assess the specific stages where intervention is needed.</li> </ol>	Long term	Variety and species list published Publications on the reproductive biology	Universities and research Institutes	
<ol style="list-style-type: none"> <li>5. Develop crop varieties that can withstand climate extremes such as temperature, drought, floods, etc.</li> </ol>	Long term	Crop varieties developed	Universities and research Institutes	
<ol style="list-style-type: none"> <li>6. Take up research on the emerging pests and diseases spreading due to impact of climate change and the need to plan the cropping seasons accordingly</li> </ol>	Long term	Information generation	Universities and research Institutes	
<ol style="list-style-type: none"> <li>7. Set up mechanisms for crop insurance covering both annual and perennial crops against climate hazards</li> </ol>	Short term	Insurance scheme in place	Insurance companies, Agri. Dept.	
<ol style="list-style-type: none"> <li>8. Develop weather forecasting facilities for farmers at district level</li> </ol>	Short term	Weather forecasting developed	IMD, CUSAT, KAU	

9. Improve the post-harvest technologies for all major crops so that the loss of commodities due to climate vagaries is prevented.	Long term	New post-harvest technologies developed	KAU, NGOs
10. Create awareness programmes among farmers about using new tolerant or cultivar resistant for cultivation and other farm information	Short term	Publications and websites	KSBB
11. Training farmers and other stakeholders on the need to use climate resistant varieties and also about climate change problems.	Short term	Number of training courses conducted	Agriculture Dept, KAU

**Strategy 5.1.7: Improve the resilience of the ecosystems to climate change so that they can continue to deliver ecosystem services and provide stable livelihood options for the community**

Action Plan	Time frame	Indicators	Implementing agency	Remarks
1. Implement appropriate measures to avoid air, water and land pollution	Long term	Status and trends of ambient air quality; monitoring water quality for physico-chemical and bacteriological parameters, trace metals, pesticides at selected sites; trends in noise levels	LSGD, PCB, Water authority	
2. Set up facilities or link existing facilities with monitoring of environmental pollution with quarterly reports generated	Long term	Monitoring reports generated	LSGD&PCB	

3. Make waste handling an important duty of the LSGD	Short term	No of waste treatment plants set up	SPCB, LSGD
4. Plant more indigenous trees on marginal lands and river banks to avoid soil erosion	Long term		LSGD/Forest dept
5. Allow sand mining in low lands and midlands based on sand auditing.	Long term	Policies framed	Revenue Dept and LSGD
6. Allow ecological flow in rivers with dams to conserve the riparian biodiversity.			
7. Create awareness among people about proper disposal of waste	Short term	Publications and websites	KSBB/LSGD
8. Adequate training to be given for waste handling staff in local bodies.	Short term	Number of training courses conducted	Green Kerala Kudumbasree Mission

#### Strategy 5.1.8: Ecosystem based /landscape-based adaptation for important ecosystems or landscapes of Kerala to address climate change

Action Plan	Time frame	Indicators	Implementing agency	Remarks
1. Implement adaptation schemes for wetlands, mangroves, sacred groves, bird sanctuaries, etc.	Long term	Adaptation projects in place	LSG, KFD, NGOs	
2. GIS maps to be generated for all protected areas including National Parks, Wildlife Sanctuaries, Ramsar sites, Sacred Groves, Botanical Gardens, Zoological parks, etc.	Short term	GIS maps generated	Universities and Research Institutes	
3. Ecologically important biomes to be identified, surveyed and notified for preservation.	Long term	Areas Notified	KFD	

4. Increase green cover outside the forest by encouraging planting of trees through agro forestry	Long term	Percentage change in trees outside forest	NGOs
5. Enforce strict rules to prevent dumping of waste materials in the forest.	Long term	Number of cases filed under Pollution control Acts	KFD, LSG
6. Adopt forest fire control measures by providing fire weather predictions and controlled burning in areas with heavy fuel load.	Short term	Fire weather predictions made available, Percentage change in forest fires	KFD
7. Execute Forest management plans for the different types of forests based on future climate change predictions.	Long term	Management plans revised	KFD
8. Create awareness among people about importance of forests and the surrounding landscape	Short term	Publications and websites	KSBB
9. Training sessions for planting of suitable trees for different geographical locations	Short term	Training courses conducted	Green Kerala Mission, KFD
<b>Strategy 5.1.9: Conservation of domesticated animal diversity in response to climate change</b>			
Action Plan	Time frame	Indicators	Implementing agency
1. Compile available research on the vulnerability-resilience of domesticated animal breeds in Kerala.	Long term	Research reports	KVASU, KAHD, KLDB
2. Assess the vulnerability and resilience to climate change of major domesticated animal breeds in Kerala with reference to the future climate predictions.			
3. Develop feed and fodder plants that are tolerant to climate extremes.	Long term	Species list published	KVASU, KAHD, KLDB

4. Ex situ conservation of some of the native breeds of cattle which are not popular with the farmers.	Long term	Breeds conserved ex situ	KVASU, KAHD, KLDB
5. Research to be promoted in emerging diseases of cattle and their potential spread in Kerala.	Long term	Trends in zoonotic diseases	KVASU
6. Research to be promoted in zoonotic and virus transmitted diseases among domesticated animals			
7. Initiate better breeding and rearing programs of native species adapted to local climate.	Long term	No of schemes related to conservation of native breeds	KVASU, KAHD, KLDB
8. Policies to be set in place for sustainable livelihood of farmers so that the new generation is encouraged to take up cattle farming.	Short term	Policy set in place	KVASU, KAHD, KLDB
9. Create awareness among farmers about climate change threats to cattle and other domesticated animals	Short term	Publications and websites	KVASU, KAHD, KLDB
<b>Strategy 5.1.10: Management of invasive species in the context of climate change</b>			
Action Plan	Time frame	Indicators	Implementing agency
1. Document all invasive flora and fauna which cause damage to the native flora and fauna	Medium term	Publications	KFRI, Universities
2. Develop practical and sustainable methods to control or manage the invasive species	Long term	Technical details published	Universities, KFRI, etc.
3. Frame rules and regulations to prevent clandestine introduction of plant/animal species	Short term	Rules framed	KSBB
4. Action to be taken for in situ or ex situ conservation of native species which are in threat from invasive species	Long term		KFD, Agriculture Dept.

5. Take up studies on understanding the life cycle and mode of spread of the invasive species. Universities, KFRI
6. Create awareness among forest protection staff and farmers about invasive species and the need to manage them Research reports  
Seminars and workshops conducted  
KSBB, KF-D, DLSG

**Strategy 5.1.11: Reducing air, water and land pollution which seriously affect biodiversity and there by ecosystem services**

Action Plan	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Encourage zero pollution vehicles such as EVs.</li> <li>2. Encourage water transport of goods wherever possible.</li> <li>3. Reduce traffic on roads by encouraging public transport and car-sharing.</li> </ol>	Medium term	Annual mean levels of fine particulate matter in cities (population weighted)	KSPCB, CPCB, Dept. of Transportation	
<ol style="list-style-type: none"> <li>4. Enforce strict rules to prevent pollution of rivers by public and especially by commercial establishments.</li> <li>5. Discourage the use of pesticides, herbicides and excessive nitrogen fertilizers.</li> </ol>	Medium term	Proportion of Water Bodies with Good Ambient Water Quality Proportion of waste water treatment capacity created vis-a-vis total generation Percentage sewage load treated in major rivers	KSPCB, CPCB, Irrigation Dept., KWA	
<ol style="list-style-type: none"> <li>6. Make arrangements for handling waste at the LSGD level.</li> <li>7. Enforce rules to prevent burning of waste materials in public places.</li> <li>8. Remove weeds from roadsides which are favourite places for waste dumping.</li> </ol>	Short term	Number of waste recycling plants installed Number of LSG banning single use plastic	KSPCB, CPCB, LSGD, DSLG	

9. Take up specific research on different aspects of reducing air and water pollution.	Long term	Research reports	Research Institutes
10. Create awareness among the public about “reduce, reuse and recycle” policy propagated by the United Nations.	Short term	Seminars and workshops conducted	Dept. of Environment, Kerala Surchitwa Mission
<b>Strategy 5.1.12: Establishing more efficient disaster management measures to minimise loss of biodiversity/human lives in a participatory mode</b>			
Action Plan	Time frame	Indicators	Implementing agency
1. Plant more trees or bamboos in marginal lands, river banks and other locations where landslides are common. 2. Revive mangrove restoration, which protects coastal communities from high waves and winds.	Medium term	No of schemes implemented	KFD, LSGD, NGOs
3. Enforce strict rules to prevent the construction of buildings in hazardous locations/slopes 4. EIA should be obligatory for all buildings above a specified floor area	Medium term	Rules enforced	PWD, LSGD, Disaster Management Authority
5. Farmers should be discouraged to cultivate in hazardous locations. 6. Give adequate insurance coverage to buildings and crops in vulnerable locations.	Medium term	Trends in Insurance schemes	Agriculture Dept.

7. Rehabilitation schemes should be put in place for all vulnerable locations so that people are given incentives to move out	Long term	Trends in Schemes declared	Housing Board
8. Limiting the urban spread in Kerala within the delineated urban profile is a must for the conservation of agricultural land, prevention of dilution of rural economy and protection of the fragile ecosystems of Kerala	Long term		LSGD
9. Strict policy guidelines should be laid down for all activities in vulnerable location	Short term	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	KSBB, KSPCB, DMA
10. Create awareness among the public about vulnerability of different locations and also about climate vagaries	Short term	Seminars and workshops conducted	Dept. of Environment, DMA
11. Train volunteers at local level to assist the DMA during times of disaster	Short term	Training courses conducted	Dept of Environ, DMA, LSGD

**Strategy 5.1.13: Development of a comprehensive spatial decision support system in the web GIS domain to show the areas of unique biodiversity with its structural and functional variable**

Action Plan	Time frame	Indicators	Implementing agency	Remarks
1. Develop a web GIS based decision support system to show areas of unique biodiversity	Medium term	GIS maps in place	KSBB, KUFOS	



2. Generate a biodiversity value (BV) map to identify locations where development or clearing will seriously affect biodiversity	Medium term	BV maps in place	KSBB, KUFOS
3. Biodiversity offset Scheme may be instituted for compensating biodiversity loss through developments	Short term	Policy laid down	KSBB

**Biodiversity and Bioresources map** – Although are very detailed information are available on the distribution of biodiversity and bioresources of Kerala, these are scattered and not retrievable for policy decision makers. KSBB may be entrusted with the development of a comprehensive spatial decision support system in the web GIS domain to show the areas of unique biodiversity with its structural and functional variable. If KSBB doesn't have infrastructure and expertise to host web GIS platform, it can entrust the work to other partnering organizations such as KUFOS.

**Investment in research and spatial data infrastructure** KSBB shall undertake comprehensive inventory of biodiversity resources at the State level with adequate funding in research, and converting the non-spatial data to spatial, and develop as a Geographical Management Information System.

**The Biodiversity Values Map (BV Map)** Identifies land with high biodiversity value that is particularly sensitive to impacts from development and clearing. The BV Map is one of the triggers for determining whether the Biodiversity Offset Scheme (BOS) applies to a clearing or development proposal.

**The Biodiversity Offsets Scheme** is the framework for offsetting unavoidable impacts on biodiversity from development with biodiversity gains through landholder stewardship agreements. Landholders can establish Biodiversity Stewardship Agreements to create offset sites on their land to generate biodiversity credits. These offset schemes are in place in countries such as USA and Australia.

## 5.2. LOCAL GOVERNANCE (PANCHAYAT, RURAL DEVELOPMENT, URBAN DEVELOPMENT)

### Strategy 5.2.1: Redefine the duties and responsibilities of BMCs for better performance and governance

Action Plan	Time frame	Indicators	Implementing agency
<p>Provide awareness trainings and capacity building programme to the elected LSG members/ officials/ ward members/ BMCs,</p> <p>Empower BMCs to work in accordance with the guidelines/ rules issued related to protection of environment by MOEFCC, NBA, Govt of Kerala, KSBB from time to time</p> <p>A standing committee of biodiversity and environment may be framed to strengthen the functioning of BMC</p> <p>Strengthen the functioning of the working group on Biodiversity, Environment and Climate change</p> <p>Provide seed money for establishing minimum infrastructure facilities like office space/ and furniture</p> <p>Periodic updation of PBR in a participatory manner</p> <p>Extended training and capacity building for periodical updation of PBR</p> <p>PBR digitization for data management and analysis for developing novel projects/ programs linked with planning process</p> <p>Formulate PBR based annual action plan for the management of Biodiversity conservation, ecosystem and sustainable utilization of bio resources</p> <p>Identify and designate locally unique areas mentioned in PBR as BHS/LBHS/OECM</p>	Long term	<p>Number of BMC trainings</p> <p>Number of PBRs updated</p>	<p>KSBB, BMCs, LSG, Line departments, TSG, KILA</p>

### Strategy 5.2.2: Strengthening the TSGs for improved functioning of BMCs

Action Plan	Time frame	Indicators	Implementing agency
<p>Currently there are TSGs at district level. The possibility of establishing TSG at BMC/ Panchayat level to be explored.</p> <p>Make the TSG involve in the PBR updation, preparation of management plans at BMC level for all activities related to Biodiversity conservation</p>	Short term	No: of projects proposed by BMC	BMC, KSBB, LSG, Line departments

**Strategy 5.2.3: Identify major threats, and implement effective measures through participatory approach for mitigating the gaps/issues at LSG level.**

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>1. Convergence with different line departments / nodal departments for integrated planning implementation and monitoring.</li> <li>2. Monitoring committee under the aegis/patron ship of BMC at the ward level to assess the diverse activities related to biodiversity conservation and its sustainable utilization, carried out at ward level.</li> </ol>	Long term	No: of environmental issues in which BMC was involved	BMC, LSG, KSBB, Line departments, KILA

**Strategy 5.2.4: Developing Model BMCs based on the geographical locations, performance and good governance of BMCs**

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>1. Awareness, Capacity Building to the selected model BMCs. (10 BMCs from all 14 districts) to formulate strategies and action plans for the next 10 each year.</li> <li>2. Strengthening the institutional structure and functioning of BMCs for effective implementation of BD Act- 2002 Rule- 2004 and KSBRR 2008.</li> <li>3. Support for resource mobilization for biodiversity conservation at LSG Level.</li> <li>4. Provide technical support for Biodiversity conservation, climate adaptation and mitigation activities, using GIS tools at the local level to map tradable bioresources in a panchayat for judicious harvesting.</li> <li>5. Formulation and implementation of Biodiversity Conservation and Sustainable Utilization related projects through BMC with the help of TSGs.</li> <li>6. Utilization of Biodiversity for income generation activity in a sustainable manner through ABS / levy of collection fee for commercially tradable bioresources</li> </ol>	Short term, Medium term and Long term	Number of Local action plan developed Number of approvals for access to bioresources given by BMC	BMC, KSBB, LSG, Line departments, KILA

### Strategy 5.2.5: Encourage Urban Biodiversity conservation for a healthy life

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>Promote planting of carbon sequestration potential plant/trees species in both private and public places</li> <li>Encourage biodiversity parks, Vrikshayurveda parks, Pachathruthu type of forest to absorb high carbon dioxide concentration in the urban area in collaboration with Haritha Keralam/Kudumbashree/NGO</li> <li>Development of city biodiversity index of major cities of Kerala</li> <li>Ensure the involvement of community participation/ housing societies for the promotion and conservation activities of biodiversity in the semi urban areas of Kerala.</li> <li>Regular inventory of air, water, quality in urban areas and monitoring and alleviation program in convergence mode</li> <li>Develop suitable short- and long-term projects related to biodiversity and ecosystem conservation and implementing through Corporation and Municipalities of Kerala State.</li> <li>Establishment of biodiversity conservation site / parks Shanthisthal in urban educational institutions</li> <li>A policy frame work shall be prepared and implemented to control indiscriminate felling of native varieties of trees in private and public sector.</li> </ol>	Short term, Medium term and Long term	Number of city biodiversity index developed Number of District plan on biodiversity developed	BMC, LSG, Line departments, TSG, RTSG

### Strategy 5.2.6: Protection of Local biodiversity from invasive alien plant species/ animals at LSG Level

Action Plan	Time frame	Indicators	Implementing agency
<ol style="list-style-type: none"> <li>Document invasive alien species that destroy the local biodiversity, their distribution in the different locations within and outside the forest.</li> <li>Develop protocol for invasive management and implementation through MNREGS</li> <li>Encourage R &amp; D centres to find out alternative uses of IAS</li> </ol>	Short term, Medium term & Long term		BMC, KSBB, LSG, Line departments, JNTBGRI, MBGIPS, KFRI, RGCB, University

## 6. STRATEGY AND ACTION PLAN FOR INFRASTRUCTURE SECTOR

### 6.1. WATER RESOURCES

#### Strategy 6.1.1: Comprehensive Integrated Water Resources Management (IWRM)

Action Plan	Time frame	Indicators	Implementing agency	Remarks
	Short term/ Medium term/ Long term	Policy implementation Strategies		
Cross-Sectoral coordination in policy development, planning, and implementation of water resources and related infrastructure	Long term / Short term	Number of integrated watershed management programs implemented	1. Irrigation Department; 2. Ground Water Department; 3. Command Area Development Authority (CADA); 4. Kerala Irrigation and Infrastructure Development Corporation, 5. Department of Agriculture and farmers Welfare. 6. CWRDIY	
Integrated Watershed Management in the Hilly area and upper sub-catchments	Medium term		1. Soil Survey and Conservation 2. Agriculture Development and Farmer's welfare	
Soil conservation and erosion protection in the upper catchments			Soil Survey and Conservation Agriculture Development and Farmer's welfare	
Management of coastal river outlets.				
Mitigation of flood risks – through 'Room for the River'	Long term		Irrigation department	

Riparian stabilization of river banks with vegetative cover for preventing bank erosion	Medium term	Soil Survey and Conservation
Promotion of conjunctive use of surface and groundwater	Medium term	Ground water department Irrigation department
<b>Strategy 6.1.2. Promotion of water conservation</b>		
Promotion of both in situ and ex situ water harvesting	Medium term	1. Soil Survey and Conservation 2. Agriculture Development and Farmer's welfare
Repair and Maintenance of traditional ground water sources such as Surangam, Keni, and Springs	Medium/long term	1. Soil Survey and Conservation 2. Agriculture Development and Farmer's welfare 3. Irrigation Department
Promotion of rooftop rainwater harvesting at household and at institutional levels	Short/long term	LSGDs
<b>Strategy 6.1.3. Reduce water footprint</b>		
Collective action to reduce basin water footprint	Long term	1. Irrigation Department; 2. Kerala Water Authority; 3. Ground Water Department; 4. Jala Nidhi (Rural Water Supply and Sanitation); 5. (Irrigation) Command Area Development Authority (CADA); 6. Kerala Irrigation and Infrastructure Development Corporation
Reduce water footprint through improved practices and technologies	Medium/Long term	1. Soil Survey and Conservation 2. Agriculture Development and Farmer's welfare

<p>Decrease green water footprint (m3 /ton) by increasing green water productivity (ton/m3) in both rain-fed and irrigated agriculture. Increase total production from rain-fed agriculture</p>	<p>Department of Agriculture Development and Farmer's welfare Kerala Agriculture University, CWRDM</p>
<p>Decrease blue water footprint (m3/ton) by increasing blue water productivity (ton/m3) in irrigated agriculture</p>	<p>Department of Agriculture Development and Farmer's welfare</p>
<p>Reduce grey water footprint in agriculture by using less fertilizers and pesticides</p>	<p>Department of Agriculture Development and Farmer's welfare</p>
<p>Step up measures for full recycling of blue water in industry</p>	<p>Industries</p>
<p>Reusing grey water, for improving water foot print</p>	<p>Industries</p>

1. IWRM is a process that promotes the coordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”
2. The concept of ‘Room for the River’ is essentially to provide more space for the river or a water body so that it can manage high water flows during floods.
3. Water footprint is a consumption-based indicator referring to the total amount of water including virtual water consumed by a person, group, company, or a region per unit time- mostly year.

