

# **RESPONSE TO CLIMATE CHANGE: STRATEGY AND ACTION**

## **KERALA**

### **STATE ACTION PLAN ON CLIMATE CHANGE**

**DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE**

**GOVERNMENT OF KERALA**

**THIRUVANANTHAPURAM**

## **Response to climate change: Strategy and Action Plan for Kerala**

The concern on climate change has caught intense focus after the publication of Fourth Assessment Report (AR4) of the Inter Governmental Panel on Climate Change (IPCC) and when the post Kyoto strategy became the agenda for discussions in the Conferences of Parties for UNFCCC. India had started its work on an action plan in 2007 and the National Action Plan for Climate Change (NAPCC) was released in October 2008. It was on October 5, 2009 that the Union Minister of State for Environment and Forests apprised the Chief Ministers of the states about the strategy for global negotiations in Copenhagen and sought cooperation in national efforts for dealing with this global concern. Honourable Chief Minister Kerala in his reply confirmed the support for the cause and emphasized the need of involving states in the concerted action on response to climate change.

The national vision in the global background for mitigating the causes of global warming and resultant climate change governs the national efforts in this direction. The state level actions thus will be led largely by the National Action Plan for Climate Change as far as mitigation efforts are concerned.

However, another facet of this is the impending implications of climate change on the local environment, the need to understand those, and taking preventive actions or adaptive measures accordingly. As the implications are expected across the development sectors, the concerns need to be addressed at systemic levels. With this view, the state had set up Working Groups on the major sectors including General Policy and Governance, Monitoring and Strategic Knowledge Management, Water Resources, Forests, Agriculture, Fisheries and Coastal Ecosystems; and Communication and Education. The Working Groups deliberated and preliminary recommendations were discussed at the state level Empowered Group under the leadership of Chief Secretary to Government of Kerala, before incorporating in this document.

This document is a preliminary attempt to outline the strategy for actions on the aspects which could be relevant in climate change context, as a first step in the series of deliberations for detailed strategic planning for action. The document enumerates the sectors and scope of coverage of action for adaptation to climate change. The document only shows the indicative possibilities in the state, based on the information, available literature and understanding. It is intended to take follow up action on this document for designing a detailed long term action plan based on wider consultation and information base, with finally defined tasks, responsibilities, resource and time estimates for the activities contemplated.

Thiruvananthapuram

## **Response to climate change: Strategy and action in Kerala**

### **1. Context**

Climate change is a global phenomenon and the efforts in containing it by containing anthropogenic Green House Gas (GHG) emissions cannot be different for different states. The National Action Plan for Climate Change provides the basic approach for dealing with the issue of climate change. Government of India was expected to formulate national programmes and modalities for the implementation of the eight specific National Missions suggested in the National Action Plan by December 2008. These are in various stages of formulation.

Government of Kerala has been working on a strategy for action in the state in response to Climate Change. It is proposed to identify specific vulnerabilities and plan appropriate responses keeping those in focus. As the foremost impact of the changing climatic pattern relates to the land and water resources, a system for monitoring it will be the first imperative. Further, the information at global as well as local level would be needed to be analysed for any strategy. This will essentially include assessment of efficacy of the present development strategies in this context and probable mid course corrections wherever found necessary.

The principles adopted for the National Action Plan for Climate Change include achieving sustainable development path while advancing economic and environmental objectives. The following points form the basis of the national strategy.

1. Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change.
2. Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of GHG emissions.
3. Devising efficient and cost effective strategies for end use Demand Side Management.
4. Deploying appropriate technologies both for adaptation and mitigation of GHG emissions extensively as well as at an accelerated pace.
5. Engineering new and innovative market, regulatory and voluntary mechanisms to promote sustainable development.
6. Effecting implementation of programmes through unique linkages including with civil society and local government institutions and through public private partnerships.

7. Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global IPR regime that enables technology transfer to developing countries under UNFCCC.

Thus in essence the NAPCC provides for measures to promote our development objectives with co-benefits for addressing climate change effectively (NAPCC, 2008).

The demographic, socio-economic and physiographic situations in the states determine the specific vulnerabilities of their economies towards climate change and in such circumstances, it is imperative to work on the precautionary and anticipatory measures for facing the expected changes and adapting to the changes in the long term. At the same time it is also important to work on our environment in a manner that the shocks of changes are not able to alter the circumstances rapidly and there is sufficient time and scope to adopt appropriate adaptive mechanisms to suit the changes.

In these backgrounds strategies to deal with Climate Change have to be in the following areas:

1. Contributing to the efforts for postponing / containing the change by mitigation efforts, led by the national strategies as provided in the National Action Plan on Climate Change, and to be implemented with the adoption of local models.
2. Generating resilience in the existing natural resource base of the state to ensure that the influence of the shock of climate change is gradual and sufficient time is available for identifying, working on and adopting suitable adaptive measures. It will be basically aimed at enriching the natural resources in the state and optimizing their use for ensuring sustainability.
3. Working on adaptive methods, processes based on the available and upcoming information related to the impacts and implications of climate change. Adaptations need to be in all the spheres of human environment: natural resources use, food and nutrition, health care, socio-economic domains and civic amenities. Main determinants being energy flow and material flow through the ecological components, environmental balance has to be the main focus.
4. Building the capacity of the stakeholder communities and institutions for realizing and coping up with the impacts and devising methods based on the local knowledge and experiences.

The strategic possibilities for dealing with the climate change situations in the state have been suggested below. These need to be further considered in view of information and analysis to work on a road map for action in response to climate change for the state. Though sectoral compartmentalization of actions and strategies is not possible, attempt has been made to name broad domains for suggesting a focus of strategic attention for planning purpose.