## 6.2. Tourism

### Strategy 6.2.1: Implement sustainable ecotourism

Action Plan	Time frame	Indicators	Implementing agency
Landscape based approach to tourism with sustainable management of environment	Long term	Maps generated	L.SGD Responsible tourism Forest dept
<ol style="list-style-type: none"> <li>Study of carrying capacity of major tourist destinations and promotion of carrying capacity-based tourist flow</li> <li>Develop strategies for round the year tourism to reduce pressure during peak season</li> <li>Promote sustainable transportation methods like electric cars, electric boats, pedal boats, cycles.</li> <li>Green certification to tourist hotels for conserving and preserving environment</li> <li>Institutionalize community-based surveillance and patrolling systems especially in higher altitude landscapes</li> </ol>	Long term	<p>No of carrying capacity studies conducted</p> <p>No of Green hotels certified</p> <p>No of no-go areas earmarked</p> <p>Green protocols implemented</p>	<p>Forest Dept., SPCB</p> <p>Responsible tourism mission LSGD</p>
Regular monitoring of environmental quality and land-use change, spread of invasive species in and around tourism sites	Long term	Environment audit	Forest Dept., LSGD, KSBB
Environmental assessment, including assessment of cumulative impacts and effects on biodiversity of all proposed tourism development projects			



<p>Tour operators and guides must be trained to understand and implement the ideas of “Responsible Tourism”, training to function as nature interpreters, training for home-based hospitality.</p>	<p>Short term</p>	<p>KSBB, LSGD, Tourism Department, Responsible tourism missions.</p>
<p>Awareness to tourists to prevent road kills and other irresponsible behavior in vulnerable areas</p>		
<p>Strategy 6.2.2: Improve/uplift the livelihood of local communities through ecotourism</p>		
<p>Action Plan</p>	<p>Time frame</p>	<p>Implementing agency</p>
<p>Study nature of local-tourist interactions and attitudes towards tourists and tourism and tribals/local communities</p>	<p>Short term</p>	<p>LSGD, Tourism Dept.</p>
<p>Explore effective participation of indigenous and local communities in the development, operation and monitoring of tourism activities on lands and waters</p>	<p>Short term</p>	<p>Tourism related employment generated No of entrepreneur trained under Responsible Tourism mission No of homestays</p>
<p><b>Strategy 6.2.3: Mainstreaming Biodiversity in Tourism</b></p>		
<p>Action Plan</p>	<p>Time frame</p>	<p>Implementing agency</p>

KFD

Maps generated

1. Identification and mapping of key biodiversity areas in tourist places and develop local management plans
2. Mapping of no-go areas in core areas of protected areas, nesting sites, sites with RET species, no plastic areas etc.
3. Mapping of wild life corridors and other sensitive areas and regulating night traffic
4. Enforce bio security measures for foreign tourists to prevent spread of invasive species

Guidelines developed

5. Promoting eco-friendly construction.
6. Establishment of Nature Interpretation centers in selected areas
7. Insist green auditing and social auditing in major tourist spots and also implement polluter pay principle

Kerala Forest Dept.,  
LSGD,  
Tourism Dept.

Long term      Guidelines developed

### 6.3. Energy

#### Strategy 6.3.1: Conserve energy by reducing the use of power/electricity

Action Plans	Time frame	Indicators	Implementing agency	Remarks
1. Limit the use of fans/lights in all public places. Govt. offices should be a model in this and enforce through orders.	Short term	Unit of electricity consumed	Electricity department ANERT	

2. Change the bulbs/tubes to energy saving LED bulbs/tubes.	Long term	Electricity department ANERT
4. Encourage the use of biogas in rural areas	Long term	Electricity department ANERT
5. Train peoples in energy saving/ conservation activities.	Long term	Electricity department ANERT
<b>Strategy 6.3.2: Encourage alternate sources of energy</b>		
6. Establish roof top solar plants	Long term	Solar/Wind energy generated Electricity department ANERT
7. Wind farms are possible in many parts of Kerala especially in Idukki and Palakkad districts and technical feasibility to be explored	Long term	Solar/Wind energy generated Electricity department ANERT
8. By burning waste, power can be generated, but improved technologies to be designed to avoid pollution issues.	Long term	
9. Replicate the solar powered energy utilization installed in cochin International Airport to other places as well	Long term	
10. Remedial measures to control possible environmental impacts of renewable energy	Long term	
<b>Strategy 6.3.3: Reduce the transmission loss in electricity</b>		
1. Locate areas in the State where transmission loss is high and try to control the same.	Medium term	Electricity department ANERT
2. The LSGs may be given a role in decentralized power generation and distribution.	Medium term	

## 6.4. Transport

### Strategy 6.4.1: Avoid constructing new roads and other transport facility by destroying natural forests, wetlands, mangroves etc.

Action Plans	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>Maintain and manage efficiently the existing transport system and avoid construction of new roads by damaging the existing fragile ecosystems.</li> <li>Even while laying new roads, hills shall not be demolished and wherever water bodies come, construct bridges.</li> <li>Measures to be adopted to reduce sound pollution in the roads adjacent to forest areas/ecotourism areas to avoid disturbances to wild animals. Same is the case with some of the adventure tourism related activities in the forest areas.</li> <li>Wherever public land is available, provide the same for widening the existing roads, and if land is acquired from private parties compensate suitably without delay.</li> <li>Encourage transport of goods/materials through waterways and railways rather than through road.</li> </ol>	Long term	Roads constructed in forest areas	Transport Dept.	

### Strategy 6.4.2: Encourage more eco-friendly public transport system

Action Plans	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>Increase the public transport facilities</li> <li>Encourage water transport facilities and provide incentives to those who make water service in rivers.</li> <li>Encourage use of cycles in cities (in level grounds) and also provide separate tracks for cycle riders and pedestrians to avoid accidents.</li> <li>All existing Ports in the State to be upgraded for efficient water transport.</li> <li>Encourage solar powered boats, which is cost effective and eco-friendly and provide subsidies for the fishermen to go for this option who now uses kerosene, which is not economical.</li> </ol>	Long term	Number of electric vehicles registered	Transport Dept.	

**Strategy 6.4.3: Develop quality roads for transport which can sustain the traffic pressure for next 25 years**

Action Plans	Time frame	Indicators	Implementing agency	Remarks
<ol style="list-style-type: none"> <li>1. Ensure run off of rainwater to avoid damage to roads</li> <li>2. Use eco-friendly materials and ensure life of roads for at least 20- 25 years without damage.</li> <li>3. Provide avenue trees, wherever possible to maintain the microclimate of the roads and also maintain foot paths.</li> <li>4. Ensure speed breaks, all markings, road signs in all major junctions and vulnerable places to prevent accidents/traffic blocks.</li> <li>5. Ensure the enjoyment of a driver while driving a vehicle than driving with tension.</li> </ol>			Transport Dept.	

# CHAPTER 5

## Convergence with International, National and State Policies and legislations

### 5.1 Relevant policies and legislations

#### 5.1.1 International Conventions

- 1. United Nations Convention to Combat Desertification (UNCCD) 1994:** Desertification, along with climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit. Established in 1994, UNCCD is the sole legally binding international agreement linking environment and development to sustainable land management.
- 2. UN Framework Convention to Climate Change, (UNFCCC) 1992.** The UNFCCC is a “Rio Convention”, one of three adopted at the “Rio Earth Summit “in 1992. The ultimate objective of the Convention is to stabilize the greenhouse gas concentrations “at a level that would prevent anthropogenic (human induced) interference with the climate system” It states that “such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner”
- 3. Convention on Biological Diversity (CBD) 1992:** The Convention on Biological Diversity (CBD) came into force on 29 December 1993 and has

3 main objectives: conservation of biological diversity, sustainable use of the components of biological diversity, fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

4. The **United Nations Convention on the Law of the Sea (UNCLOS) 1982**: It is also called the **Law of the Sea Convention** or the **Law of the Sea Treaty**. It is an international agreement that establishes a legal framework for all marine and maritime activities.
5. **Convention on the Conservation of Migratory Species of Wild Animals (CMS)/Bonn Convention 1979**: As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.
6. **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1975**: Aims to ensure that international trade of wild animals and plants does not threaten their survival.
7. **The UNESCO World Heritage Convention 1972**: The World Heritage Convention under the aegis of the United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for listing of World Heritage Sites, which include both cultural and natural sites. It links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.
8. The **Ramsar Convention on Wetlands of International Importance 1971**: The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world"

## 5.1.2 National and State policies and legislations

### 1. Forest

In India, the national and state governments are jointly responsible for the sustainable management of the forest resource. The Indian Forest Act of 1927, the country's guiding forestry legislation, sought to consolidate and preserve areas with forest cover or significant wildlife, to regulate movement and transit of forest produce, and to levy duties on timber and other forest produce.

The Forest Conservation Act 1980 necessitates prior approval of the Central Government for the diversion of forest areas for the non-forestry purposes. Diversion of forest land is mostly allowed in order to meet developmental needs for drinking water and irrigation projects, transmission lines, railways, roads, power projects etc. The Act stipulates that compensatory afforestation must take place and plans for catchment area treatment, biodiversity and wildlife conservation, rehabilitation etc., must be submitted to the State authority. The National Forest Policy, 1988 was formulated to ensure compensatory afforestation, essential environmental safeguards, sustainable utilization, maintenance, restoration, and enhancement of forest areas and stressed that forests should meet the subsistence requirements of people. The various Central and State Government legislations in this context are listed below:

### Central Acts and Rules

- 1. The Scheduled Tribes And Other Traditional Forest Dwellers Act, 2006:**  
An Act to recognize and vest the forest rights and occupation in forest land in forest dwelling. The list of rights as provided under the Act includes:
  - Right to live in the forest under the individual or common occupation for habitation or for self-cultivation for livelihood
  - Right to access, use or dispose of minor forest produce
  - Rights of entitlement such as grazing and traditional seasonal resource access
  - Rights for conversion of leases or grants issued by any local authority or any state government on forest lands to titles
  - Right to protect, regenerate or conserve or manage any community forest resource.
- 2. The Biological Diversity Act 2002 and Biological Diversity Rules 2004 :**  
The Act covers conservation, use of biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey and bio-utilisation. It provides a framework for access to biological resources and sharing the benefits arising out of such access and use. The Act also includes in its ambit the transfer of research results and application for Intellectual Property Rights (IPRs) relating to Indian biological resources. The Act covers foreigners, non-resident Indians, body corporate, association or organization that is either not incorporated in India or incorporated in India with non-Indian participation in its share capital or management.
- 3. The Forest (Conservation) Act 1980, Amended in 1988,** provides for the protection of and the conservation of the forests. It strictly restricts and



regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government

4. **The Wildlife Protection Act 1972, Amended 1993 , 2006** was enacted with the objective of effectively protecting the wild life of the country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. It has six schedules which give varying degrees of protection. Schedule I and Schedule II provide absolute protection - offences under these are prescribed the highest penalties. Species listed in Schedule III and Schedule IV are also protected, but the penalties are much lower. Schedule V includes the animals which may be hunted. The plants in Schedule VI are prohibited from cultivation and planting.
5. **The Indian Forest Act 1927 and Amendment, 1984**, was enacted to consolidate the law related to forest, the transit of forest produce, and the duty on timber and other forest produce.
6. **The Prevention Of Cruelty To Animals Act, 1960** An act to prevent the infliction of unnecessary pain or suffering on animals and for that purpose to amend the law relating to the prevention of cruelty to animals

### Rules

1. Forest (conservation) Amendment Rules, 2014
2. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Amendment Rules 2012
3. Wetlands (Conservation and Management) Rules, 2010.
4. Biological Diversity Rules 2004
5. Forest (Conservation) Rules, 2003
6. National Board for Wildlife Rules, 2003
7. Wildlife Stock Rules 2003
8. Wildlife (Specified Plant Stock Declaration) Central Rules, 1995
9. Wildlife (Specified Plants- Condition for Possession by Licensee) Rules, 1995  
Wildlife (Protection) Rules, 1995
10. Recognition of Zoo Rules, 1992
11. Environment Protection Rules, 1986
12. Wildlife (Protection) Licensing (Additional Matters for Consideration) Rules, 1983
13. Wildlife (Stock Declaration) Central Rules, 1973

14. Wildlife (Transactions & Taxidermy) Rules, 1973

#### State Acts

1. **Kerala Forests (Vesting and Management of Ecologically Fragile Lands) Act, 2003 Amendment 2009** An Act to provide vesting of ecologically fragile lands in the State of Kerala with the Government and for the management of such lands with a view to maintain ecological balance and conserving the bio-diversity.
2. **Kerala Preservation of Trees Act 1986** An Act regulating trees standing in the area specified in the Schedule from being cut, uprooted, burnt or otherwise destroyed except on the ground that the tree constitutes a danger to life or property or the tree is dead, decayed or wind fallen.
3. **The Kerala private forests (vesting and assignment) act, 1971 (act 26 of 1971) (as amended by act 5 of 1978, act 20 of 1981 and act 36 of 1986)** An Act to provide for the vesting in the Government of private forests in the State of Kerala and for the assignment thereof to agriculturists or agricultural labourers for cultivation
4. **Kerala Restriction on cutting and destruction of valuable trees Act 1974**
5. **Kerala forest act, 1961(act 4 of 1962)** An act to unify and amend the law relating to the protection and management of forests in the State of Kerala

#### State Rules

1. Kerala Forest (Regulation of Sawmills and Other Wood-based Industrial Units) Rules,2021
2. Kerala Captive Elephants (Management and Maintenance) Rules,2012
3. Kerala promotion of Tree Growth in Non - forest areas Rules, 2011
4. The Kerala Forest(Vesting and Management of Ecologically Fragile Lands) Rules,2007 Amendment 2009
5. The Kerala Captive Elephants(Management and Maintenance) Rules,2003
6. Kerala Forest (Salvaging, Collection and disposal of Drift and Stranded Timber) Rules, 1995
7. Kerala Forest (Regulation of Rewards) Rules, 1995
8. Kerala Forest (Prohibition of Felling of Trees Standing on Land Temporarily or Permanently Assigned) Rules, 1995
9. Kerala Forest (Grazing) Rules, 1985
10. Kerala Forest Development Fund Rules, 1989

11. The Kerala Rules for Payment of Compensation to Victims of Attack by Wild Animals, 1980
12. The Kerala Forest Produce Transit Rules, 1975
13. Kerala Private Forest (Vesting and Assignment) Rules, 1975
14. Kerala Forest (Preservation, Reproduction and Disposal of Trees and Timber belonging to Government but Grown on Lands in the Occupation of Private Persons) Rules, 1975
15. The Kerala Restriction on Cutting and Destruction of Valuable Trees Rules, 1974
16. The Forest Settlement Rules, 1965
17. Kerala Forest (Regulation of Timber transit by Waterways) Rules, 1965
18. Kerala Hillmen Rules, 1964

## 2. Agriculture and Animal Husbandry

### Central Acts

1. State /UT Agricultural Produce & Livestock Contract Farming and Services (Promotion & Facilitation) Act, 2018.
2. Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017 and Rules
3. Organic Agricultural Produce Grading and Marking Act and Rules 2009 (Amendment) Rules, 2011
4. Protection of Plant Varieties & Farmers' Rights Act, 2001 and Rules 2003
5. Model Agricultural Produce Market Committee Act, 2003
6. The Seeds Act 1966 and Rules 1968, (Amendment) Rules, 1973, 1974, 1981
7. Insecticides Act, 1968 and Rules 1971
8. Agriculture Produce (Grading & Marking) Act, 1937
9. The Destructive Insects and Pests Act, 1914
10. The Essential Commodities Act, 1955

### State Acts

1. Kerala Agriculture workers Act, 1974, Amendment 2010
2. The Kerala Agricultural Pests And Diseases Act, **1958** to make provision for preventing the spread of insect pests, plant diseases and noxious weeds within the State of Kerala

3. Kerala State Organic Farming Policy, 2010
4. Kerala State Environment Policy, 2009
5. The Kerala Conservation of Paddy and Wetland Act, 2008
6. Agricultural Development Policy, 2015

### 3. Fisheries

#### Central Acts, Policies and Rules

1. **The Indian Fisheries Act, 1897:** An Act to provide for certain matters relating to Fisheries. Destruction of fish by explosives in inland waters and on coasts, Destruction of fish by poisoning of waters, and Protection of fish in selected waters by rules of State Government are covered under this Act.
2. **National Fisheries Policy, 2020:** The National Fisheries Policy 2020 would offer a strategized way forward to develop, harness, manage and regulate capture and culture fisheries in a responsible and sustainable manner. The Policy will ensure a productive integration with other economic sectors, such as agriculture, coastal area development and eco-tourism, to meet the goals of the 'Blue Economy'.

#### State Acts and Rules

1. **The Kerala Marine Fishing Regulation Act, 1980, amendments 2021** An act to provide for the regulation of fishing-by-fishing vessels in the sea along the coastline of the State, \*registration of boat building yard and fishing net production Unit, constitution of fisheries management councils and for matters connected therewith or incidental thereto.
2. **The Kerala Fishermen Welfare Societies Act ,1980** An Act to provide the organisation of fisheries villages and to constitute fishermen welfare societies for such villages with a view to develop the economic, social and cultural life of the fishermen community in the State of Kerala.
3. **The Kerala Monsoon Fishery ( Pelagic)Protection Act,2007(Act 13 of 2007)** An Act to provide for security of life and livelihood of the traditional fishermen and to ensure their subsistence by occupying pelagic fishery through tapping the unique pelagic fishery resources in the State like *chakara* in monsoon season and to, regulate them and for matters connected therewith or incidental thereto
4. **The Kerala Fishermen's and allied workers Welfare Cess Act 2007(9 of 2007)** An Act to provide for the levy and collection of cess on the sale proceeds of fish, fish products, allied objects and equipment's within the State with a view to augmenting the resources of the Kerala Fishermen's

Welfare Fund constituted under section 3 of the Kerala Fishermen's Welfare Fund Act, 1985 (30 of 1985)

5. The Kerala **Inland Fisheries and Aquaculture Act 2010** amendments 2021
6. The Kerala Fish Seed Act, 2014 (4 of 2015)

#### 4. Environment

1. **The Water (Prevention and Control of Pollution) Act 1974** The Act aims to prevent and control water pollution and to maintain/restore wholesomeness of water by establishing central and state pollution control board to monitor and enforce the regulations. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The Pollution Control Board (CPCB) was constituted under this act.
2. **The Water (Prevention and Control of Pollution) Cess Act 1977** provides for the levy and collection of cess or fees on water consuming industries and local authorities.
3. **The Air (Prevention and Control of Pollution Act 1981** provides for the control and abatement of air pollution.

**The Air (Prevention and Control of Pollution) Rules 1982** defines the procedures of the meetings of the Boards and the powers entrusted to them.

4. **The Environment (Protection) Act 1986** was enacted in 1986 with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities [under section 3(3)] charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. The Act was last amended in 1991.

**The Environment (Protection) Rules 1986** lay down procedures for setting standards of emission or discharge of environmental pollutants.

5. **National Environment Tribunal Act 1995** has been created to award compensation for damages to persons, property and the environment arising from any activity involving hazardous substances.
6. **The National Environment Appellate Authority Act 1997** has been created to hear appeals with respect to restrictions of areas subject to certain safeguards under the EPA (Environment Protection Act)
7. **The Coastal Regulation Zone Notification 1991 Amended 2011** This impose restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ. This notification reconcile three objectives: protection of livelihoods of traditional fisher folk communities;

preservation of coastal ecology; and promotion of economic activity that have necessarily to be located in coastal regions.

- 8. The National Green Tribunal Act, 2010:** The Central Government shall, by notification, establish, with effect from such date as may be specified therein, a Tribunal to be known as the National Green Tribunal to exercise the jurisdiction, powers and authority conferred on such Tribunal by or under this Act. The Tribunal has jurisdiction over all civil cases involving substantial question relating to environment (including enforcement of any legal right relating to environment)

### Other relevant legislations

- 1. The Patents Act 1970 Amendment 1999, 2002, 2005 and Patents Rules, 2003, as amended by the Patents (Amendment) Rules 2006, 2012, 2014.** An invention relating to a product or a process that is new, involving inventive step and capable of industrial application can be patented in India. However, it must not fall into the category of inventions that are non-patentable as provided under Section 3 and 4 of the (Indian) Patents Act
2. The Kerala Protection of River Banks and Regulation of Removal of Sand Act, 2001
3. The Kerala Ground Water (Control and Regulation) Act, 2002
4. Kerala Minor Mineral Concession Rules, 1967, Amendment 2015

### 5.2 Linkages with National and International Legislations

India has adopted the Sustainable Development Goals (SDG) and aligned its development priorities with the Global Goals. The State Government of Kerala has also undertaken a massive exercise of mapping all the plan schemes of the various departments with the core principle, “to leave no one behind”. The State Planning Board has also provided directions to all government departments to ensure that adequate investments across sectors target achieving the SDGs. Localisation of SDGs based on the individual critical development priorities, data availability, state specific issues etc ., is crucial to achieving the goals under the 2030 agenda. Kerala is in the process of developing state specific indicators. The Aspirational District Programme (ADP) of NITI Aayog aims to rapidly transform the development parameters of low-performing districts in the country and metamorphose them into champions and in Kerala only one district namely Wayanad has been identified as an aspirational district. The SDG Index developed by NITI Ayog for 2020-21 shows that Kerala has achieved commendable progress and has also retained its rank as the top State with a composite score of 75 against the national score of 66 in 2020-21.