## **2. Baseline Scenario**

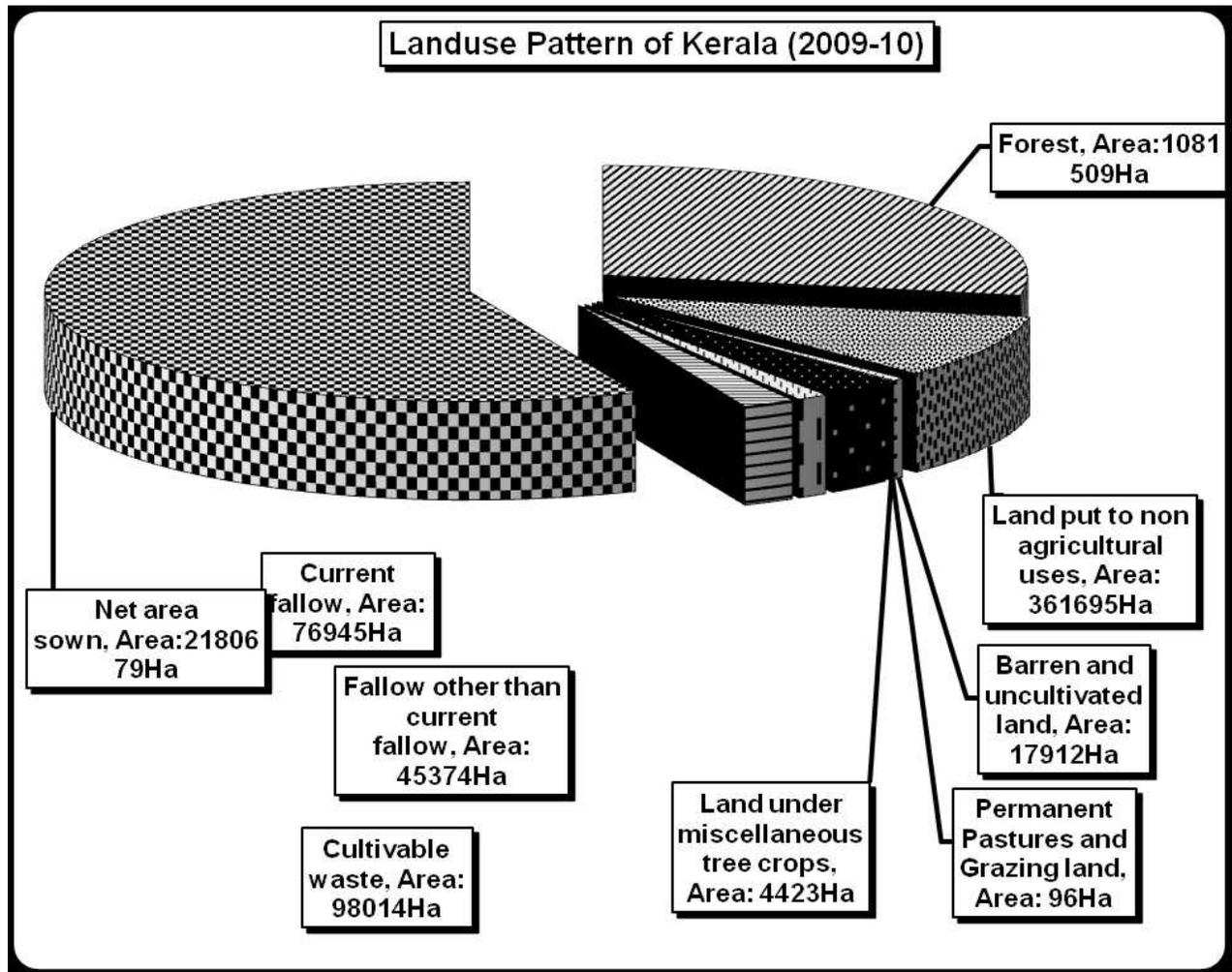
Kerala state lies on the south western coastal region of the country between latitude 8<sup>o</sup>17' and 12<sup>o</sup> 47' N and longitude 74<sup>o</sup> 52' and 77<sup>o</sup> 24' E. It is spread over an area of 38863 sq. km or about 1.2% of geographical area of India. Physiographically, the state can be divided into coastal, midland and highland zones. The state is drained by 41 west flowing and 3 east flowing rivers. Kerala is also bestowed with 590 kilometres of coastal line. Backwaters form an attractive and economically valuable feature of the state. Situated in the humid tropical belt, the state is characterized by high rain fall and humidity. Rainfall varies from 1520mm to 4075mm and the temperature ranges from 19.8<sup>o</sup>C to 36.7<sup>o</sup>C. Analysis of rainfall from 1951 to 2003 indicates increasing tendency in winter and autumn extreme rainfalls and decreasing trends in spring rainfalls with increasing frequency of dry days (Economic review, 2010).

### **State of Natural Resources**

With a total Geographical area of 38,863 sq. km, total cropped area covers about 68%, forests 29% and cultivable waste 3% of it. Barren and uncultivated lands are only 0.5% and only 96 ha has been classified as pastures and grazing lands (Fig.1). Out of the total cropped area of 2.67 m ha, 11.86% covers food crops. Largest extent of 0.78 m ha is under coconut cultivation, other important cash crops being rubber, pepper, areca nut, coffee, cardamom, cashew, tea etc. Livestock sector contributes as much as 40% to the agricultural GSDP and is livelihood intensive. Annual growth rate of milk and poultry for last 5 years has been recorded as 6.18% and 10.85% compared to the national average of 3.69% and 5.71% respectively.

The total population of 3,33,87,677 (2011 census) indicates a population density of 859 persons/sq.km. which is 2.25 times the national average. About 47.72% of the population lives in urban areas. However, rural areas are also highly urbanized. Decadal growth rate of population has been 4.86% compared to 17.64% of the country. Sex ratio is 1084 against national figure of 940 in 2011. Scheduled Tribe Population (2001 Census) is 3,64,189 (1.14%) and scheduled Caste Population is 31,23,941(9.81%). Per Capita Land availability as per the 2001 Census is 0.122 Ha.