Almost all of the SDGs are relevant to biodiversity conservation although SDGs 13 (combating climate change) and 14 and 15 (marine and terrestrial biodiversity and ecosystems) have been identified as the Environmental dimensions of SDG and have greater biodiversity conservation linkages. Linkages between NBTs, ABTs and SDGs are depicted in Table 14.

**Table 13: Kerala SDG India Index Performance**

CATEGORIES	GOALS	SCORE	RANK	
PERFORMER (50-64)	SDG-5 (Gender Equality)	63	2	
	SDG-8 (Decent work and economic growth)	62	12	
	SDG-9 (Industry, innovation and infrastructure)	60	9	
	SDG-14 (Life below water)	53	6	
FRONT-RUNNER (65-99)	SDG-1 (No poverty)	83	2	
	SDG-2 (Zero hunger)	80	1	
	SDG-3 (Good health and well-being)	72	14	
	SDG-4 (Quality education)	80	1	
	SDG-6 (Clean water and sanitation)	89	8	
	SDG-10 (Reduced inequalities)	69	12	
	SDG-11 (Sustainable cities and communities)	75	17	
	SDG-12 (Responsible consumption and production)	65	23	
	SDG-13 (Climate action)	69	2	
	SDG-15 (Life on land)	77	6	
	SDG-16 (Peace, justice and strong institutions)	80	5	
ACHIEVER (100)	SDG-7 (Affordable and clean energy)	100	1	
OVERALL PERFORMANCE	All SDG's	75	1	

**Table 14 Linkages between CBD Strategic Goals, NBTs, SDGs and Aichi Targets**

	<b>Strategic Goal A</b>	<b>Strategic Goal B</b>	<b>Strategic Goal C</b>	<b>Strategic Goal D</b>	<b>Strategic Goal E</b>
CBD Strategic Goals (Different aspects of conservation)	Address causes of biodiversity loss by mainstreaming biodiversity across sectors	Reduce direct pressures on BD and promote sustainable use	Improve the status of BD by safeguarding ecosystems species and genetic diversity	Enhance the benefits to all from biodiversity and ecosystem services	Enhance implementation through participatory Planning, knowledge management and Capacity building
NBTs (alignment)	NBTs (1, 2 & 10)	NBTs (3, 4, 5 & 6)	NBTs (6 & 7)	NBTs (3, 8 & 9)	NBTs (10, 11 & 12)
Aichi Targets (alignment)	1, 2, 3 & 4	5, 6, 7, 8, 9 & 10	11, 12 & 13	14, 15 & 16	17, 18, 19 & 20
Sustainable Development Goals	1,2,3,4,5,8, 10, 12,13, 17	2, 6, 7, 11, 13, 14, 15	2, 6, 11, 14, 16	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 14, 15	2, 3, 4, 7, 9, 12, 14, 15, 17

The Aichi biodiversity targets of direct relevance to Agro diversity includes

- **Target 3 (phasing out incentives and subsidies harmful to biodiversity)**
- **Target 4 (sustainable consumption and production)**
- **Target 7 (sustainable agriculture)**
- **Target 8 (control of pollution, including from excess nutrients)**
- **Target 9 (invasive alien species prevented and controlled)**
- **Target 13 (genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives).**

The Sustainable Development Goals of relevance to Agrobiodiversity includes

1. SDG 2 : Zero Hunger emphasizes that by 2030, the agricultural productivity and the income of the small scale food producer's (women, indigenous people, family farmers, pastoralists and fishers) doubled and also the genetic diversity of seeds, cultivated plants, farmed and domesticated animals and their wild species need to be maintained.

SDG 2.1 - By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round .



SDG 2.2 - By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.

2. SDG 3 -Good health and well being

3. SDG 12 Responsible consumption and Production

In consonance with the international commitments India has developed 12 National Biodiversity Targets of which the following are relevant to Agrobiodiversity:

1. Target 5 - By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries;
2. Target 7 - By 2020, genetic diversity of cultivated plants, farm livestock and their wild relatives, including other socio-economically as well as culturally valuable species, is maintained and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

It is important to have a broader perspective of multiple synergies and trade-offs with other goal/targets. Health-biodiversity linkages need to be integrated not only into strategies and policies for health and for biodiversity, but also for agriculture, fisheries and food production, planning (urban and rural planning and land use), and adaptation to climate change and disaster risk reduction, as well as economy and finance. The SDGs are intertwined with areas involved in climate change and will contribute immensely to the pathways of climate change adaptation and mitigation in the State. Strategies for poverty eradication (SDG 1), food security (SDG 2), health (SDG 3), water and sanitation (SDG 6) will get affected by changing climatic conditions. The energy source (SDG 7), nature of economic activities (SDG 8), urbanisation (SDG 11) will determine carbon emissions and country Goals 12 through 15 of the SDGs focus on strategies for reversing the negative impacts of economic development on ecosystems and the services they provide. SDG 12 (Target 12.2, 12.8) focus on reducing the pressure on resources through promotion of sustainable consumption and production pattern. SDG 15 on sustainable use of terrestrial ecosystem is further defined by nine 'level 1' targets and three 'level 2' targets. SDG 15 is linked to SDG 2 on food security (target 2.3, 2.4, 2.5), SDG 6 (Target 6.3, 6.4, 6.5, 6.6) on water and sanitation, SDG 11 (Target 11.4, 11.6, 11.7) on sustainable cities and SDG 13 (13.1) on Climate Change. Tourism relates to many of the 20 Aichi Biodiversity Targets. Some Targets (5, 8, 9, 10 and 12) ensure greater control and management to reduce damage to biodiversity from tourism. For others (1, 11, 15, 18, and 20) this is about the positive contribution of tourism to biodiversity awareness, protected areas, habitat restoration, community engagement, and resource mobilization. A

major limitation as documented in the SDG India Index report 2020-21 is pertaining to the frequency of data sources. National **Biodiversity** Targets (NBT) 2, 3,4,5,6,8,9,10,12 and Aichi Targets 2,3, 4, 5,6, 7, 8, 9, 10, 11, 12, 14, 15, 17, 19, 20 are concomitant with SDG 15.

### **Linkages and Synergies between NBTs and NDCs**

In 2015, 196 countries came together to sign the historic Paris Agreement, guided by the United Nations Framework Convention on Climate Change (UNFCCC), in order to deal with global warming impacts. Countries submitted their Intended Nationally Determined Contribution (INDC) to the UNFCCC which outlines their commitments to reduce greenhouse gas emissions and strengthen resilience to climate change. The National Action Plan on Climate Change (NAPCC) in India is implemented through eight National Missions. The eight missions are:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

The National Biodiversity Mission of 2018 proposes a two-component programme to bring biodiversity science to the forefront of scientific and public engagement. The first component, titled the 'Cataloguing and Mapping Life of India' programme will focus on building an inventory of India's biodiversity, and will use digital tools to map this biodiversity with people, cultures, and management regimes. This component aims to build databases that can assess and monitor changes in biodiversity and ecosystem services, and link biodiversity knowledge with societal benefits. The component will also engage citizens in collecting biodiversity data to build awareness of the rich natural heritage of India and the need for conservation. The second component is divided into six programmes, which will focus on biodiversity with regard to ecosystem services; climate change and disaster risk reduction; agriculture; health; bio-economy; and capacity building and outreach.

Almost all of the NDCs are relevant to biodiversity conservation although NDC 5, 6 and 7 have stronger biodiversity conservation linkages. The NDC framework includes:

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level.
4. To achieve about 40 per cent cumulative electric power installed capacity from nonfossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
5. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO<sub>2</sub> equivalent through additional forest and tree cover by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
7. To mobilize domestic and new and additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

The Government of India has launched a number of schemes for transformation and rejuvenation of urban areas including Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and National Heritage City Development and Augmentation Yojana (HRIDAY). Under the Smart Cities Mission, 100 smart cities are planned with the objective to develop new generation cities, which will provide core infrastructure and a decent quality of life to its citizens by building a clean and sustainable environment. Smart solutions like recycling and reuse of waste, use of renewables, protection of sensitive natural environment will be incorporated to make these cities climate resilient. In Kerala two cities Kochi and Thiruvananthapuram have been included in the scheme. Kochi is the first city in India to develop a Local Biodiversity Strategy and Action Plan through a participatory process and has identified nine focus area.

## 5.3 Linkages of State Biodiversity Strategies and Action Plan with National Biodiversity Targets

**Table 15 Linkages of State Biodiversity Strategies and Action Plan with National Biodiversity Targets**

Sl. No.	Strategy	NBT
1. Forest and Biodiversity		
1.1	Restoration of degraded ecosystems	2, 3, 5, 6, 8, 11
1.2	Accelerate the carbon sink potential of forests	3, 5, 6, 8
1.3	Enhance resilience to combat climate extremes such as flood, drought, landslides, forest fire, natural calamities etc.	2, 3, 5, 8
1.4	Manage human wildlife conflicts and road kills of wild animals in a participatory mode	3, 5, 6
1.5	Forest plantation management to enhance wood productivity	5
1.6	Eco restoration of riverbanks	2, 5, 6, 8
1.7	Regulate unscientific mining and quarrying along the fringes of the forests	2, 3
1.8	Restoration/ Conservation of unique ecosystems such as sacred groves, laterite hillocks, cliff vegetation and fresh water swamps, Grasslands etc.	2, 3, 4, 5, 6, 7
1.9	A landscape approach of conservation in the PAs, wildlife sanctuary, Biosphere reserves/ community reserves and areas where human -wildlife interact constantly	2, 3, 6, 7, 8
1.10	Documentation of Biodiversity in PAs and Outside PAs	2, 3, 6, 7, 8
1.11	Documentation and conservation of NTFP/medicinal plants	2, 3, 5, 7, 9, 11
1.12	Conservation of biodiversity rich areas outside protected areas	3, 5, 6, 11
1.13	Ex- situ conservation of threatened /endemic species/ stone species	2, 5, 6, 7
1.14	Conservation of traditional knowledge associated with biodiversity, patent and benefit sharing	1, 2, 7, 9, 10, 11, 12
1.15	Documentation and eradication of invasive/alien species within and outside forest	1, 2, 4, 11

<b>Sl. No.</b>	<b>Strategy</b>	<b>NBT</b>
1.16	Development of urban forest and articulation urban heat islands	2, 6, 8, 11
1.17	Prevent depletion and degradation of wild biodiversity resources	2, 3, 5
1.18	Conservation of below ground biodiversity including microbes	1, 2, 3, 7, 12
1.19	Strengthening implementation of policy, legislative and administrative measures for biodiversity conservation and management	1, 2, 11, 12
1.20	Adopt agroforestry to achieve food security and for accelerating restoration of local biodiversity	2, 3, 5, 8, 11
1.21	Prevention of zoonotic diseases/ disease spread to humans/ domestic animals through wild animals	1, 2, 6
<b>2. Coastal and Inland biodiversity</b>		
2.1	Conservation of Mangrove ecosystems	1, 2, 3, 5, 6, 8, 11
2.2	Eco restoration of Riparian vegetation	1, 3, 6, 8, 11, 12
2.3	Protection and Sustainance of Coastal habitat for biodiversity conservation	1, 2, 3, 5, 6, 11
2.4	Conservation of Freshwater biodiversity	2, 3, 4, 5, 6, 8, 12
2.5	Marine biodiversity, conservation and sustainable utilization	1, 2, 5, 6, 11
2.6	Sustainable utilization of Aquatic Bioresources/ fishes	2, 5, 7, 8, 9, 11
2.7	Conservation of wetland for water security and food	2, 3, 4, 5, 6
2.8	Conservation of aquatic subterranean biodiversity	2, 3, 6, 8, 12
2.9	Fish processing and Products	1, 2, 5, 8, 9, 11
2.10	Nutraceuticals, bioactive compounds and microbial products	2, 5, 11, 12
2.11	Generate income from fish waste	2, 5, 8, 9, 11, 12
2.12	Implement responsible tourism guidelines	1, 2, 8, 9, 11
2.13	Prevent pollution of water bodies to conserve biodiversity	1, 3, 6, 11
2.14	Ensure the Socio Economic and livelihood security of fisher folk	1, 2, 8, 11
2.15	Managing Invasive Alien Species in water bodies	3, 4, 8

<b>Sl. No.</b>	<b>Strategy</b>	<b>NBT</b>
<b>3. Agro-biodiversity</b>		
<b>3.1. Agro-biodiversity</b>		
3.1.1	Documentation of crop diversity and varietal diversity for developing database of agro-biodiversity	1, 4, 5, 6, 7, 9, 11
3.1.2	Incentivising farmer breeders, farmer conservers and custodian farmers	2, 5, 7, 11, 12
3.1.3	Promote agro-biodiversity among farming community as part of land use strategy	1, 2, 5, 6, 7, 8
3.1.4	Promote Sustainable utilisation of agro-biodiversity	5, 7, 8, 9, 11
3.1.5	Strengthening research needs on agro-biodiversity	1, 2, 5, 6, 7, 8, 9, 12
3.1.6	Protect IPR on crop diversity	9, 11, 12
<b>3.2. Animal Husbandry</b>		
3.2.1	Documentation of population structure and morphological traits of indigenous species	5, 7
3.2.2	Recognition of genetic groups of livestock and poultry as breeds	5, 7
3.2.3	Identify uniqueness specialities and alternative uses of indigenous animal genetic groups	7, 11, 12
3.2.4	Incentivize the farmers who maintain indigenous animal genetic resources	2, 5, 6, 7, 11
3.2.5	Registration of Geographical Indications and variety protection tag	9, 12
3.2.6	Maintain Healthy and Productive Populations of Indigenous Breeds for Distribution	7
3.2.7	Formation of Farmer Producer Companies for multiplication and sale of indigenous genetic resources	5, 7
<b>4. Social Sector</b>		
<b>4.1. Traditional Knowledge and Tribal Development</b>		
4.1.1	Documentation of TK/Folk practices associated with Bioresources	6, 7, 9, 10, 11
4.1.2	Sustainable Collection of Non-Wood Forest Produce (NWFP) and bio resources other than NWFP	2, 9, 10, 11
4.1.3	Supply Chain and Value Chain analysis of Tradable Bio resources	2, 11

<b>Sl. No.</b>	<b>Strategy</b>	<b>NBT</b>
4.1.4	Create a permanent revolving fund exclusively for the tribal communities for the collection of NWFP and other tradeable forest bio-resources	11, 12
4.1.5	Development of entrepreneurship program among the tribal communities of Kerala	2, 9, 10, 11, 12
4.1.6	Scientific validation of selected bio resources and developing novel products	9, 11
4.2. Education		
4.2.1	Promote Biodiversity education among students and youth	1, 2, 6
4.2.2	Promote Biodiversity awareness for different stakeholders	1, 11, 12
5. Strategy and Action Plan for Cross cutting sectors		
5.1. Environment and Climate change		
5.1.1	Acquiring deeper knowledge on the climate change phenomena in Kerala	1, 2, 11, 12
5.1.2	Downscale the global climate change predictions to suit Kerala	2, 11
5.1.3	Conservation, restoration and sustainable management of forest ecosystems (all major ones) to reduce vulnerability to climate hazards such as landslides, floods, drought, etc.	2, 3, 5, 6, 11
5.1.4	Conservation of Floral and Faunal diversity in response to climate change	1, 2, 6, 8
5.1.5	Intensive Conservation of RET plant/animal species in response to climate change	1, 2, 6, 7, 8
5.1.6	Conservation of agricultural biodiversity in response to climate change	1, 2, 5, 7, 8
5.1.7	Improve the resilience of the ecosystems to climate change so that they can continue to deliver ecosystem services and provide stable livelihood options for the community	1, 2, 6, 8, 11
5.1.8	Ecosystem based /landscape-based adaptation for important ecosystems or landscapes of Kerala to address climate change	1, 2, 5, 6, 8, 11
5.1.9	Conservation of domesticated animal diversity in response to climate change	2, 5, 7
5.1.10	Management of invasive species in the context of climate change	2, 4, 5, 7, 11

<b>Sl. No.</b>	<b>Strategy</b>	<b>NBT</b>
5.1.11	Reducing air, water and land pollution which seriously affect biodiversity and there by ecosystem services	1, 2, 5, 6, 8, 12
5.1.12	Establishing more efficient disaster management measures to minimise loss of biodiversity/human lives in a participatory mode	1, 2, 3, 5, 11, 12
5.1.13	Development of a comprehensive spatial decision support system in the web GIS domain to show the areas of unique biodiversity with its structural and functional variable	2, 6, 12
5.1.14	Conservation of Coastal Ecosystems and Biodiversity	1, 2, 3, 5, 12
<b>5.2. Local Governance (Panchayat, Rural development, Urban development)</b>		
5.2.1	Redefine the duties and responsibilities of BMCs for better performance and governance	6, 10, 11, 12
5.2.2	Strengthening the TSGs for improved functioning of BMCS	10, 11, 12
5.2.3	Identify major threats, and implement effective measures through participatory approach for mitigating the gaps/issues at LSG level.	9, 10
5.2.4	Developing Model BMCs based on the geographical locations, performance and good governance of BMCs	10, 11, 12
5.2.5	Encourage Urban Biodiversity conservation for a healthy life	2, 5, 8, 10, 11
5.2.6	Protection of Local biodiversity from invasive alien plant species/ animals at LSG Level	4, 11
<b>6. Infrastructure</b>		
<b>6.1. Water</b>		
6.1.1	Comprehensive Integrated Water Resources Management (IWRM)	3, 6, 8, 12
6.1.2	Promotion of water conservation	2, 3, 8
6.1.3	Reduce water footprint	2, 5, 8
<b>6.2. Tourism</b>		
6.2.1	Implement sustainable ecotourism	1, 2, 11
6.2.2	Improve/uplift the livelihood of local communities through ecotourism	2, 11
6.2.3	Mainstreaming Biodiversity in Tourism	1, 2, 4, 6
<b>6.3. Energy</b>		



Sl. No.	Strategy	NBT
6.3.1	Conserve energy by reducing the use of power/electricity	2
6.3.2	Encourage alternate sources of energy	2, 6
6.3.3	Reduce the transmission loss in electricity	2, 10, 11
<b>6.4. Transport</b>		
6.4.1	Avoid constructing new roads and other transport facility by destroying natural forests, wetlands, mangroves etc.	2, 3, 6, 8
6.4.2	Encourage more eco-friendly public transport system	2, 6, 8
6.4.3	Develop quality roads for transport which can sustain the traffic pressure for next 25 years	2, 5, 8

In the State Biodiversity Strategies and Action Plan efforts have been made to link the indicators with the SDG indicators and the data source available and also the relevant National Biodiversity Target.

#### **Major stakeholder/ Institutes/ Departments identified**

About 50 central and state government departments/institutes are directly or indirectly implementing projects/ schemes in Kerala. The list of institutions is given below.