Fig. 1



Kerala is a water resource rich state owing to its tropical and coastal location. The total annual rainwater of 1,18,896 Mm<sup>3</sup> facilitates a total annual yield of 70,323 Mm<sup>3</sup> which constitutes the utilizable annual yield of about 42,772 Mm<sup>3</sup>. However these estimates were made in 1974 by Kerala PWD, 1974 and present estimates are not available. There are 18 dams in the state intended for irrigation, including 13 with storages and 5 barrages. CWRDM has identified 236 perennial springs in the state. About 910 ponds and tanks with a minimum of 0.5 ha waterspread area exist. There are five large wetland/ lakes of which three are Ramsar sites.

Annual Replenishable Ground Water has been assessed by Central Ground Water Board in 2008 to be 6,841 Mm<sup>3</sup> of which the quantity available as Annual Net Available Ground Water is estimated as 6,230 Mm<sup>3</sup>. Thus a total utilizable quantity of 49002 Mm<sup>3</sup> has been projected. The total Storage capacity created in all dams has been 5,311 Mm<sup>3</sup> (12.5% of the Utilizable Surface

Water). However, the storage of water in 2010 has been estimated to be only 1233 Mm<sup>3</sup> (Economic Review, 2010). It is observed that only 7% of the gross cropped area is under irrigation against 11.86% under food crops. The status indicates that there is plenty of scope of bringing in water use efficiency in the existing available utilizable yield of water in the state.

Fisheries sector contributes 3% of the economy of the state. Fisheries resources include 44 rivers, 53 reservoirs, and 53 backwaters and other brackish water bodies. A coastline of 590 km covering a continental shelf area of about 39139 sq km covers the marine fisheries resources. A population of about 11.43 lakh practices fisheries out of which about 8.8 lakh dwell along the coastal areas of the state. Fisheries contributes about 8% to the Agricultural GSDP of the state. Marine fish landings in Kerala have been on decline. It has been 5.7 lakh tonnes in 2009-10, 7.2% less than previous year. Sustainable yield has been estimated to be 6.99 lakh tonnes. Biodiversity includes about 300 species with about 40 of commercial importance. Oil sardine, Lesser Sardine, Prawn, Mackarel, Perches, Caranx include some of such species. Backwaters are the repositories and epicenters of aquaculture practices which are also supported by government under the Matsyakeralam project since 2008-09. Integrated coastal area development programme covers activities of improvement of socio-economic conditions of fisherfolks in coastal areas. Establishment of 17 fishing harbours is progressing out of which 9 are complete.

### **Infrastructure**

Power sector in Kerala is almost fully based on its natural resources. Out of the total installed capacity of 2746.19 MW, 1933 MW comes from 24 Hydel stations, 783 MW from thermal projects including NTPC and rest from some alternate energy projects. There is an additional requirement of about 1000 MW. There has been a growth of about 10% in per capita consumption of electricity in last two years. Therefore sustainable ways of power generation need to be explored.

Kerala has a network of 151652 km of roads ranging from national highways to panchayat roads. The number of motor vehicles registered in the state up to March 2010 is 5.4 million. This includes annual addition of 0.50 million vehicles in 2009-10. Public transport accounts for 43753 buses, 89% of which are in private sector. Only one fourth of the buses of the state corporation are more than 10 years old. Similar trend could be expected in private sector also.

Kerala has one major port (Kochi) and 17 non major ports. An international container transshipment terminal has been opened recently at Kochi and one more is in offing. The total

length of inland waterways in the state is 1687 km. A state Water Transport Department operates 81 passenger boats in 14 operating centres serving for a distance of 7900 km for 80000 persons per day.

Total railway route in the state covers 1199 km over 13 routes. Three airports service the air traffic to domestic and international destinations. In 2009-10, a total of 6.48 million passengers were served from these airports. A new airport is proposed at Kannur.

Manufacturing sector has contributed above 9% to the GSDP in the recent years. Growth rate has been over 10.65% during the last 5 years. Most of the industries have been natural resource based for example tea, coffee, cashew kernel, coir products, sea food processing etc. Recent developments in IT based service sector have been fast. There are 63 PSUs under Industries Department, 37 being in manufacturing sector ranging from chemical, ceramics, engineering, textiles, electrical equipments etc.