1. ICAR -Central Marine Fisheries Research Institute, Kochi
2. ICAR – Central Institute of Fisheries Technology, Kochi
3. ICAR -National Bureau of Fish Genetic Resources, Kochi
4. Zoological Survey of India, Calicut
5. National Institute of Fisheries Post Harvest Technology, Kochi
6. Department of Aquatic Biology and Fisheries, Kerala University, Trivandrum
7. Kerala University of Fisheries and Ocean Studies, Kochi
8. Department of Marine Sciences, CUSAT, Kochi
9. Department of Fisheries, Government of Kerala
10. Matsyafed, Government of Kerala
11. Marine Products Export Development Authority (MPEDA), Kochi
12. Council Of Scientific And Industrial Research, National Institute of Oceanography, Kochi
13. Centre for Marine Living Resources and Ecology (CMLRE), Kochi

14. Department of Forest and Wildlife, Thiruvananthapuram
15. Kerala Forest Research Institute, Peechi, Kerala
16. Jawaharlal Nehru Tropical Botanic Garden, Thiruvananthapuram
17. Malabar Botanic Garden and Institute for Plant Sciences, Kozhikode
18. Centre for Tuber Crops Research Institute, Thiruvananthapuram
19. ICAR- Indian Institute of Spices Research, Kozhikode
20. Spices Board, Kochi
21. Department of Agricultural Development and Farmers Welfare, Thiruvananthapuram
22. Department of Dairy development, Thiruvananthapuram
23. Department of Animal Husbandry, Government of Kerala
24. Department of Soil Survey & Soil Conservation, Thiruvananthapuram
25. Indian Cardamom Research Institute, Myladumpara, Nedumkandan
26. National Bureau of Plant Genetic Resources, Trichur
27. Kerala State Biodiversity Board, Thiruvananthapuram
28. State Medicinal Plants Board (SMPB), Trichur
29. Pollution Control Board, Thiruvananthapuram
30. Department of Environment and Climate Change, Thiruvananthapuram
31. Institute of Climate Change Studies, Kottayam
32. National Centre for Earth Science, Thiruvananthapuram
33. Kerala State Remote Sensing & Env't. Centre, Thiruvananthapuram
34. Kerala State Council for Science, Technology and Environment, Thiruvananthapuram
35. Department of Health and Family welfare, Thiruvananthapuram
36. Department of Ayush, Thiruvanahtapuram
37. Director of Panchayats, LSGD Government of Kerala
38. Urban Affairs Department, LSGD Government of Kerala
39. Rural Development Department, Government of Kerala
40. Department of Tourism, Government of Kerala, Thiruvananthapuram
41. Kerala Water Authority Thiruvananthapuram
42. Kerala Irrigation Department, Thiruvananthapuram
43. Centre for Water Resources Development & Management, Kozhikode

44. Department of General Education, Thiruvananthapuram
45. Department of Mining and Geology, Thiruvananthapuram
46. Department of Industries and Commerce, Thiruvananthapuram
47. Kerala Institute of Local Administration, Thrissur, Kerala
48. Mahatma Gandhi NREGA State Mission, Thiruvananthapuram
49. State Horticulture Mission, Thiruvananthapuram
50. Haritha Keralam Mission, Thiruvananthapuram

The implementation of the SBSAP will require cross-sectoral linkages with several of the above-mentioned departments and institutes. Moreover, several NGOs are also actively involved in biodiversity conservation activities. Progress towards achieving SBSAPs requires widespread public engagement and participation of citizens.

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# CHAPTER 5

## Annexure

### **Annexure 1: Aichi Biodiversity Targets**

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

#### **Target 1**

By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

#### **Target 2**

By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

#### **Target 3**

By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.

#### **Target 4**

By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

#### **Target 5**

By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

#### **Target 6**

By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

#### **Target 7**

By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

#### **Target 8**

By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

#### **Target 9**

By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

#### **Target 10**

By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

**Target 11**

By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

**Target 12**

By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

**Target 13**

By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

**Target 14**

By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

**Target 15**

By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

### **Target 16**

By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

### **Target 17**

By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

### **Target 18**

By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

### **Target 19**

By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

### **Target 20**

By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.



## Annexure:2 Sustainable Development Goals

### Goal 1

#### NO POVERTY

- By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
- Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable
- By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance
- By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
- Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions
- Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions

### Goal 2

#### ZERO HUNGER

- By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons
- By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land,

other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

- By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
- By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed
- Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries
- Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round
- Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

### Goal 3

#### GOOD HEALTH AND WELL-BEING

- By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
- By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
- By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

- By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
- Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
- By 2020, halve the number of global deaths and injuries from road traffic accidents
- By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
- Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
- By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
- Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate
- Support the research and development of vaccines and medicines for the communicable and noncommunicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all
- Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States
- Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

## Goal 4

### QUALITY EDUCATION

- By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes

- By 2030, ensure that all girls and boys have access to quality early childhood development, care and preprimary education so that they are ready for primary education
- By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
- By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
- By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations
- By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
- By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development
- Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all
- By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries
- By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing states

## Goal 5

### GENDER EQUALITY

- End all forms of discrimination against all women and girls everywhere

- Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation
- Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation
- Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate
- Ensure women's full and effective participation and equal opportunities for leadership at all levels of decisionmaking in political, economic and public life
- Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences
- Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws
- Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women
- Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels

## Goal 6

### CLEAN WATER AND SANITATION

- By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

- By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
- By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
- Support and strengthen the participation of local communities in improving water and sanitation management

## Goal 7

### AFFORDABLE AND CLEAN ENERGY

- By 2030, ensure universal access to affordable, reliable and modern energy services
- By 2030, increase substantially the share of renewable energy in the global energy mix
- By 2030, double the global rate of improvement in energy efficiency
- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing country

## Goal 8

### DECENT WORK AND ECONOMIC GROWTH

- Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries

- Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors
- Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
- Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead
- By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
- By 2020, substantially reduce the proportion of youth not in employment, education or training
- Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms
- Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
- By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
- Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all
- Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-Related Technical Assistance to Least Developed Countries
- By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization

## Goal 9

### INDUSTRY, INNOVATION AND INFRASTRUCTURE

- Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
- Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries
- Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets
- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending
- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States 18
- Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities
- Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020

## Goal 10

### REDUCED INEQUALITIES

- By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average



- By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
- Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard
- Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality
- Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations
- Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions
- Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies
- Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements
- Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes
- By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent

## Goal 11

### SUSTAINABLE CITIES AND COMMUNITIES

- By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
- By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

- By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- Strengthen efforts to protect and safeguard the world's cultural and natural heritage
- By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
- By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels
- Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

## Goal 12

### RESPONSIBLE CONSUMPTION AND PRODUCTION

- Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
- By 2030, achieve the sustainable management and efficient use of natural resources

- By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
- By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
- Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
- Promote public procurement practices that are sustainable, in accordance with national policies and priorities
- By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature
- Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
- Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products
- Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

## Goal 13

### CLIMATE ACTION

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- Integrate climate change measures into national policies, strategies and planning

- Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
- Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly \$100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
- Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

## Goal 14

### LIFE BELOW WATER

- By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
- By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
- Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels
- By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics
- By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information
- By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should

be an integral part of the World Trade Organization fisheries subsidies negotiation

- By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism
- Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries
- Provide access for small-scale artisanal fishers to marine resources and markets
- Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want

## Goal 15

### LIFE ON LAND

- By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements
- By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
- By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world
- By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development
- Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

- Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed
- Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products
- By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species
- By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts
- Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems
- Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation
- Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

## Goal 16

### PEACE, JUSTICE AND STRONG INSTITUTIONS

- Significantly reduce all forms of violence and related death rates everywhere
- End abuse, exploitation, trafficking and all forms of violence against and torture of children
- Promote the rule of law at the national and international levels and ensure equal access to justice for all
- By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime
- Substantially reduce corruption and bribery in all their forms
- Develop effective, accountable and transparent institutions at all levels
- Ensure responsive, inclusive, participatory and representative decision-making at all levels

- Broaden and strengthen the participation of developing countries in the institutions of global governance
- By 2030, provide legal identity for all, including birth registration
- Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements
- Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime
- Promote and enforce non-discriminatory laws and policies for sustainable development

## Goal 17

### PARTNERSHIPS FOR THE GOALS

- Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection
- Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of ODA/GNI to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries
- Mobilize additional financial resources for developing countries from multiple sources
- Assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress
- Adopt and implement investment promotion regimes for least developed countries

### Technology

- Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in

particular at the United Nations level, and through a global technology facilitation mechanism

- Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed
- Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology

### **Capacity building**

- Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation

### **Trade**

- Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda
- Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020
- Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access

### **Policy and institutional coherence**

- Enhance global macroeconomic stability, including through policy coordination and policy coherence
- Enhance policy coherence for sustainable development
- Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development

### **Multi-stakeholder partnerships**

- Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge,



expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries

- Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

#### **Data, monitoring and accountability**

- By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts
- By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries

### **Annexure 3: National Biodiversity Targets**

1. By 2020, a significant proportion of the country's population, especially the youth, is aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
2. By 2020, values of biodiversity are integrated in national and state planning processes, development programmes and poverty alleviation strategies.
3. Strategies for reducing rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place by 2020 for environmental amelioration and human well-being.
4. By 2020, invasive alien species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive alien species are managed
5. By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries
6. Ecologically representative areas under terrestrial and inland water, and also coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably, based on protected area designation and management and other areabased conservation measures and are integrated into the wider landscapes and seascapes, covering over 20% of the geographic area of the country, by 2020.
7. By 2020, genetic diversity of cultivated plants, farm livestock, and their wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity
8. By 2020, ecosystem services, especially those relating to water, human health, livelihoods and well-being, are enumerated and measures to safeguard them are identified, taking into account the needs of women and local communities, particularly the poor and vulnerable sections.
9. By 2015, Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization as per the Nagoya Protocol are operational, consistent with national legislations.
10. By 2020, an effective, participatory and updated national biodiversity action plan is made operational at different levels of governance
11. By 2020, national initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with the view to protecting this

knowledge in accordance with national legislations and international obligations.

12. By 2020, opportunities to increase the availability of financial, human and technical resources to facilitate effective implementation of the Strategic Plan for Biodiversity 2011-2020 and the national targets are identified and the Strategy for Resource Mobilization is adopted.

## Annexure 4: State Level and Sectoral Meetings

Sl No	Sector	Date
1	Subcommittee of Board	01.10.2021
2	Inception workshop	27.10.2021
3	Local governance	2.11.2021, 11.11.2021
4	Forest sector	19.11.2021
5	Coastal and Inland resources	8.11.2021 and 24.11.2021
6.	Envt and Climate change	12.11.2021
7.	Consultative workshop of Chairpersons of committees	27.11.2021
8.	State level consultative workshop	5, 6.12.2021

## Annexure 5: Soils of Kerala

SOIL TYPES IN KERALA (DISTRICT WISE)		
District	Type of Soil	Details of Location
Thiruvananthapuram	Fairy rich brown loam of laterite	Middle part of the district
	Sandy loam	Western coastal region
	Rich dark brown loam of granite origin	Eastern hilly parts of the district
Kollam	Sandy loam	Karunagapally and part of Kollam taluk
	Laterite soil	Kottarakkara, Kunnathur and parts of Kollam and Pathanapuram taluks
Pathanamthitta	Clay soil	Western and Eastern hilly regions
	Laterite soil	Parts of Ranni and Kozhencheritaluks

### SOIL TYPES IN KERALA (DISTRICT WISE)

District	Type of Soil	Details of Location
Alappuzha	Sandy loam	Karthikappally and parts of Mavelikkara
	Sandy soil	Cherthala and Ambalapuzhataluks
	Clayey loam with much acidity	Kuttanad
	Laterite soil	Chengannur and parts of Mavelikkarataluk
Kottayam	Laterite soil	Parts of Changanacherry and Kottayam, Kanjirapally and Meenachaltaluks
	Alluvial soil	Vaikomtaluk and part of Changanacherry and Kottayamtaluks
Idukki	Laterite soil	Peerumade and Thodupuzhataluks
	Alluvial soil	Devikulam and Udumbancholataluks
Ernakulam	Laterite soil	Muvatupuzha, Kothamangalam and part of Aluva and Kunnathunadtaluks
	Sandy loam	Parur, Kochi and Kanayannurtaluks
	Alluvial soil	Parts of Aluva and Kunnathunadtaluks
Thrissur	Sandy loam	Part of Mukundapuram, Thrissur and Chavakkadtaluks
	Laterite soil	Eastern part of Thrissur and Western parts of Thalappallytaluks
	Clayey soil	Black-water area of Chavakkad and Mukundapuramtaluk
	Alluvial soil	Portions of Chavakkadtaluk
Palakkad	Laterite soil	Major part of the district
	Black soil	North-Eastern part of Chitturtaluk
Malappuram	Laterite soil	Interior region of the district
	Sandy soil	Along the coastal belt on the district
Kozhikode	Laterite soil	Major part of the district except coastal strip
	Sandy soil	Coastal strip
Wayanad	Laterite soil	Major part of the district
	Loamy soil	Valleys in the middle part of the district
Kannur	Laterite soil	Major part of the district except coastal strip
	Sandy soil	Coastal strip

### SOIL TYPES IN KERALA (DISTRICT WISE)

District	Type of Soil	Details of Location
Kasaragod	Laterite soil	Major part of the district except coastal strip
	Sandy soil	Coastal strip

Source: Kerala State Land Use Board, 2009

## Annexure 6: Rivers of Kerala

No	West Flowing Rivers of Kerala	Place of Origin	Major Tributaries / Distributaries	Empties Into	Length (km)
1	Anjarakkandi			Arabian Sea	52
2	Achenkovil			Pampa	128
3	Ayiroor				17
4	Bharathapuzha (Nila)	Anamalai (Tamil Nadu)	Gayathripuzha, Kannadipuzha, Kalppathipuzha, Poothapuzha	Arabian Sea	209
5	Chalakkudy	Anamalai	Periyar	Periyar	144
6	Chaliyar	Elampaleri Hills	Iringipuzha, Cherupuzha, Kurumbanpuzha	Arabian Sea	168
7	Chandragiri			Arabian Sea	105
8	Chittari			Arabian Sea	25
9	Itthikkara	Madathara		Paravoor Lake	56
10	Karangode			Kavvai Lake	64
11	Kadalundi			Arabian Sea	130
12	Kallada	Kulathoorpuzha hills		Ashtamudi lake	121
13	Kallai			Arabian Sea	22
14	Mamom				27
15	Karamana			Arabian Sea	68
16	Karuvannoor	Poomalai		Enamaakkal Lake	48

No	West Flowing Rivers of Kerala	Place of Origin	Major Tributaries / Distributaries	Empties Into	Length (km)
17	Kavvai			Kavvai Lake	31
18	Keecheri			Enamaakkal Lake	51
19	Korappuzha	Arikkan Hills		Arabian Sea	40
20	Pallichal				42
21	Kuppam			Valapattanam River	82
22	Kuttyadi			Arabian Sea	74
23	Maahi	Wayanad Hills		Arabian Sea	54
24	Manjeshwaram	Baleppooney hills		Uppala Lake	16
25	Manimala	Thattamalai		Pampa	90
26	Mogral			Arabian Sea	34
27	Meenachil				78
28	Muvattupuzha			Vembanadu lake	121
29	Neeleshwaram			Kaariyankode River	46
30	Neyyar	Agasthi Hills		Arabian Sea	56
31	Pampa	Peermedu	Azhuthayaar, Kakkattaar, Kallar, Manimala, Achenkovil	Vembanad lake	176
32	Periyar	Sivagiri	Splits into two	Kodangalloor lake	244
33	Peruvampa				51
34	Puzhakkal				29
35	Ramapuram-puzha	Eringal Hills		Arabian Sea	19
36	Shiriya			Arabian Sea	67
37	Thalasseri			Arabian Sea	28
38	Tiroor			Bharatapuzha	48

No	West Flowing Rivers of Kerala	Place of Origin	Major Tributaries / Distributaries	Empties Into	Length (km)
39	Uppala			Arabian Sea	50
40	Valapattanam	Brahmagiri Forests		Arabian Sea	110
41	Vamanapuram			Anchuthengu Lake	88

No	East Flowing Rivers		Length (km)
1	Paampar	Paampar and Bhavani flows into Tamilnadu. Kabani enters Karnataka. All three of them empties into Kaveri river	Flows only a few kilometres through Kerala
2	Bhavani		
3	Kabani		

## Annexure 7: Estuaries of Kerala

No	Name	District
1.	Karingote estuary	Kasaragode
2.	Nileswar back water	Kasaragode
3.	Kava back water	Kannur
4.	Dharmapatanam back water	Kannur
5.	Mannayed estuary	Kannur
6.	Mahe estuary	Kannur
7.	Kattampally	Kannur
8.	Kotta back water	Kozhikode
9.	Korapuzha estuary	Kozhikode
10.	Payyoli back water	Kozhikode
11.	Elathur back water	Kozhikode
12.	Kallayi back water	Kozhikode
13.	Beypore estuary	Kozhikode
14.	Kadalundi estuary	Kozhikode/Malappuram
15.	Conolly Canal	Kozhikode
16.	Puraparamba back water	Malappuram
17.	Purathur/ Ponnani estuary	Malappuram

No	Name	District
18.	Chettuva back water	Thrissur
19.	Azheekode estuary	Thrissur
20.	Kodungalloor back water	Thrissur
21.	Akathumurilake	Thrissur
22.	Cochin estuary	Ernakulam
23.	Vembanad back water	Kottayam& Alappuzha
24.	Kayamkulam back water	Alappuzha
25.	Ashtamudi estuary	Kollam
26.	Paravoor back water	Kollam
27.	EdavaNadayara back water	Thiruvananthapuram
28.	Anchuthengu back water	Thiruvananthapuram
29.	Kadinamkulam back water	Thiruvananthapuram
30.	Velilake	Thiruvananthapuram
31.	Poonthura back water	Thiruvananthapuram
32.	Poovar back water	Thiruvananthapuram

## Annexure 8: Fresh water lakes of Kerala

Sl. No.	Name of Lake	District	Area (ha)
1	Vellayani 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	Muriyad Lake	Thrissur	94
9	Pookode Lake	Wayanad	7
	Total area (ha)		1620

Source: Fisheries handbook 2020



## Annexure 9: Agricultural crops of Kerala

### a. Area under major crops of Kerala

Sl. No.	Crop	Area(ha)	Sl. No.	Crop	Area(ha)
Cereals and Millets			Fruits & Nuts		
1	Rice	198180	1	Cashew nut	39898
2	Wheat	1	2	Mango	78554
3	Maize	113	3	Banana	60678
4	Sorghum	285	4	Plantain	56199
5	Little millet	57	5	Jack fruit	93209
6	Finger millet	213	6	Pine apple	9625
Pulses			7	Papaya	18550
1	Red gram	313	8	Orange	240
2	Gram	600	9	Lemon	1150
3	Other pulses	1347	10	Other fruits	12927
Oil seeds			Total fruits		
1	Coconut	760776	Vegetables		
2	Sesame	208	1	Drumstick	16977
3	Ground nut	117	2	Amaranth	1956
4	Sunflower	1	3	Bitter gourd	1936
5	Other oil seeds	2241	4	Snake gourd	994
Tuber Crops			5	Okra	1462
1	Cassava	62070	6	Brinjal	1270
2	Elephant foot yam	6049	7	Green chillies	1621
3	Colocasia	6336	8	Bottle gourd	224
4	Greater yam	1419	9	Little gourd	1662
5	Lesser yam	187	10	Ash gourd	1067
6	Sweet potato	194	11	Pumpkin	1258
7	Koorka	993	12	Cucumber	1024
8	Potato	490	13	Veg. cowpea	5128
9	Other tuber crops	478	14	Carrot	953
Sugars and Starches			15	Beet root	3

Sl. No.	Crop	Area(ha)	Sl. No.	Crop	Area(ha)
1	Sugarcane	950	16	Cabbage	150
2	Palmyrah	1873	17	Beans	1154
	Spices & Condi-ments		18	Onion	11
1	Black pepper	83765	19	Tomato	464
2	Cardamom	39697	20	Other vegeta-bles	1225
3	Cinnamon	92		Total vegetables	41053
4	Nutmeg	23329		Beverage crops	
5	Tamarind	9962	1	Coffee	85880
6	Vanilla	53	2	Tea	35871
7	Clove	854	3	Cocoa	14276
8	Ginger	2819		Other Crops	
9	Turmeric	2277	1	Rubber	551200
10	Garlic	191	2	Cotton	54
11	Others	1413	3	Lemon grass	101
	Stimulants		4	Fodder crops	6307
1	Tobacco	8	5	Green manure crops	19712
2	Arecanut	96921	6	Medicinal plants	1328
3	Betel leaf	259		Other crops & trees	126213
				Teak	26786

### b. Cultivated crops of Kerala

Sl. No	Common name	Malayalam name	Botanical name	Family
<b>1. Cereals and millets</b>				
1	Barnyard millet	Kuthiravali	<i>Echinohloa frumentacea</i>	Poaceae
2	Finger millet	Ragi	<i>Eleusine coracana</i>	Poaceae
3	Foxtail millet	Thina	<i>Setaria italica</i>	Poaceae
4	Kodo millet	Varagu	<i>Paspalum scorbiculatum</i>	Poaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
5	Little millet	Chama	<i>Panicum sumatrense</i>	Poaceae
6	Maize	Makka cholam	<i>Zea mays</i>	Poaceae
7	Pearl millet	Kambam	<i>Pennisetum glaucum</i>	Poaceae
8	Proso millet	Pani varaku	<i>Panicum miliaceum</i>	Poaceae
9	Rice	Nellu	<i>Oryza sativa</i>	Poaceae
10	Sorghum	Mani cholam	<i>Sorghum bicolor</i>	Poaceae
11	Wheat (Emmer)	Gothambu (Uppuma)	<i>Triticum dicoccum</i>	Poaceae
<b>2. Pseudo cereals</b>				
1	Chia	Chia	<i>Salvinia hispanica</i>	Lamiaceae
2	Grain amaranth	Cheera ari	<i>Amaranthus caudatus</i>	Amaranthaceae
3	Grain amaranth	Pori cheera	<i>Amaranthus hypochondriacus</i>	Amaranthaceae
4	Quinoa	Quinoa	<i>Chenopodium quinoa</i>	Amaranthaceae
<b>3. Pulses</b>				
1	Black gram	Uzhunnu	<i>Vigna mungo</i>	Fabaceae
2	Chick pea	Cheru kadala	<i>Cicer arietinum</i>	Fabaceae
3	Cowpea	Mampayar	<i>Vigna unguiculata</i>	Fabaceae
4	Green gram	Cherupayar	<i>Vigna radiata</i>	Fabaceae
5	Horse gram	Muthira	<i>Macrotyloma uniflorum</i>	Fabaceae
6	Lima bean	Butter beans	<i>Phaseolus lunatus</i>	Fabaceae
7	Moth bean	Moth payar	<i>Vigna aconitifolia</i>	Fabaceae
8	Red gram	Thuvarappayar	<i>Cajanus cajan</i>	Fabaceae
9	Rice bean	Arippayar	<i>Vigna umbellata</i>	Fabaceae
10	Dry peas	Pattani	<i>Pisum sativum var. arvense</i>	Fabaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
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#### 4. Oil seeds

1	Brown mustard	Cherukaduku	<i>Brassica juncea</i>	Brassicaceae
2	Coconut	Nalikeram	<i>Cocos nucifera</i>	Arecaceae
3	Sesame	Ellu	<i>Sesamum indicum</i>	Pedaliaceae
4	Groundnut	Nilakkadala	<i>Arachis hypogaea</i>	Fabaceae
5	Castor	Avanakku	<i>Ricinus communis</i>	Euphorbiaceae
6	Oil palm	Ennappana	<i>Elaeis guineensis</i>	Arecaceae
7	Soybean	Soya payar	<i>Glycine max</i>	Fabaceae
8	Sunflower	Soorya kanthi	<i>Helianthus annuus</i>	Asteraceae

#### 5. Sugars and starches

1	Indian date	Eentha pana	<i>Phoenix sylvestris</i>	Arecaceae
2	Palmyrah palm	Nonku pana	<i>Borasses flabellifer</i>	Arecaceae
3	Queen sago	Eenthu	<i>Cycas circinalis</i>	Cycadaceae
4	Stevia	Madhura thulasi	<i>Stevia rebaudiana</i>	Asteraceae
5	Sugarcane	Karimbu	<i>Saccharum officinarum</i>	Poaceae
6	Talipot palm	Kudappana	<i>Corypha umbraculifera</i>	Arecaceae
7	Toddy palm	Choonda pana	<i>Caryota urens</i>	Arecaceae
8	Wight's sago palm	Kattu thengu	<i>Arenga wightii</i>	Arecaceae

#### 6. Tuber crops

1	Aerial yam	Adathappu	<i>Dioscorea bulbifera</i>	Dioscoreaceae
2	Black turmeric	Karimanjal	<i>Curcuma caesia</i>	Zingiberaceae
3	Blue arrow root	Neela koova	<i>Curcuma aeruginosa</i>	Zingiberaceae
4	Blue taro	Neela chembu	<i>Xanthosoma violaceum</i>	Araceae
5	Chinese potato	Koorka	<i>Coleus rotundifolius</i>	Lamiaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
6	Dasheen	Kolambu chembu	<i>Colocasia esculenta</i> <i>var.esculenta</i>	Araceae
7	Indian arrow root	Nadan koova	<i>Curcuma angustifolia</i>	Zingiberaceae
8	Elephant foot yam	Chena	<i>Amorphophallus</i> <i>paeoniifolius</i>	Araceae
9	Five leaf yam	Nooron	<i>Dioscorea pentaphylla</i>	Dioscoreaceae
10	Giant alocasia	Maran chembu	<i>Alocasia indica</i>	Araceae
11	Greater yam	Kachil	<i>Dioscorea alata</i>	Dioscoreaceae
12	Indian yam	Vettila kizhnagu	<i>Dioscorea oppositifolia</i>	Dioscoreaceae
13	Intoxicating yam	Poodakizhangu	<i>Dioscorea hispida</i>	Dioscoreaceae
14	Lesser yam	Cheru kizhangu	<i>Dioscorea esculenta</i>	Dioscoreaceae
15	Potato	Urula kizhangu	<i>Solanum tuberosum</i>	Solanaceae
16	Queensland arrow root	Madhura koova	<i>Canna edulis</i>	Cannaceae
17	Sweet potato	Cheenikizhangu	<i>Ipomoea batatas</i>	Convolvulaceae
18	Tannia	Seema chembu	<i>Xanthosoma sagittifolium</i>	Araceae
19	Tapioca	Kappa	<i>Manihot esculenta</i>	Euphorbiaceae
20	Taro	Cheru chembu	<i>Colocasia esculenta</i> <i>var.antiquorum</i>	Araceae
21	Indian Arrow root	Vella koova	<i>Maranta arundinacea</i>	Marantaceae
22	White yam	African kachil	<i>Dioscorea rotundata</i>	Dioscoreaceae
23	Yacon	Yacon	<i>Smallanthus sonchifolius</i>	Asteraceae
24	Yam bean	Payaru kachil	<i>Pachyrhizus erosus</i>	Fabaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
<b>7. Vegetables</b>				
1	African egg plant	African vazhuthana	<i>Solanum macrocarpon</i>	Solanaceae
2	African okra	Mara venda	<i>Abelmoschus caillei</i>	Malvaceae
3	Agathi	Agathicheera	<i>Sesbania grandiflora</i>	Fabaceae
4	Amaranth	Cheera	<i>Amaranthus tricolor</i>	Amaranthaceae
5	Ash gourd	Kumbalam	<i>Benincasa hispida</i>	Cucurbitaceae
6	Bell pepper	Capsicum	<i>Capsicum annum var. grossum</i>	Solanaceae
7	Bird chilly	Kanthari	<i>Capsicum frutescens</i>	Solanaceae
8	Bitter gourd	Paval	<i>Momordica charantia</i>	Cucurbitaceae
9	Bonnet pepper	Karanam potti	<i>Capsicum chinense</i>	Solanaceae
10	Bottle gourd	Churakka	<i>Lagenaria siceraria</i>	Cucurbitaceae
11	Bread fruit	Seemachakka	<i>Artocarpus altilis</i>	Moraceae
12	Brinjal	Vazhuthana	<i>Solanum melongena</i>	Solanaceae
13	Cabbage tree	Souhrada cheera	<i>Pisonia grandis</i>	Nyctaginaceae
14	Chayamansa	Mexican cheera	<i>Cnidioscolus aconitifolius</i>	Euphorbiaceae
15	Chekkurmanis	Madhura cheera	<i>Sauropus androgynous</i>	Euphorbiaceae
16	Clove bean	Nithya vazhuthana	<i>Ipomoea muricata</i>	Convolvulaceae
17	Cluster beans	Kothamara	<i>Cyamopsis tetragonoloba</i>	Fabaceae
18	Cranberry hibiscus	Puli venda	<i>Hibiscus acetosella</i>	Malvaceae
19	Curry leaf	Kari veppila	<i>Murraya koenigii</i>	Rutaceae
20	Drumstick	Muringa	<i>Moringa oleifera</i>	Moringaceae
21	Dwarf copperleaf	Ponnamkanni	<i>Alternanthera sessilis</i>	Amaranthaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
22	Gac	Gac	<i>Momordica cochinchinensis</i>	Cucurbitaceae
23	Giant granadilla	Akasha vellari	<i>Passiflora quadrangularis</i>	Passifloraceae
24	Green basella	Valli cheera	<i>Basella alba</i>	Basellaceae
25	Green chilli	Pacha mulaku	<i>Capsicum annum</i>	Solanaceae
26	Horned cucumber	Mullan kakkiri	<i>Cucumis metulifer</i>	Cucurbitaceae
27	Indian bean	Amara payar	<i>Lablab purpureus</i>	Fabaceae
28	Indian snap melon	Pottu vellari	<i>Cucumis melo var. momordica</i>	Cucurbitaceae
29	Jack bean	Kathi payar	<i>Canavalia ensiformis</i>	Fabaceae
30	Little gourd	Koval	<i>Coccinia grandis</i>	Cucurbitaceae
31	Musk melon	Thaikumbalam	<i>Cucumis melo</i>	Cucurbitaceae
32	Okra	Venda	<i>Abelmoschus esculentus</i>	Malvaceae
33	Oriental pickling melon Kani vellari		<i>Cucumis melo var. conomon</i>	Cucurbitaceae
34	Pruvian pepper	Peru mulaku	<i>Capsicum baccatum</i>	Solanaceae
35	Pumpkin	Mathan	<i>Cucurbita moschata</i>	Cucurbitaceae
36	Red basella	Valli cheera	<i>Basella rubra</i>	Basellaceae
37	Red pumpkin	Vellari mathan	<i>Cucurbita maxima</i>	Cucurbitaceae
38	Ridge gourd	Peechanga	<i>Luffa acutangula</i>	Cucurbitaceae
39	Roselle	Mathipuli	<i>Hibiscus subdariffa</i>	Malvaceae
40	Runner bean	Runner bean	<i>Phaseolus coccineus</i>	Fabaceae
41	Salad cucumber	Salad vellari	<i>Cucumis sativus</i>	Cucurbitaceae
42	Smooth gourd	Enilla peechinga	<i>Luffa cylindrica</i>	Cucurbitaceae
43	Snake gourd	Padavalam	<i>Trichosanthes cucumerina</i>	Cucurbitaceae
44	Spiny gourd	Mullan paval	<i>Momordica dioica</i>	Cucurbitaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
45	Spleen amaranth	Pacha cheera	<i>Amaranthus dubius</i>	Amaranthaceae
46	Summer squash	Zuchini	<i>Cucurbita pepo</i>	Cucurbitaceae
47	Sword bean	Valaripayar	<i>Canavalia gladiata</i>	Fabaceae
48	Tahitian spinach	Cheerachembu	<i>Xanthosoma brasiliense</i>	Araceae
49	Teasle gourd	Ven paval	<i>Momordica subangulata</i>	Cucurbitaceae
50	Tomato	Thakkali	<i>Solanum lycopersicum</i>	Solanaceae
51	Velvet beans	Velvet payar	<i>Mucuna pruriens var. utilis</i>	Fabaceae
52	Water leaf	Sambar cheera	<i>Talinum triangulare</i>	Portulacaceae
53	Water melon	Thanni mathan	<i>Citrullus lanatus</i>	Cucurbitaceae
54	Water spinach	Neer cheera	<i>Ipomoea aquatica</i>	Convolvulaceae
55	Winged bean	Chathura payar	<i>Psophocarpus tetragonolobus</i>	Fabaceae
56	Yard long bean	Kuruthola payar	<i>V. unguiculata subsp. sesquipedalis</i>	Fabaceae

#### Cool season vegetables

1	Beet root	Beet root	<i>Beta vulgaris</i>	Chenopodiaceae
2	Broccoli	Broccoli	<i>Brassica oleracea var. italica</i>	Brassicaceae
3	Brussels sprout	Brussels sprout	<i>B. oleracea var. gemmifera</i>	Brassicaceae
4	Cabbage	Muttakose	<i>Brassica oleracea var. capitata</i>	Brassicaceae
5	Carrot	Carrot	<i>Daucus carota</i>	Apiaceae
6	Cauliflower	Cauliflower	<i>Brassica oleracea var. botrytis</i>	Brassicaceae
7	Celery	Celery	<i>Apium graveolens</i>	Apiaceae
8	Chow-chow	Mysore mathan	<i>Sechium edule</i>	Cucurbitaceae



Sl. No	Common name	Malayalam name	Botanical name	Family
9	French beans	Beans	<i>Phaseolus vulgaris</i>	Fabaceae
10	Green peas	Green peas	<i>Pisum sativum</i>	Fabaceae
11	Kale	Kale	<i>Brassica olerace var. sabellica</i>	Brassicaceae
12	Lettuce	Lettuce	<i>Lactuca sativa</i>	Asteraceae
13	Onion	Sabola	<i>Allium cepa</i>	Amaryllidaceae
14	Radish	Mullangi	<i>Raphanus sativus</i>	Brassicaceae
15	Shallot	Chuvannulli	<i>Allium cepa var. aggregatum</i>	Amaryllidaceae
16	Spinach	Spinach	<i>Spinacea oleraceae</i>	Amaranthaceae
17	Turnip	Seema mullangi	<i>Brassica rapa</i>	Brassicaceae
<b>8. Fruits and nuts</b>				
1	Abiu	Abiu	<i>Pouteria caimito</i>	Sapotaceae
2	Acai palm	Akai berry	<i>Euterpe oleracea</i>	Arecaceae
3	Achachairu	Achacha pazham	<i>Garcinia humilis</i>	Clusiaceae
4	Acid lime	Cheru narakam	<i>Citrus aurantifolia</i>	Rutaceae
5	Araza	Araza	<i>Eugenia stipitata</i>	Myrtaceae
6	Atemoya	Athimoya	<i>Annona × atemoya</i>	Annonaceae
7	Banana & plantain	Vazha	<i>Musa spp.</i>	Musaceae
8	Ber	Elantha	<i>Ziziphus mauritiana</i>	Rhamnaceae
9	Bilimbi	Bilimbipuli	<i>Averrhoa bilimbi</i>	Oxalidaceae
10	Black sapote	Black sapota	<i>Diospyros nigra</i>	Ebenaceae
11	Brazilian guava	Munthiri pera	<i>Psidium guineense</i>	Myrtaceae
12	Bumese grape	Burma munthiri	<i>Baccaurea ramiflora</i>	Phyllanthaceae
13	Bush orange	Kutti orange	<i>Citrus mitis</i>	Rutaceae
14	Cape goose berry	Njottanodian	<i>Physalis peruviana</i>	Solanaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
15	Carabao lime	Vadukapuli	<i>Citrus pennivesiculata</i>	Rutaceae
16	Carambola	Chathurappuli	<i>Averrhoa carambola</i>	Oxalidaceae
17	Cashew	Kashuvandi	<i>Anacardium occidentale</i>	Anacardiaceae
18	Cat eye plant	Malarkay maram	<i>Syzygium zeylanicum</i>	Myrtaceae
19	Chempadak	Chempadak	<i>Artocarpus integer</i>	Moraceae
20	Cherimoya	Mexican atha	<i>Annona cherimola</i>	Annonaceae
21	Cherry mangosteen	Beraba	<i>Garcinia intermedia</i>	Clusiaceae
22	Chop choppa	Chop choppa	<i>Garcinia kydia</i>	Clusiaceae
23	Chupa	Chupa	<i>Quararibea cordata</i>	Malvaceae
24	Citron	Ganapathi narakam	<i>Citrus medica</i>	Rutaceae
25	Cluster fig	Cluster athi	<i>Ficus racemosa</i>	Moraceae
26	Common fig	Sheemayathi	<i>Ficus carica</i>	Moraceae
27	Cupuassu	Cupuassu	<i>Theobroma grandiflorum</i>	Malvaceae
28	Custard apple	Atha chakka	<i>Annona reticulata</i>	Annonaceae
29	Dragon fruit	Vella dragon	<i>Selenicereus undatus</i>	Cactaceae
30	Durian	Durian	<i>Durio zibethinus</i>	Malvaceae
31	Egg fruit	Mutta pazham	<i>Pouteria campechiana</i>	Sapotaceae
32	Elephant ear fig	Valiya athi	<i>Ficus auriculata</i>	Moraceae
33	Guava	Perakka	<i>Psidium guajava</i>	Myrtaceae
34	Hog plum	Ambazham	<i>Spondias pinnata</i>	Anacardiaceae
35	Icecream plant	Icecream pazham	<i>Inga edulis</i>	Fabaceae
36	Indian coffee plum	Loobi	<i>Flacourtia jangomas</i>	Flacourtiaceae
37	Indian date palm	Eentha pana	<i>Phoenix sylvestris</i>	Arecaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
38	Indian gooseberry	Nellikka	<i>Phyllanthus emblica</i>	Phyllanthaceae
39	Indian oleaster	Ankola pazham	<i>Elaeagnus conferta</i>	Elaeagnaceae
40	Indian olive	Kara	<i>Elaeocarpus serratus</i>	Elaecarpaceae
41	Indian plum	Rukam	<i>Flacourtia rukam</i>	Flacourtiaceae
42	Jaboticaba	Mara munthiri	<i>Plinia cauliflora</i>	Myrtaceae
43	Jack fruit	Chakka	<i>Artocarpus heterophyllus</i>	Moraceae
44	Jamun	Njaval	<i>Syzygium cumini</i>	Myrtaceae
45	Java apple	Mezhuku champa	<i>Syzygium samarangense</i>	Myrtaceae
46	Karonda cherry	Karonda	<i>Carissa carandas</i>	Apocynaceae
47	Kokum	Raja puli	<i>Garcinia indica</i>	Clusiaceae
48	Lemon	Odichu kuthi	<i>Citrus limon</i>	Rutaceae
49	Lindley's aporosa	Vetti	<i>Aporosa cardiosperma</i>	Phyllanthaceae
50	Longan	Longan	<i>Dimocarpus longan</i>	Sapindaceae
51	Lovi-lovi	lovelovi	<i>Flacourtia inermis</i>	Flacourtiaceae
52	Malabar chest nut	Pachira	<i>Pachira aquatic</i>	Malvaceae
53	Malay apple	Perakka champa	<i>Syzygium malaccensis</i>	Myrtaceae
54	Mamey sapote	Mammi sapota	<i>Pouteria sapota</i>	Sapotaceae
55	Mango	Manga	<i>Mangifera indica</i>	Anacardiaceae
56	Mangosteen	Mangosteen	<i>Garcinia mangostana</i>	Clusiaceae
57	Manila tamarind	Kodukkapuli	<i>Pithecellobium dulce</i>	Fabaceae
58	Maprang	Maprang	<i>Bouea macrophylla</i>	Anacardiaceae
59	Marang	Marang	<i>Artocarpus odoratissimus</i>	Moraceae