### **Civic Infrastructure**

The civic infrastructure is largely looked after by the local self governments. Kerala consists of 5 Municipal Corporations, 60 Municipalities and 999 gram panchayats. Urbanization is not limited to cities and towns. For building capacity and guiding the civic bodies for taking up sanitation related environment management, Kerala Suchitwa Mission has been set up. However, high population density, lack of isolated lands and generation of high quantity of garbage has resulted in solid and liquid waste management concern as a big problem. Quantity of waste generated has been roughly estimated to be about 2800-3000 tonnes per day. There are no sewage treatment plants and a few existing solid waste treatment plants are facing problems due to high accumulation of waste than the treatment capacity. Desirable components of minimizing waste like segregation at source, decentralised composting of biodegradable waste and safe disposal of only non recyclable waste into scientific landfills are yet to be integrated in the civic amenities.

Safe drinking water is presently accessible to almost 73% of the total population of Kerala. About 77% of the rural and 56% of the urban population is dependent on wells for drinking water. Well density has been high in lowland areas (320-900/km<sup>2</sup>) compared to highlands (18-330/ km<sup>2</sup>). Between 1980 and 2005 the well density in the state has increased by a factor of 1.5 to 3. Forests, wetlands and paddylands serve as natural means of rainwater harvesting and ground water recharge.

## State of GHG emissions

Central Government has set up an Indian Network on Climate Change Assessment (INCCA) in 2009 for taking up compilation of climate change related information in a format which would be comparable to the global information on various related aspects. INCCA has been working on compilation since then and two reports have been published so far. First in this series has been the assessment of Green House Gas emissions and comparison between the values for 1994 and 2007. As regional/ state level emission data are not available in comparable figures, state level figures may be based on the national data and projections based on per capita values.

- The net Greenhouse Gas (GHG) emissions from India, that is emissions along with LULUCF, in 2007 were 1727.71 million tons of CO<sub>2</sub> equivalent (eq) of which
  - CO<sub>2</sub> emissions were 1221.76 million tons;
  - CH<sub>4</sub> emissions were 20.56 million tons; and
  - N<sub>2</sub>O emissions were 0.24 million tons
- GHG emissions from Energy, Industry, Agriculture, and Waste sectors constituted 58%, 22%, 17% and 3% of the net CO<sub>2</sub> eq emissions respectively.
- Energy sector emitted 1100.06 million tons of CO<sub>2</sub> eq, of which 719.31 million tons of CO<sub>2</sub> eq were emitted from electricity generation and 142.04 million tons of CO<sub>2</sub> eq from the transport sector.
- Industry sector emitted 412.55 million tons of CO<sub>2</sub> eq.
- LULUCF sector was a net sink. It sequestered 177.03 million tons of CO<sub>2</sub>.
- India's per capita CO<sub>2</sub> eq emissions including LULUCF were 1.5 tons/capita in 2007.

Considering the population of the state as 3,33,87,677 (2011 census provisional figures), the total GHG emissions will be 50.08 million tons. However, the actual emissions for the state could be far below this range for the fact that in Energy, Industry and Agriculture sector, the relative contribution of the state can only be lower for the reason that larger proportion of power generation is from hydroelectric power, heavy industry sector is small in extent and agriculture sector is dominated by perennial crops which are usually net sequesterers than emitters.

The trend of emissions as revealed in the assessment, between 1994 and 2007 has indicated a compounded annual growth rate of 2.9% of which largest share has been in Waste, Cement, Electricity generation, transport and residential sectors. While infrastructure development sectors have been contributing substantially to the GHG emissions, this can be only a temporary phase. However, in the sectors like waste management and power sector, technology and management issues may have to be taken seriously for optimizing carbon foot prints in long term.