Sl. No	Common name	Malayalam name	Botanical name	Family
60	Matoa	Matoa	<i>Pometia pinnata</i>	Sapindaceae
61	Miracle fruit	Miracle fruit	<i>Synsepalum dulcificum</i>	Sapotaceae
62	Mootty fruit	Mootty pazham	<i>Baccaurea courtallensis</i>	Phyllanthaceae
63	Mysore gamboge	Monthanpuli	<i>Garcinia xanthochymus</i>	Clusiaceae
64	Noni	Noni	<i>Morinda citrifolia</i>	Rubiaceae
65	Papaya	Papaya	<i>Carica papaya</i>	Caricaceae
66	Passion fruit	Passion fruit	<i>Passiflora edulis</i>	Passifloraceae
67	Peanut butter fruit	Bunchosia	<i>Bunchosia glandulifera</i>	Malpighiaceae
68	Phalsa	Chadachi	<i>Grewia asiatica,</i>	Malvaceae
69	Pineapple	Kaithachakka	<i>Ananas comosus</i>	Bromeliaceae
70	Pomelo	Kampili narakam	<i>Citrus maxima</i>	Rutaceae
71	Pulasan	Pulasan	<i>Nephelium ramboutan-ake</i>	Sapindaceae
72	Rambai	Rambai	<i>Baccaurea motleyana</i>	Phyllanthaceae
73	Rambutan	Rambutan	<i>Nephelium lappaceum</i>	Sapindaceae
74	Red pitaya	Chuvappu dragon	<i>Selenicereus costaricensis</i>	Cactaceae
75	Rollinia	Rollinia	<i>Rollinia deliciosa</i>	Annonaceae
76	Rose apple	Champa	<i>Syzygium jambos</i>	Myrtaceae
77	Salak	Snake fruit	<i>Salacca zalacca</i>	Arecaceae
78	Santol	Santol	<i>Sandoricum koetjape</i>	Meliaceae
79	Sapota	Sapota	<i>Manilkara zapota</i>	Sapotaceae
80	Seashore mangosteen	Puli mangosteen	<i>Garcinia hombroniana</i>	Clusiaceae
81	Singapore holly	Singapore holly	<i>Malpighia coccigera</i>	Malpighiaceae
82	Sour orange	Puli orange	<i>Citrus ×aurantium</i>	Rutaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
83	Sour-sop	Mullatha	<i>Annona muricata</i>	Annonaceae
84	Star apple	Star apple	<i>Chrysophyllum cainito</i>	Sapotaceae
85	Star gooseberry	Arinelli	<i>Phyllanthus acidus</i>	Euphorbiaceae
86	Strawberry guava	Strawberry pera	<i>Psidium cattleianum</i>	Myrtaceae
87	Surinam cherry	Surinam cherry	<i>Eugenia uniflora</i>	Myrtaceae
88	Sweet-sop	Seetha pazham	<i>Annona squamosa.</i>	Annonaceae
89	Tropical apricot	Tropical apricot	<i>Dovyalis abyssinica</i>	Salicaceae
90	Velvet apple	Velvet apple	<i>Diospyros discolor</i>	Ebenaceae
91	Watery rose apple	Panineer champa	<i>Syzygium aqueum</i>	Myrtaceae
92	West Indian cherry	West Indian cherry	<i>Malpighia emarginata</i>	Malpighiaceae
93	White sapote	Vella sapota	<i>Casimiroa edulis</i>	Rutaceae
94	Wood apple	Vilankai	<i>Limonia acidissima</i>	Rutaceae
95	Yellow mombin	Madhura ambazham	<i>Spondias mombin</i>	Anacardiaceae
96	Yellow pitaya	Manja dragon	<i>Selenicereus megalanthus</i>	Cactaceae

#### Subtropical fruits

1	Apple	Apple	<i>Malus domestica</i>	Rosaceae
2	Apricot	Apricot	<i>Prunus armeniaca</i>	Rosaceae
3	Asian pear	Sabarjilli	<i>Pyrus pyrifolia</i>	Rosaceae
4	Avocado	Venna pazham	<i>Persea americana</i>	Lauraceae
5	Banana passion fruit	Taxo	<i>Passiflora mollissima</i>	Passifloraceae
6	Blackberry	black berry	<i>Rubus spp</i>	Rosaceae
7	Grape fruit	Munthiri naranga	<i>Citrus paradisi</i>	Rutaceae
8	Grapes	Munthiri	<i>Vitis vinifera</i>	Vitaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
9	Japanese plum	Japan plum	<i>Prunus salicina</i>	Rosaceae
10	Kumquat	Israel orange	<i>Citrus japonica</i>	Rutaceae
11	Langsat	Langsat	<i>Lansium parasiticum</i>	Meliaceae
12	Litchi	Litchi	<i>Litchi sinensis</i>	Sapindaceae
13	Loquat	Loquat	<i>Eriobotrya japonica</i>	Rosaceae
14	Macadamia nut	Macadamia nut	<i>Macadamia integrifolia</i>	Proteaceae
15	Mandarin Orange	Orange	<i>Citrus reticulata</i>	Rutaceae
16	Peach	Peach	<i>Prunus persica</i>	Rosaceae
17	Pepino	Pepino	<i>Solanum muricatum</i>	Solanaceae
18	Persimmon	Persimmon	<i>Diospyros kaki</i>	Ebenaceae
19	Pomegranate	Mathalanaranga	<i>Punica granatum</i>	Punicaceae
20	Straw berry	Straw berry	<i>Fragaria ananassa</i>	Rosaceae
21	Sweet orange	Musambi	<i>Citrus X sinensis</i>	Rutaceae
22	Tree tomato	Mara thakkali	<i>Solanum betaceum</i>	Solanaceae
<b>9. Spices &amp; Condiments</b>				
1	African coriander	African malli	<i>Eryngium foetidum</i>	Apiaceae
2	Allspice	Sarva sugandhi	<i>Pimenta dioica</i>	Myrtaceae
3	Basmathi plant	Rambha	<i>Pandanus amaryllifolius</i>	Pandanaceae
4	Camboge	Kudampuli	<i>Garcinia gummi-gutta</i>	Clusiaceae
5	Cardamom	Elam	<i>Elettaria cardamomum</i>	Zingiberaceae
6	Cinnamon	Karuvapatta	<i>Cinnamomum zeylanicum</i>	Lauraceae
7	Clove	Grambu	<i>Syzygium aromaticum</i>	Myrtaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
8	Coriander	Kothamalli	<i>Coriandrum sativum</i>	Apiaceae
9	Cumin	Jeerakam	<i>Cuminum cyminum</i>	Apiaceae
10	Dry chilly	Vattal mulaku	<i>Capsicum annum</i>	Solanaceae
11	Fennel	Perumjeerakam	<i>Foeniculum vulgare</i>	Apiaceae
12	Garlic	Veluthulli	<i>Allium sativum</i>	Amaryllidaceae
13	Ginger	Inchi	<i>Zingiber officinale</i>	Zingiberaceae
14	Mango ginger	Manga inchi	<i>Curcuma amada</i>	Zingiberaceae
15	Nutmeg	Jathikka	<i>Myristica fragrans</i>	Myristicaceae
16	Pepper	Kurumulaku	<i>Piper nigrum</i>	Piperaceae
17	Spear mint	Puthina	<i>Mentha spicata</i>	Lamiaceae
18	Table mustard	Kaduku	<i>Brassica nigra</i>	Brassicaceae
19	Tamarind	Valan puli	<i>Tamarindus indicus</i>	Fabaceae
20	Turmeric	Manjal	<i>Curcuma longa</i>	Zingiberaceae
21	Vanilla	Vanilla	<i>Vanilla planifolia</i>	Orchidaceae

#### 10. Beverages

1	Arabica coffee	Arabica kappi	<i>Coffea arabica</i>	Rubiaceae
2	Cacao	Cocoa	<i>Theobroma cacao</i>	Malvaceae
3	Liberian coffee	Liberian kappi	<i>Coffea liberica</i>	Rubiaceae
4	Robusta coffee	Robusta kappi	<i>Coffea robusta</i>	Rubiaceae
5	Tea	Theyila	<i>Camellia sinensis</i>	Theaceae

#### 11. Stimulants

1	Areca nut	Kamuku	<i>Areca catechu</i>	Arecaceae
2	Betel vine	Vettila	<i>Piper betle</i>	Piperaceae
3	Tobacco	Pukayila	<i>Nicotiana tabacum</i>	Solanaceae

#### 12. Green manure crops

1	Avaram senna	Avaram poo	<i>Senna auriculata</i>	Fabaceae
2	Common sesban	Kedangu	<i>Sesbania sesban</i>	Fabaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
3	Crotalaria	Kilukki	<i>Crotalaria mucronata</i>	Fabaceae
4	Daincha	Dainch	<i>Sesbania aculeata</i>	Fabaceae
5	Gliricidia	Seemakonna	<i>Gliricidia maculata</i>	Fabaceae
6	Indigo	Neelayamari	<i>Indigofera tinctoria</i>	Fabaceae
7	Sesbania	Sesbania	<i>Sesbania rostrata</i>	Fabaceae
8	Shevri	Shevri	<i>Sesbaia aegyptica</i>	Fabaceae
9	Sunn hemp	Chanambu	<i>Crotalaria juncea</i>	Fabaceae
10	Wild indigo	Kozhinjil	<i>Tephrosia purpurea</i>	Fabaceae

### 13. Cover crops

1	Calopo	Calopo	<i>Calopogonium mucunoides</i>	Fabaceae
2	Centro	Centro	<i>Centrosema pubescens</i>	Fabaceae
3	Mucuna	Mucuna	<i>Mucuna bracteata</i>	Fabaceae
4	Peuro	Thotta payar	<i>Pueraria phaseoloides</i>	Fabaceae

### 14. Fodder crops

1	Azolla	Azolla	<i>Azolla pinnata</i>	Salviniaceae
2	Bermuda grass	Karuka	<i>Cynodon dactylon</i>	Poaceae
3	Buffel grass	Kozhukkatta pullu	<i>Cenchrus ciliaris</i>	Poaceae
4	Calliandra	Kalli vaka	<i>Calliandra calothyrsus</i>	Fabaceae
5	Caribbean stylo	Caribbean stylo	<i>Stylosanthes hamata</i>	Fabaceae
6	Carpet grass	Paravathani pullu	<i>Axonopus compressus</i>	Poaceae
7	Cocks foot	Poocha pullu	<i>Dactylis glomerata</i>	Poaceae
8	Common stylo	Sadharana stylo	<i>Stylosanthes guianensis</i>	Fabaceae
9	Congo signal	Congo signal	<i>Brachiaria ruziziensis</i>	Poaceae



Sl. No	Common name	Malayalam name	Botanical name	Family
10	Dheenanth grass	Poochavalan pullu	<i>Pennisetum pedicellatum</i>	Poaceae
11	Fodder sorghum	Theetta cholam	<i>Sorghum bicolor</i>	Poaceae
12	Fodder bajra	Fodder bajra	<i>Pennisetum glaucum</i>	Poaceae
13	Fodder cowpea	Theetta payar	<i>Vigna unguiculata</i>	Poaceae
14	Fodder maize	Makka cholam	<i>Zea mays</i>	Poaceae
15	Gamba grass	Gamba pullu	<i>Andropogon gayanus</i>	Poaceae
16	Green leaf desmodium	Pacha desmodium	<i>Desmodium intortum</i>	Fabaceae
17	Golden timothy	Setaria	<i>Setaria sphacelata</i>	Poaceae
18	Guatemala grass	Guatemala pullu	<i>Tripsacum laxum</i>	Poaceae
19	Guinea grass	Kuthira pullu	<i>Panicum maximum</i>	Poaceae
20	Hedge lucerne	Veli vaka	<i>Desmanthus virgatus</i>	Fabaceae
21	Humidicola	Humidicola	<i>Brachiaria humidicola</i>	Poaceae
22	Hybrid napier	Sankara napier	<i>P. glaucum X P. purpureum</i>	Poaceae
23	Kangaru grass	Potha pullu	<i>Themeda cymbaria</i>	Poaceae
24	Kikuyu grass	Kikuyu grass	<i>Pennisetum clandestinum</i>	Poaceae
25	Molasses grass	Sharkkara pullu	<i>Melinis minutiflora</i>	Poaceae
26	Napier	Napier pullu	<i>Pennisetum purpureum</i>	Poaceae
27	Palisade grass	Palisade pullu	<i>Brachiaria brizantha</i>	Poaceae
28	Para grass	Para pullu	<i>Brachiaria mutica</i>	Poaceae
29	Perennial horse grass	Kattu muthira	<i>Macrotyloma axillare</i>	Fabaceae
30	Pinto pea nut	Pintoi	<i>Arachis pintoii</i>	Fabaceae
31	Rice bean	Arippayar	<i>Vigna umbellate</i>	Fabaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
32	Rhodes grass	Rhodess pullu	<i>Chloris gayana</i>	Poaceae
33	Rye grass	Rai pullu	<i>Lolium perenne</i>	Poaceae
34	Silver leaf	desmodium Velli desmodium	<i>Desmodium uncinatum</i>	Fabaceae
35	Shrubby stylo	Kutti stylo	<i>Stylosanthes scabra</i>	Fabaceae
36	Signal	Signal	<i>Brachiaria decumbens</i>	Poaceae
37	Siratro	Siratro	<i>Macroptilium atropurpureum</i>	Fabaceae
38	St. Augustine grass	Eruma pullu	<i>Stenotaphrum secundatum</i>	Poaceae
39	Subabul	Peeli vaka	<i>Leucaena leucocephala</i>	Fabaceae
40	Teosinte	Teosinte	<i>Zea mexicana</i>	Poaceae
41	Townville stylo	Humilis stylo	<i>Stylosanthes humilis</i>	Fabaceae
42	White clover	White clover	<i>Trifolium repens</i>	Fabaceae
<b>15. Fibre crops</b>				
1	Cotton	Paruthi	<i>Gossypium hirsutum</i>	Malvaceae
2	Tree cotton	Paruthi	<i>Gossypium arboreum</i>	Malvaceae
3	Jute mallow	Chanam	<i>Corchorus olitorius</i>	Malvaceae
4	Kenaf	Pulichhi	<i>Hibiscus cannabinus</i>	Malvaceae
5	Silk cotton tree	Panjimaram	<i>Ceiba pentandra</i>	Malvaceae
6	White jute	Chanam	<i>Corchorus capsularis</i>	Malvaceae
<b>16. Rubber crops</b>				
1	Rubber	Rubber	<i>Hevea brasiliensis</i>	Euphorbiaceae
<b>17. Essential oil yielding plants</b>				
1	Citronella	Citronella	<i>Cymbopogon nardus</i>	Poaceae
2	Eucalyptus	Eucalyptus	<i>Eucalyptus citriodora</i>	Myrtaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
3	Lemon grass	Inchippullu	<i>Cymbopogon flexuosus</i>	Poaceae
4	Palamarosa	Palmarosa	<i>Cymbopogon martinii var. motia</i>	Poaceae
5	Sandal wood	Chandanam	<i>Santalum album</i>	Santalaceae
6	Vetiver	Ramacham	<i>Chrysopogon zizanioides</i>	Poaceae
7	Ylang-ylang	Kanangamaram	<i>Cananga odorata</i>	Annonaceae

#### 18. Cut flowers

1	African Marigold	Chendumalli	<i>Tagetes erecta</i>	Asteraceae
2	Anthurium	Anthurium	<i>Anthurium andreanum</i>	Araceae
3	Arabian jasmine	Kudamulla	<i>Jasminum sambac</i>	Oleaceae
4	Cattleya orchid	Cattleya	<i>Cattleya spp</i>	Orchidaceae
5	China aster	Aster	<i>Callistephus chinensis</i>	Asteraceae
6	Common jasmine	Mulla	<i>Jasminum auriculatum</i>	Oleaceae
7	Dancing-lady orchid	Oncidium	<i>Oncidium spp</i>	Orchidaceae
8	Dendrobium orchid	Dendrobium	<i>Dendrobium spp.</i>	Orchidaceae
9	Firecracker flower	Kanakambaram	<i>Crossandra infundibuliformis</i>	Acanthaceae
10	French marigold	Marigold	<i>Tagetes patula</i>	Asteraceae
11	Gladiolus	Gladiolus	<i>Gladiolus spp</i>	Iridaceae
12	Lotus	Thamara	<i>Nelumbo nucifera</i>	Nelumbonaceae
13	Mokara orchid	Mokara	<i>Mokara spp</i>	Orchidaceae
14	Moth orchid	Phalaenopsis	<i>Phalaenopsis spp</i>	Orchidaceae
15	Rose	Rosa poovu	<i>Rosa spp.</i>	Rosaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
16	Royal jasmine	Pitchi	<i>Jasminum grandiflorum</i>	Oleaceae
17	Scorpion orchid	Arachnis	<i>Arachnis spp</i>	Orchidaceae
18	Star jasmine	Kurukuthimulla	<i>Jasminum multiflorum</i>	Oleaceae
19	Tube rose	Tube rose	<i>Poliantha tuberosa</i>	Asparagaceae
20	Vanda orchid	Vanda	<i>Vanda spp</i>	Orchidaceae

#### 19. Cut foliage plants

1	Asparagus fern	Evergreen	<i>Asparagus plumosus</i>	Asparagaceae
2	Bird of paradise	Bird of paradise	<i>Strelitzia reginae</i>	Strelitziaceae
3	Boston fern	Boston fern	<i>Nephrolepis exaltata</i>	Nephrolepidaceae
4	Lether leaf	Lether leaf	<i>Rumohra adiantiformis</i>	Dryopteridaceae
5	Lucky bamboo	Lucky bamboo	<i>Dracaena sanderiana</i>	Asparagaceae
6	Massangeana	Massangeana	<i>D. fragrans 'Massangeana'</i>	Asparagaceae
7	Monstera	Monstera	<i>Monstera deliciosa</i>	Araceae
8	Red star	Red star	<i>Cordyline australis</i>	Asparagaceae
9	Red-edged dracaena	Marginata	<i>Dracaena marginata</i>	Asparagaceae
10	Schefflera	Schefflera	<i>Schefflera arboricola</i>	Araliaceae
11	Song of India	Song of India	<i>D. reflexa 'Song of India'</i>	Asparagaceae
12	Song of Jamaica	Song of Jamaica	<i>D. reflexa' Song of Jamaica'</i>	Asparagaceae
13	Ti plant	Mahathma	<i>Cordyline fruticosa</i>	Asparagaceae
14	Victoria	Victoria	<i>D. fragrans 'Victoria'</i>	Asparagaceae

#### 20. Medicinal plants (cultivated only)

1	Adhatoda	Adalodakam	<i>Justicia adhatoda</i>	Acanthaceae
2	Aromatic ginger	Kacholam	<i>Kaempferia galanga</i>	Zingiberaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
3	Aromatic turmeric	Kasthuri manjal	<i>Curcuma aromatica</i>	Zingiberaceae
4	Ashwagandha	Amukkuram	<i>Withania somnifera</i>	Solanaceae
5	Asoka	Asokam	<i>Saraca asoca</i>	Fabaceae
6	Ayyappana	Ayyappana	<i>Ayapana triplinervis</i>	Asteraceae
7	Balloon vine	Uzhinja	<i>Cardiospermum helicacabum</i>	Sapindaceae
8	Beddomei	Chittadalodakam	<i>Justicia beddomei</i>	Acanthaceae
9	Black catechu	Karingali	<i>Senegalia catechu</i>	Fabaceae
10	Black musale	Nilappana	<i>Curculigo orchiodes</i>	Orchidaceae
11	Black nightshade	Mani thakkali	<i>Solanum nigrum</i>	Solanaceae
12	Chinese chaste tree	Karinochi	<i>Vitex negundo</i>	Lamiaceae
13	Cinchona	Cinchona	<i>Cinchona officinalis</i>	Rubiaceae
14	Common rue	Arutha	<i>Ruta graveolens</i>	Rutaceae
15	Conch flower creeper	Shamku puzhpam	<i>Clitoria ternatea</i>	Fabaceae
16	Dyer's Oleander	Dantappala	<i>Wrightia tinctoria</i>	Apocynaceae
17	Holostemma	Adapathiyam	<i>Holostemma adakodien</i>	Asclepiadoideae
18	Holy basil	Krishna thulasi	<i>Ocimum tenuiflorum</i>	Lamiaceae
19	Indian aloe	Kattar vazha	<i>Aloe vera</i>	Asphodelaceae
20	Indian bael	Koovalam	<i>Aegle marmalos</i>	Rutaceae
21	Indian borage	Pani koorkka	<i>Coleus ambonicus</i>	Lamiaceae
22	Indian ipecac	Vallippala	<i>Tylophora indica</i>	Apocynaceae
23	Indian Sarasparilla	Naruneendi	<i>Hemidesmus indicus</i>	Apocynaceae
24	Iruveli	Iruveli	<i>Coleus zeylanicus</i>	Lamiaceae
25	Jeevakom	Jeevakom	<i>Seidenfia rheedii</i>	Orchidaceae
26	Long pepper	Thippali	<i>Piper longum</i>	Piperaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
27	Milk yam	Pal muthukku	<i>Ipomoea mauritiana</i>	Convolvulaceae
28	Neem	Veppu	<i>Azadirachta indica</i>	Meliaceae
29	Nux-vomica	Kanjiram	<i>Strychnos nux-vomica</i>	Loganiaceae
30	Pajanelia	Payyani	<i>Pajanelia longifolia</i>	Bignoniaceae
31	Peacock ginger	Chenganeer kizhangu	<i>Kaempferia rotunda</i>	Zingiberaceae
32	Penny wort	Kudangal	<i>Centella asiatica</i>	Apiaceae
33	Plumbago	Chethikoduveli	<i>Plumbago indica</i>	Plumbaginaceae
34	Pointed gourd	Kattu padavalam	<i>Trichosanthes dioica</i>	Cucurbitaceae
35	Red ginger	Chuvanna inchi	<i>Alpinia purpurata</i>	Zingiberaceae
36	Safed musale	Safed musale	<i>Chlorophytum borivillianum</i>	Asparagaceae
37	Sappan wood	Patimugham	<i>Biancaea sappan</i>	Fabaceae
38	Sarivan	Orila	<i>Desmodium gangeticum</i>	Fabaceae
39	Shathavari	Shathavari	<i>Asparagus racemosus</i>	Asparagaceae
40	Siamese ginger	Chittaratha	<i>Alpinia calcarata</i>	Zingiberaceae
41	Sida hemp	Kurumthotti	<i>Sida alnifolia</i>	Malvaceae
42	Stone breaker	Keezharnelli	<i>Phyllanthus fraternus</i>	Phyllanthaceae
43	Tinospora	Chittamruthu	<i>Tinospora codifolia</i>	Menispermaceae
44	Trellis vine	Velipparuthy	<i>Pergularia daemia</i>	Apocynaceae
45	Water hyssop	Brahmi	<i>Bacopa monnieri</i>	Plantaginaceae

#### 21. Miscellaneous uses

1	Ceara rubber	Mara kappa	<i>Manihot glaziovii</i>	Euphorbiaceae
2	Dadap	Mullilla murikku	<i>Erythrina subumbrans</i>	Fabaceae

Sl. No	Common name	Malayalam name	Botanical name	Family
3	Garuga	Karayam	<i>Garuga pinnata</i>	Burseraceae
4	Golden shower	Kanikkonna	<i>Cassia fistula</i>	Fabaceae
5	Henna	Mailanji	<i>Lawsonia inermis</i>	Lythraceae
6	Indian beech	Ung	<i>Pongamia pinnata</i>	Fabaceae
7	Indian Coral tree	Mullumurikku	<i>Erythrina variegata</i>	Fabaceae
8	Jamaican cherry	Jamaican cherry	<i>Muntingia calabura</i>	Muntingiaceae
9	Lipstick plant	Kurangan mailanji	<i>Bixa orellana</i>	Bixaceae
10	Large indigo	Mara neelum	<i>Indigofera zollingeriana</i>	Fabaceae
11	Mulberry	Mulberry	<i>Morus alba</i>	Moraceae
12	Physic nut	Appa	<i>Jatropha curcas</i>	Euphorbiaceae
13	Screw pine	Kaitha	<i>Pandanus odorifer</i>	Pandanaceae
14	Turkey berry	Aanachunda	<i>Solanum torvum</i>	Solanaceae
15	Shoe flower	Chemparuthy	<i>Hibiscus rosa-sinensis</i>	Malvaceae
16	Silver oak	Silver oak	<i>Grevillea robusta</i>	Proteaceae
17	Tree of heaven	Pongalyam	<i>Ailanthus excelsa</i>	Simaroubaceae
18	Wild jack	Anjili	<i>Artocarpus hirsutus</i>	Moraceae

## Annexure 10: Diversity of spice crops conserved at ICAR-Indian Institute of Spices Research, Kozhikode

Sl. No	Crop	Number of accessions from Kerala, place of collection, salient characters, if any	Number of cultivated crops and wild relatives in Kerala	Details on farmers varieties, land races, wild crop relatives in Kerala
1	Black pepper	No. of collections: 1100 (Cultivated types)  Places of collection: From various districts in Kerala (Trivandrum, Kollam, Alappuzha, Pathanamthitta, Idukki, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad, Kozhikode, Wayanad, Kannur and Kasaragod).	More than 100 varieties of which about 60 are commonly cultivated in different parts of Kerala	Farmers varieties collected: Thekkan, WayanadanBold, Ponnmani, Undan, Zion Mundi, Kambackal

### Salient characters of collections:

Thekkan: Branched spike;

Naranyakodi: Fruits with persistent stigma;

Aimpiriyan: Twisted spike;

Jeerakamundi: Small berries;

Arakkulamunda: Moderate and regular bearer, medium in quality, well adapted;

Balankotta: With large droopy leaves, moderate and irregular bearing;

Wild crop relatives/related species collected from Kerala: 17 wild species (943 accessions)

Chengannurkodi: Moderate yielder from South Kerala, medium in quality; Cheppakulamundi: Moderate yielder from Central Kerala, medium in quality; Cheryakaniakadan: Popular in North Kerala, moderate and early bearing variety; Kalluvally: A promising North Kerala cultivar, good yielder, medium in quality with high dry recovery, drought tolerant; Karimunda: Most popular cultivar suitable for most of the black pepper growing areas, high yielder and medium in quality, shade tolerant; Kottan: A cultivar from North Kerala, moderate in yield and medium in quality; Kottanadan: A high yielding cultivar from South Kerala, drought tolerant type; Kuthiravally: A cultivar with long spikes, high yield and good quality; Kuttianikodi: A moderate yielder from Central Kerala with relatively long spikes and good spiking intensity; Malamundi: A moderate yielder, medium in quality; Neelamundi: A good yielder from central Kerala medium in quality, tolerant to Phytophthora infection; Nedumchola:



Sl. No	Crop	Number of accessions from Kerala, place of collection, salient characters, if any	Number of cultivated crops and wild relatives in Kerala	Details on farmers varieties, land races, wild crop relatives in Kerala
		<p>A cultivar with small leaves and short spikes, moderate yielder, moderate yielder; Neyyattinkaramundi: A cultivar from Central Kerala, medium in quality and yield; Perambaramunda: A cultivar from North Kerala, moderate yielder with medium quality; Perumkodi: A cultivar from Central Kerala, moderate in yield and quality; Poonjaranmunda: A cultivar originally from Central Kerala, sporadically found in gardens of North Kerala. Moderately good in yield and quality; Thommankodi: A cultivar from central Kerala, moderately good in yield and quality; Thulamundi: A Central Kerala cultivar, medium in yield and quality; Vadakkan:</p>		
		<p>A cultivar from North Kerala, medium in quality and yield with relatively large berries; Valliyakaniyakadan: A cultivar with larger leaves, medium in yield and quality; Vattamundi: A moderate yielder from Central Kerala; Vellanamban: Relatively moderate yielder and medium in quality characterized by the white colour of the young shoot tip.</p>		
2	Cardamom	<p>No. of collections: 580</p> <p>Places of collection: Myladumpara, Neliyampathy, Wayanad, Silent Valley, Idukki, Thrissur.</p> <p>Salient characters of collection: IC 349447: Narrow leaf width; IC 349448: Pink pseudostem; IC 349619: Vazhukka type; IC 349639: Vazhukka, long panicles; IC 349645: Vazhukka, dark green capsules; IC 349646: Vazhukka, high yielding, Njallayanil; IC547223: Vazhukka, white flower type.</p>	16	<p>Farmers varieties collected: Green Gold, Vander Cardamom, Panikulanga green bold-1, 2, Vally green Bold, Kalarichal White, PNS Vaigai, Elarajan, Thiruthali, Palakudy, Kaniparamban, Arjun, Paupalu.</p> <p>Wild crop relatives/related species collected from Kerala: 10</p>

Sl. No	Crop	Number of accessions from Kerala, place of collection, salient characters, if any	Number of cultivated crops and wild relatives in Kerala	Details on farmers varieties, land races, wild crop relatives in Kerala
3	Ginger	<p>No. of collections: 196</p> <p>Places of collection: From various districts in Kerala (Trivandrum, Kollam, Alappuzha, Pathanamthitta, Idukki, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad, Kozhikode, Wayanad, Kannur and Kasaragod)</p> <p>Salient characters of collection: Himachal, Nadan: High yield; Local: Yellow/blue core; Nadan: Short internodes; Nadan: Long internodes; Nadan: Bold rhizomes; Nadan: High dry recovery; Primitive types: Kakkakalan, Kozhikkalan, Sabarimala; Ellakkalan: High oil type</p>	<p>5 (Himachal*, Maran* Nadan, Rio de Janeiro*, Wayanad Local) from different places in Kerala (*Cultivars from other states/**exotic types acclimatized in the state)</p>	<p>Farmers varieties collected: Nil</p> <p>Wild crop relatives/related species collected from Kerala: 53</p>
4	Turmeric	<p>No. of collections: 121</p> <p>Places of collection: From various districts in Kerala (Trivandrum, Kollam, Alappuzha, Pathanamthitta, Idukki, Kottayam, Ernakulam, Thrissur, Malappuram, Palakkad, Kozhikode, Wayanad, Kannur and Kasaragod)</p> <p>Salient characters of collection: Alleppey: High curcumin; Nadan: High yield, Nadan: Bold rhizome; Nadan: Slender rhizome; Local: Low curcumin; Wayanadan: High curcumin</p>	<p>Alleppey (high quality)</p>	<p>Farmers varieties collected: Nil</p> <p>Wild crop relatives/related species collected from Kerala: 64</p>

Sl. No	Crop	Number of accessions from Kerala, place of collection, salient characters, if any	Number of cultivated crops and wild relatives in Kerala	Details on farmers varieties, land races, wild crop relatives in Kerala
5	Nutmeg	No. of collections: 333 Places of collection: Thenmala, Cheekilodu, Balussery, Mannuthy, Sugandhagiri, Munnar, Kozhikode, Malapuram, Idukki, Kottayam Salient characters of collection: High yielding, high quality, bold nut, thick mace, yellow mace type, seedless nutmegs; fruiting in clusters, double nut type, monoecious types, farmers variety, etc .	5	Farmers varieties collected: 10 Wild crop relatives/related species collected from Kerala: 18
6	Cinnamon	No. of collections: 248 Places of collection: Kozhikode, Wyanad, Ernakulam, Kottayam Salient characters of collection: High yield and high quality lines	2	Farmers varieties collected: Nil Wild crop relatives/related species collected from Kerala: 26
7	Clove	No. of collections: 10 Places of collection: Ambanad Estate, Kollam, Wayanad Salient characters of collection: High yield, more number of flowers/bunch, etc.	-	Farmers varieties collected: Nil Wild crop relatives/related species collected from Kerala: 9

Sl. No	Crop	Number of accessions from Kerala, place of collection, salient characters, if any	Number of cultivated crops and wild relatives in Kerala	Details on farmers varieties, land races, wild crop relatives in Kerala
8	Vanilla	<p>No. of collections: 93</p> <p>Places of collection: From research institutes namely, TBGRI, Palode, ICRI, Myladumpara and Indo American Hybrid Seeds, Bangalore</p> <p>Salient characters of collection: Vanilla planifolia, Vanilla tahitensis: Source of disease resistance. Wild relatives like V. aphylla, Vanilla sp. (A &amp; N Islands): Source of disease resistance.</p>	-	<p>Farmers varieties collected: Nil</p> <p>Wild crop relatives/related species collected from Kerala: 11</p>

## Annexure 11: Diversity of crops conserved at National Bureau of Plant Genetic Resources (ICAR), Vellanikkara, Thrissur

Sl. No.	Botanical Name	Crop	Group	Accns.	Varieties/Landraces
1	<i>Abelmoschus esculentus</i>	Okra	Vegetable	96	Aanakomban, Nilavenda, Plavenda, Ezhilavenda, Nattuvenda, Maravenda
2	<i>Alocasia macrorrhiza</i>	Giant taro	Tuber	1	Marachembu
3	<i>Amorphophallus campanulatus</i>	Elephant foot yam	Tuber	26	Neychena
4	<i>Artocarpus heterophyllus</i>	Jack fruit	Fruit	40	Koozha, Navarikka, Thamarachakka, Thenvarikka, Undachakka, Varikka
5	<i>Artocarpus hirsutus</i>	Aini jack	Fruit	2	-
6	<i>Benincasa hispida</i>	Ashgourd	Vegetable	4	Neykumbalam, Vaidyakumbalam
7	<i>Cajanus cajan</i>	Red gram	Vegetable	1	Malanthuvara
8	<i>Canavalia gladiata</i>	Sword bean	Vegetable	6	Valaringa, Valanpayar, Thamattavari
9	<i>Coccinia grandis</i>	Ivygourd	Vegetable	8	Marunnukoval
10	<i>Colocasia esculenta</i>	Taro	Tuber	6	Arattupuzhakannan, Karichembu, Kudachembu, Malamaran, Neelachembu, Thamarakkannan
11	<i>Cucumis melo var. Acidulous</i>	Oriental pickling melon	Vegetable	22	-
12	<i>Cucumis sativus</i>	Cucumber	Vegetable	1	Vellari
13	<i>Curcuma longa</i>	Turmeric	Spice	35	-

14	<i>Dioscorea alata</i>	Greater yam	Tuber	65	Bharanikkachil, Kaduvakkaiyyan, Neelkkachil, Parakkachil, Vazhakkachil
15	<i>Dioscorea bulbifera</i>	Potatoyam	Tuber	11	Erachikachil, Kattukachil, Mekkachil
16	<i>Dioscorea esculenta</i>	Lesser yam	Tuber	30	Cherukizhangu, Mullankizhangu, Nanakizhangu
17	<i>Garcinia cambogia</i>	Malabar tamarind	Spice	66	Kachampuli, Kodampuli, Koozhapuli, Penampuli, Thenpuli, Vadakkanpuli, Varikkapuli
18	<i>Garcinia indica</i>	Kokam	Spice	2	-
19	<i>Garcinia mangostana</i>	Mangosteen	Fruit	1	-
20	<i>Garcinia xanthochymus</i>	Mysore gamboge	Spice	8	-
21	<i>Lawsonia inermis</i>	Henna	Dye	18	Mailanchi, Marudhani
22	<i>Macrotyloma uniflorum</i>	Horsegram	Pulse	45	-
23	<i>Mangifera indica</i>	Mango	Fruit	99	Chandrakkaran, Chembazhanthay, Kadumanga, Kanjipuzhathadiyan, Karuthakilichundan, Kattupuliyam, Kilichundan, Kochukilichundan, Kolambu, Komanga, Kottamanga, Kotturkonam, Moovandan, Mylapoovan, Nadasala, Nallapuliyam, Nattumanga, Neelan, Olor, Perakkamanga, Puliyam, Salem, Sundari, Tholikaippan, Valiyakilichundan, Vellakomanga, Vellarimanga
24	<i>Manihot esculenta</i>	Cassava	Tuber	45	Aarumasam, Ambakkadan, Aryan, Blockkappa, Elamuriyan, Ethakkakappa, Quintakappa, Pancharavella, Narukku, Vellakappa
25	<i>Momordica charantia</i>	Bitter gourd	Vegetable	137	Kaipa, Paval
26	<i>Moringa oleifera</i>	Drumstick	Vegetable	6	Seema muringa, Jaffna muringa, Marunnumuringa, Kaippanmuringa, Ilamuringa

27	<i>Oryza sativa</i>	Rice	469	Cereal	469	<p>Adukkam, Allikannan, Ambaladan, Anakkulam-pokkali, Ana kodan, Arampoottan, Ariankali, Arikkarai, Arimodan, Aryan ,Avittam, Bharathi, Champola, Chara, Cheera, Chemban, Che mbav, Chenkayama, Chennullu, Cheruchitteni, Cherumani, Cherupuncha, Cheruvellari, Chettadi Chettivirippu, Chinga ppadan, Chitteni, Chomala, Choori, Chornali, Chungan, Chuv annachitteni, Chuvannachomam, Chuvanthavattan, Elamk ulampokkali, Ennappatta, Gandhakasala, Jeerakasala, Kara kozhivalan, Karathallikannan, Karathikannan, Karinjan, Ka rivadakkan, Karumkaima, Karuthachitteni, Karuthachoma n, Karuthakuruka, Karuthanavara, Karuthavattan, Karutha vellari, Kathir, Kattamodan, Kattamuttan, Keeripallan, Keeri poothada, Kichadi, Kochumundon, Kaima, Kalladayan, Kall arikkoyala, Kallunni, Kalluruli, Kannicheera, Kannivithu, Ko chuvithu, Kochuthonnooran, Konna, Koottumundakan, Koz hiala, Kozhipullipokkali, Kunjinellu, Kunjukunju, Kuruka, K uttipuncha, Kuttivelian, Malaadumban, Malakannan, Malak aran, Malakkarivadakkan, Malamkurava, Malamuda, Mala yidumban, Malippurampokkali, Mannuvelian, Marathondi, Markati, Matta, Mattathondi, Modan, Mullan koyala, Mundak an, Nageri, Navara, Nayaruvithu, Omanakuttan, Onavattan, Orkaima, Padannavella, Palkaima, Pallippurampokkali, Pall iyara, Palthondi, Pandakari, Pandi, Parambucheera, Param buvattan, Pokkali, Ponnaryan, Poochambal, Punchavattan, Rajakaima, Thaichundan, Thavalakannan, Thekkan, Thekk ancheera, Thondi, Thonnooran, Thonnooranthondi, Thotta kaima, Thottathavalakannan, Thottathilvithu, Thouvan, Un dachitteni, Undaponni, Valiavattan, Valichuri, Varukkunna nellu, Vattana, Velian, Vellachitteni, Vellakaima, Vellakattan, Vellakkoyala, Vellapara, Vellapravalan, Vellari, Veluthadich an, Veluthamundodan, Veluthanavara, Velutharikaima, Vel uthon, Vettuvari, Virippu, Vrishchikapandi</p>
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28	<i>Phaseolus lunatus</i>	Lima bean	Pulse	1	
29	<i>Phyllanthus emblica</i>	Indian gooseberry	Fruit	10	
30	<i>Piper nigrum</i>	Black pepper	Spice	72	Vadakkan, Karivally, Karalanji, Kumbhanadan, Narayakod i, Kanikkadan
31	<i>Sesamum indicum</i>	Sesame	Oilseed	67	Ayaliellu, Chittelu, Kareallu, Karuthaellu, naellu
32	<i>Solanum melongena</i>	Brinjal	Vegetable	22	Waynadan Gaint, West Coast White Round, White Oblong, Cheruvazhuthina, Kalakomban, Neelavazhuthina, Vellottu vazhuthina
33	<i>Solenostemon parviflorus</i>	Chinese potato	Tuber	26	
34	<i>Trichosanthes anguina</i>	Snake gourd	Vegetable	16	Padavalam, Parankikoval
35	<i>Vanilla planifolia</i>	Vanilla	Spice	1	
36	<i>Vigna umbellata</i>	Rice bean	Pulse	1	
37	<i>Vigna unguiculata</i>	Cow pea	Pulse	3	Kurutholapayar, Kuttipayar, Pannimuttam
38	<i>Zingiber officinale</i>	Ginger	Spice	8	Elakkallan, Maran, Nadan, Thekkan, Wayanadan



### Accessions of Minor Fruits conserved at ICAR-NBPGR Regional Station, Thrissur

Sl. No.	Botanical Name	Crop Name	Accns.	Local Name
1	<i>Annona squamosa</i>	Sweet sop	1	Sithapazham
2	<i>Aporosa lindleyana</i>		1	Vettipazham
3	<i>Baccaurea courtallensis</i>	Rambai wild	1	Moottipotti
4	<i>Carissa carandas</i>	Christ's thorn	1	
5	<i>Citrus grandis</i>	Pumelo	1	
6	<i>Citrus limon</i>	Lemon	1	Odichukuthi
7	<i>Citrus medica</i>	Citron	1	Karinaragam
8	<i>Flacourtia inermis</i>	Governor's plum	1	
9	<i>Pouteria campechiana</i>	Egg fruit	2	Muttapazham
10	<i>Psidium guajava</i>	Guava	2	
11	<i>Spondias pinnata</i>	Hog plum	1	Ambazham
12	<i>Syzygium cuminii</i>	Java plum	1	

### Wild Relatives of agricultural crops at ICAR-NBPGR Regional Station, Thrissur

Sl. No.	Botanical Name	Related Crop	Accns.	Local Name
1	<i>Abelmoschus angulosus</i> - <i>subsp. Angulosus</i>	Okra	1	
2	<i>Abelmoschus angulosus</i> - <i>subsp. Grandiflorus</i>	Okra	8	
3	<i>Abelmoschus angulosus</i> - <i>subsp. Purpureus</i>	Okra	1	
4	<i>Abelmoschus caillei</i>	Okra	20	
5	<i>Abelmoschus enbeepeege</i> - <i>arensis</i>	Okra	2	
6	<i>Abelmoschus moschatus</i> - <i>subsp. moschatus</i>	Okra	5	Kasturivenda, Up- panchari, Karthika- poovu
7	<i>Abelmoschus moschatus</i> - <i>subsp. tuberosus</i>	Okra	2	
8	<i>Amorphophallus bulbifer</i>	Elephant foot yam	1	Kattuchena
9	<i>Amorphophallus commu</i> - <i>tatus</i>	Elephant foot yam	3	

Sl. No.	Botanical Name	Related Crop	Accns.	Local Name
10	<i>Amorphophallus onco-phyllus</i>	Elephant foot yam	1	
11	<i>Amorphophallus paeonii-folius</i>	Elephant foot yam	4	Kattuchena
12	<i>Cinnamomum malabath-rum</i>	Cinnamon	1	
13	<i>Cinnamomum verum</i>	Cinnamon	2	Karuvapatta
14	<i>Cucumis madraspatana</i>	Cucumber	1	
15	<i>Cucumis sativus var hard-wickii</i>	Cucumber	27	
16	<i>Cucumis silentvallei</i>	Cucumber	3	Mullari
17	<i>Curcuma aurantiaca</i>	Turmeric	1	Kattumanjal
18	<i>Dioscorea belophylla</i>	Yams(Greater/Lesser)	1	Venni
19	<i>Dioscorea floribunda</i>	Yams(Greater/Lesser)	1	
20	<i>Dioscorea hamiltonii</i>	Yams(Greater/Lesser)	4	
21	<i>Dioscorea hispida</i>	Yams(Greater/Lesser)	12	Mathukka, Thek-kizhangu, Vallik-izhangu
22	<i>Dioscorea intermedia</i>	Yams(Greater/Lesser)	2	Cholakkachil
23	<i>Dioscorea oppositifolia</i>	Yams(Greater/Lesser)	14	Kavalakizhangu, Pinnankizhangu
24	<i>Dioscorea pentaphylla</i>	Yams(Greater/Lesser)	17	Keerinooran, Noorankizhangu
25	<i>Dioscorea pubera</i>	Yams(Greater/Lesser)	5	Nadunooli, Pula-yankadan
26	<i>Dioscorea spicata</i>	Yams(Greater/Lesser)	1	Mazhavallik-izhangu
27	<i>Dioscorea tomentosa</i>	Yams(Greater/Lesser)	5	Korna, Neduvan
28	<i>Dioscorea wallichii</i>	Yams(Greater/Lesser)	16	Narukizhangu, Neduvan

Sl. No.	Botanical Name	Related Crop	Acc ns.	Local Name
29	<i>Garcinia hombroniana</i>	Malabar tamarind	1	
30	<i>Momordica charantia</i> var. <i>muricata</i>	Bitter gourd	81	Kattukaipa, Kattupaval. Pagankai
31	<i>Momordica dioica</i>	Bitter gourd	4	Pavukka, Erumappaval
32	<i>Momordica sahyadrica</i>	Bitter gourd	2	
33	<i>Moringa concanensis</i>	Drumstick	1	
34	<i>Oryza meyerianasspragulata</i>	Rice	1	Onurinellu
35	<i>Oryza officinalis</i> ssp <i>officinalis</i>	Rice	11	Kozhinellu
36	<i>Oryza rufipogon</i>	Rice	7	Varinellu
37	<i>Oryza sativa</i> f <i>spontanea</i>	Rice	22	Varinellu
38	<i>Piper arboreum</i>	Black pepper	1	
39	<i>Piper argyrophyllum</i>	Black pepper	6	Naikurumulaku
40	<i>Piper betle</i> (wild & culti)	Black pepper	2	Vettila
41	<i>Piper chaba</i>	Black pepper	1	
42	<i>Piper galeatum</i>	Black pepper	3	Kattumulaku
43	<i>Piper hymenophyllum</i>	Black pepper	1	Kattumulaku
44	<i>Piper longum</i>	Black pepper	12	Pippali, Thippali
45	<i>Piper trichostachyon</i>	Black pepper	1	Kattumulaku
46	<i>Sesamum malabaricum</i>	Sesame	15	Kattellu
47	<i>Sesamum mulayanum</i>	Sesame	33	Kattellu
48	<i>Sesamum radiatum</i>	Sesame	16	Kattellu
49	<i>Solanum aculeatissimum</i>	Brinjal	2	Mullanchunda
50	<i>Solanum anguivi</i>	Brinjal	2	Cheruchunda

Sl. No.	Botanical Name	Related Crop	Acc ns.	Local Name
51	<i>Solanum incanum</i>	Brinjal	23	Cheruvazhuthina, Putharichunda
52	<i>Solanum insanum</i>	Brinjal	11	Kandankathiri
53	<i>Solanum nigrum</i>	Brinjal	1	Manithakkali
54	<i>Solanum surattense</i>	Brinjal	2	
55	<i>Solanum torvum</i>	Brinjal	2	Anachunda
56	<i>Solanum viarum</i>	Brinjal	6	Mullukai
57	<i>Trichosanthes cucumerina</i>	Snake gourd	12	
58	<i>Trichosanthes nervifolia</i>	Snake gourd	1	
59	<i>Vigna adenanthus</i>	Black/ Green-gram	1	
60	<i>Vigna bourneae</i>	Black/ Green-gram	32	
61	<i>Vigna dalzelliana</i>	Black/ Green-gram	57	
62	<i>Vigna minima</i>	Black/ Green-gram	1	
63	<i>Vigna pilosa</i>	Black/ Green-gram	11	
64	<i>Vigna radiata var. Sublobata</i>	Black/ Green-gram	28	
65	<i>Vigna trilobata</i>	Black/ Green-gram	1	
66	<i>Vigna trinervia</i>	Black/ Green-gram	1	
67	<i>Vigna vexillata</i>	Black/ Green-gram	2	
68	<i>Vigna wightii</i>	Black/ Green-gram	1	
69	<i>Zingiber cassumunar</i>	Ginger	2	Kattinji
70	<i>Zingiber rubens</i>	Ginger	1	
71	<i>Zingiber zerumbet</i>	Ginger	7	Kattinji

## Annexure 12: Mammals of Kerala recommended for inclusion under section 38 of BD Act 2002

Sl.no.	Common name	Scientific Name	Justification
1	Spiny Tree Mouse	<i>Platacanthomy slasiurus</i> Blyth	This species is sensitive to habitat changes. Habitat loss is due to expansion of coffee and tea plantations, agro-industry based farming activities, and forest fires. To maintain healthy population large areas of undisturbed rainforests is needed (Mudappa et al, 2001). Consumed because of medicinal value. Moreover, not listed in any of the schedules of wildlife protection Act, and very rare in Kerala.
2	Madras tree shrew	<i>Anathan aellioti</i> (Waterhouse)	Threat due to habitat loss, denudation for agriculture, thinning out of forest, plantation, developmental activities construction of dam sand roadways.
3	Bare-bellied Hedgehog	<i>Paraechinus udiventris</i> (Horsfield)	Threat due to expansion of agriculture and pesticide usage. Extremely rare in Kerala

## Annexure 13: Birds of Kerala recommended for inclusion under section 38 of BD Act,2002

Sl. no.	Common name	Scientific Name	Justification
1	Cinnamon Bittern	<i>Ixobrychus innamomeus</i> , (Gmelin)	Habitat loss due to draining of wetlands and paddy fields. Need conservation of wetlands especially <i>Pandanus</i> brake sand reed beds. High conservation priority species in Kerala
2.	Indian Thick-knee	<i>Burhinus indicus</i> , (Salvadori)	Threat due to habitat loss. Need conservation of wetlands, sea-shore. High conservation priority species in Kerala
3.	Jerdon's Baza	<i>Aviceda jerdoni</i> , (-Blyth)	Threat due to Deforestation. High conservation priority species in Kerala. Need intensive study of habitat requirements. Conservation off forests in Wayanad.

Sl. no.	Common name	Scientific Name	Justification
4	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i> , (Boddaert)	Species of high conservation priority in Kerala. Threat due to poaching. high demand in international market. Need monitoring of nesting sites
5	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> , (Boddaert)	Species of high conservation priority in Kerala. Threat due to habitat degradation
6	Forest Wag-tail	<i>Dendronanthus indicus</i> , (Gmelin)	Species of high conservation priority in Kerala. Threat due to degradation of low and mid-altitude forests
7	Pacific Golden Plover	<i>Pluvialis fulva</i> (Gmelin)	Species of high conservation priority in Kerala. Threat due to habitat degradation Need conservation of wetlands, seashore

### Annexure 14: Reptiles of Kerala recommended for inclusion under section 38 of BD Act,2002

Sl. No.	Common Name	Scientific Name	Justification
1	Indian Pond Terrapin	<i>Melanochelys trijuga</i> Schweigger,1812	Heavily hunted form eats. Currently not protected under any of the Schedules of Indian Wildlife (Protection)Actof1972.
2	South Indian Flying Lizard	<i>Dracodus sumieri</i> Dumeril&Bibron,1837	Locally captured a museum exhibit sand for Alleged medicinal properties

## Annexure 15: Butterflies of Kerala recommended for inclusion under section 38 of BD Act,2002

Sl. No	ScientificName	Common-Name	Family	Justification
1	<i>Troides minos</i> (Cramer, [1779])	Southern Birdwing	Papilionidae	Showy attractive butterfly. Largest butterfly in India.
2	<i>Papilio crino</i> Fabricius,1793	Common Banded Peacock	Papilionidae	One of the beautiful Butterfly species in the region. Reported from very few localities in Kerala. A popular species in illegal trade
3	<i>Papilio helenus</i> Linnaeus, 1758	Red Helen	Papilionidae	One of the largest butterflies In the region. Reported in the illegal trade
4	<i>Cethosia mahratta</i> Moore,1872	Tamil acewing	Nymphalidae	Arare and beautiful Endemic species of the Western Ghats. Rarely reported in the illegal trade
5	<i>Idea malabarica</i> (Moore, 1877)	Malabar-Tree Nymph	Nymphalidae	Arare endemic species of The Western Ghats. Reported from the illegal trade

## Annexure 16: Odonates of Kerala recommended for listing under section 38 of BD Act, 2002

Sl No	Family	Species	Justification
1	Chlorocyphidae	<i>Calocypha laidlawi</i> (Fraser, 1924)	Endemic to the Southern Western Ghats, recorded only from Kerala and Karnataka till date. Mostly restricted to Myristica swamps and associated streams. IUCN Red List Status
2	Platycnemididae	<i>Disparoneura apicalis</i> (Fraser, 1924)	Endemic to riparian habitats in the Western Ghats, reported only from Kodagu in Karnataka and Kuruva Islands, Wayanad, Kerala till date. IUCN Red List Status: Data Deficient.

## Annexure 17: Amphibians of Kerala recommended for inclusion under section 38 of biological diversity act 2002

Sl. No.	Common Name	Scientific Name	Justification
1	Carnatic Bulfrog	<i>Hoplobatrachus crassus</i> Jerdon 1853	Locally collected for frog meat consumption. Threat due to Habitat destruction and use of pesticides.
2	Kaaravali Skittering-frog	<i>Euphlyctis karaavali</i> , Priti, Naik, Seshadri, Singal, Vidisha, Ravikanth, and Gururaja, 2016	Locally collected for frog meat consumption. Threat due to Habitat destruction and use of pesticides.
3	Indian bull-frog	<i>Hoplobatrachus tigerinus</i> (Daudin, 1802)	Locally collected for frog meat consumption. Threat due to Habitat destruction and use of pesticides.

## Annexure 18: Fresh water fishes of Kerala recommended for inclusion under section 38 of BD Act, 2002

Sl. No.	Common Name	Scientific Name	Justification
1	Hump-backed mahseer	<i>Tor remadevii</i> Kurup & Radhakrishnan	Threat due to indiscriminate fishing by local communities.



Sl. No.	Common Name	Scientific Name	Justification
2	Gollum Snakehead	<i>Aenigma channa</i> Gollum Britz, Anoop, Dahanukarand Raghavan	High demand in aquarium pet trade
3	Subterranean Catfish	<i>Kryptoglanis shajii</i> Vincent&J.Thomas	Threat due to high levels of water extraction from Laterite aquifers. Species of unique evolutionary status
4	Blindcatfish	<i>Horaglanis abdulkalami</i> Babu	do
5	Blindcatfish	<i>Horaglani salikunhii</i> Subhash Babu&Nayar	do
6	Blindcatfish	<i>Horaglanis krishnai</i> , Menon	do
7	Blind synbranchidee	<i>Rakthamichthys digressus</i>	do
8	Blind synbranchidee	<i>Rakthamichthys indicus</i>	do
9	Blind synbranchidee	<i>Rakthamichthy sroseni</i>	do

### Annexure 19: Fresh water crabs of Kerala recommended for inclusion under section 38 of BD Act, 2002

Sl.no.	ScientificName	Justification
1	<i>Arcithelphu satumpikkai</i> Pati, Sujila&SudhaDevi	Facing threat due to habitat degradation and agrarian development, more likely to become extinct in the near future
2	<i>Cylindrotelphus abbreviphallus</i> -Pati, Rajesh, Raj, Sheeja, Kumar & Sureshan	Facing threat due to habitat degradation and pesticide pollution.
3	<i>Cylindrotelphus agranolata</i> (Pillai)	Threat due to habitat conversion. The species might be now on the verge of extinction
4	<i>Velavirupa</i> Bahir & Yeo	Facing threat due to habitat degradation and pesticide pollution.

## Annexure 20. List of alien/invasive flora and fauna recorded from the waterbodies along southern Western Ghats, India

Sl. No.	Common name	Species	Native Range	Pathway of introduction Rivers	Alien/ Invasive Reservoirs Freshwater lakes	Presence in number of water bodies		
						River	Reservoirs	Freshwater lakes
FLORA (Macrophytes)								
1	Kariba Weed	<i>Salvinia molesta</i>	South eastern Brazil	GP	Invasive	44	4	3
2	Water Lettuce	<i>Pistia stratiotes</i>	Pantropical	GP	Invasive	20	2	2
3	Water Hyacinth	<i>Eichhornia crassipes</i>	South America	GP	Invasive	38	0	1
4	Red Cabomba	<i>Cabomba furcata</i>	South America	AQ	Invasive	7	0	2
FAUNA (Fish)								
5	Mozambique Tilapia	<i>Oreochromis mossambicus</i>	Tropical and subtropical Africa	AS	Invasive	44	18	2
6	Nile Tilapia	<i>Oreochromis niloticus</i>	Africa	AS	Invasive	4	0	0
7	Sailfin Catfish	<i>Pterygoplichthys pardalis</i>	South America	AQ	Invasive	5	0	1
8	Common Carp	<i>Cyprinus carpio</i>	Europe to Asia	AS	Invasive	17	29	1

Sl. No.	Common name	Species	Native Range	Pathway of introduction Rivers	Alien/ Invasive Reservoirs Freshwater lakes	Presence in number of water bodies		
						River	Reservoirs	Freshwater lakes
9	North African Catfish	<i>Clarias gariepinus</i>	Pan Africa	AS	Invasive	7	10	0
10	Guppy	<i>Poecilia reticulata</i>	South America	MC	Invasive	14	22	0
11	Mosquito Fish	<i>Gambusia affinis</i>	North and Central America	MC	Invasive	2	5	0
12	Green Sword-tail	<i>Xiphophorus hellerii</i>	Central America	AQ	Alien	1	0	0
13	Southern Platyfish	<i>Xiphophorus maculatus</i>	North America	AQ	Alien	1	0	0
14	Giant Gourami	<i>Osphronemus goramy</i>	South east Asia	MC	Alien	2	0	0
15	Three Spot Gourami	<i>Trichopodus trichopterus</i>	South east Asia	AQ	Alien	1	0	0
16	Moonlight Gourami	<i>Trichopodus microlepis</i>	South east Asia	AQ	Alien	1	0	0
17	Shortfin Molly	<i>Poecilia mexicana</i>	North and Central America	AQ	Alien	1	0	0
18	Pacu	<i>Piaractus mesopotamicus</i>	South America	AS/AQ	Alien	2	0	0

Sl. No.	Common name	Species	Native Range	Pathway of introduction Rivers	Alien/ Invasive Reservoirs Freshwater lakes	Presence in number of water bodies		
						River	Reservoirs	Freshwater lakes
19	Pirapitinga	<i>Piaractus brachipomus</i>	South America	AS/AQ	Alien	9	0	1
20	Striped Catfish	<i>Pangasianodon hypophthalmus</i>	Asia	AS/AQ	Alien	8	0	0
21	Arawana	<i>Osteoglossum bicirrhosum</i>	South America	AQ	Alien	1	0	0
22	Rainbow Trout	<i>Oncorhynchus mykiss</i>	Asia and North America	SF	Alien	1	0	0
23	Silver Carp	<i>Hypophthalmichthys molitrix</i>	East Asia	AS	Alien	2	0	0
24	Kissing Gourami	<i>Helostomatemincii</i>	Asia (Thailand to Indonesia)	AQ	Alien	1	0	0
25	Grass Carp	<i>Ctenopharyngodon idella</i>	Asia (Eastern China and Russia)	AS	Alien	5	0	0
26	Forest Snakehead	<i>Channa lucius</i>	Asia (Thailand to Indonesia)	AQ	Alien	1	0	0
27	Red Tailed Tinfoil	<i>Barbonymus altus</i>	Asia	AQ	Alien	2	0	0
28	Alligator Gar	<i>Atractosteus spatula</i>	North America	AQ	Alien	3	0	0

Sl. No.	Common name	Species	Native Range	Pathway of introduction Rivers	Alien/ Invasive Reservoirs Freshwater lakes	Presence in number of water bodies		
						River	Reservoirs	Freshwater lakes
29	Oscar	<i>Astronotus ocellatus</i>	South America	AQ	Alien	1	0	0
30	Arapaima	<i>Arapaima gigas</i>	South America	AQ	Alien	3	1	0
31	Gold fish	<i>Carassius auratus</i>	Central Asia and China	AQ	Alien	1	0	0
32	Mexican mo-jarra	<i>Mayaheros urophthalmus</i>	Central America	AQ	Alien	1	0	0

GP: Garden Pond; AS: Aquaculture Systems; AQ: Aquarium System and Ornamental fish trade fish trade; MC: Mosquito larvae control; SF: Sport Fisheries

## Marine invasive species of Kerala

No.	Species name	References	Native Range
Phylum: Mollusca			
	<i>Mytella trigata</i> (d'Orbigny, 1842)	Biju Kumar et al., 2019 and Jayachandran et al., 2019.	Atlantic coast of South America
	<i>Mytilopsis sallei</i> (Recluz, 1849)	Jayachandran et al., 2018; Sandilyan 2018.	Caribbean islands and the Bay of Mexico
	<i>Perna perna</i> (Linnaeus, 1758)	Appukuttan and Alagarwami. 1980; Kuriakose 1980; Ramachandran et al., 1998; Kripa 2005; Ramakrishna and Dey 2010; Bijukumar 2012; Gardner et al., 2016; Sandilyan 2018.	Western Indian Ocean and the west coast of Africa.
	<i>Tenellia adspersa</i> (Nordmann, 1845)	Dhanya et al., 2017.	Native to the Eastern Atlantic and Western Mediterranean
	<i>Thecacera pennigera</i> (Montagu, 1813)	Ravinesh et al., 2017.	South and west of the British Isles, extending up the English Channel
Bryozoa			
	<i>Bugula neritina</i> (Linnaeus, 1758)	Menon and Nair 1971; Ravinesh and Biju Kumar 2013.	Mediterranean Sea
Cnidaria (Jellyfish)			
	<i>Pelagia noctiluca</i> (Forsskål, 1775)	Nair, 1941, 1951; and Sandilyan 2018.	Atlantic Ocean.
Crustacea (Shrimp)			
	<i>Penaeus vannamei</i> Boone, 1931	Radhakrishnan et al., 2012 and Sandilyan 2018.	Pacific Ocean.
Ascidia			
	<i>Didemnum candidum</i> Savigny, 1816	Abdul and Sivakumar 2007.	North America
Sea Weed			
	<i>Hypnea musciformis</i> (Wulfen) J.V.Lamouroux, 1813	Baby Usha Kiran et al., 2017.	Eastern and western Atlantic

# STAKEHOLDER MEETINGS



*Athirapalli Stakeholder Meeting*

# STAKEHOLDER MEETINGS



*Inception Workshop*



*Sectoral Workshop*