Assessment of contribution of India's forests in carbon mitigation by C sequestration has been made by ICFRE. India's forests have been assessed as functioning as a net sink of CO<sub>2</sub>. From 1995 to 2005, carbon stocks stored in the forests have been reported to have increased from 6244.78 to 6621.55 million tons (mt) registering an annual increment of 37.68 mt of carbon = 138.15 mt of CO<sub>2</sub> eq. This annual removal by forests is considered enough to neutralize 9.31% of the total annual emissions of 2000. The projected potential of removal of carbon by 2020 is 4.87% of the total emissions which is reported to be capable of enhancement up to 5.18% of the projected enhanced emissions of 2020, which are projected to be 95% more than those in 2000.

For considering the corresponding state and potential for Kerala, the factors related to the existing growing stock in forests, their growth rate, age profile and potential use values are needed to be considered. At present, as per the State of Forests Report 2009, the total growing stock of the tree cover in Kerala is reported as 192.77 million m<sup>3</sup>, which is 3.16% of the total assessed for the Country. Proportionate quantity of carbon stocks in Kerala thus would be about 209 million tons. Considering high growth potential of the natural forests, which constitute about 85% of the total forests of the state, a higher growth rate of carbon removal can be expected if pragmatic policy and management interventions are adopted.

## **Impacts**

The Indian Network on Climate Change Assessment (INCCA) in its second report entitled "Climate Change and India: A 4 X 4 Assessment" has provided a sectoral and regional analysis of impacts for 2030s. It includes Himalayan, Western Ghats, North Eastern and Coastal regions and Agriculture, Forests, Health and Water sectors, besides providing projections for climate, sea level rise and extreme events. It reiterates that sea level rise continues to occur even if GHG levels are brought under control. Annual Mean surface temperature has been shown to rise by 1.7 to 2 °C by 2030 with respect to 1970. For Western Ghats, it is shown to be between 1.7 to 1.8 °C and for coastal region up to 2.1 °C. In the western coastal region, mean annual temperatures are projected

as likely to increase to  $26.8 \pm 0.4$  °C to  $27.5 \pm 0.4$  °C in the 2030s. The rise in temperature with respect to the 1970s is projected to be between  $1.7$  °C and  $1.8$  °C. Extremes may vary up to  $4.5$  °C higher in minimum and  $1-3$  °C higher in maximum temperature in areas adjoining Kerala as well as coastal areas. Mean annual rainfall is shown to increase by 6-8% in western Ghats and also in the western coastal region. While number of rainy days are projected as less, intensity is likely to rise between 1-4mm/day. Severe cyclonic disturbances are not foreseen and sea level rise is expected at a global rate of  $1.3 \text{ mm} \pm 0.7 \text{ mm/year}$ .

### **Vulnerabilities**

Kerala is specifically vulnerable to the changing climatic dynamics owing to its location along the sea coast and steep gradient along the western slopes of the Western Ghats. High population density in coastal areas adds to the vulnerability to the climate related problems.

- Extreme intensity precipitation can cause heavy damage to the otherwise productive and fertile soils due to heavy runoff and resultant erosion. This may result in erosion of productive natural resource base, affecting food security and economic loss.
- High quantum of water use in uplands and midlands from surface water resources as well as ground water resources increases the incidence of salinity intrusion in the coastal areas. A few engineering based regulatory arrangements have been created for controlling this phenomenon like in Vembanad lake, Chaliyaar, Periyar and Vallapatnam rivers. .
- Paddy cultivation being mainstay of food security is especially vulnerable to climatic extremities and unpredictability.
- High population density along coastal belt and congregation of fishermen communities in several coastal areas render them vulnerable to the vagaries of coastal erosion, sea level rise, tsunami like recurrences and livelihood concerns as impact of commercial fisheries activities.
- Tropical agro-climatic conditions in the coastal belt pose health attainment challenge on human development aspect. In spite of the fact that per capita expenditure on health is comparatively high in the state, the recurrence of vector borne diseases is a matter of concern. Thus the economic cost of adaptation by improving the civic amenities may be higher.
- On human development aspects, high population density and high state of urbanization results in high per capita energy needs and thus carbon intensity. Sea level rise may shrink the habitats

by coastal erosion, flooding of productive agricultural areas and ingress of salinity, risking the sustainability of habitation.

- Aquatic resources – marine as well as fresh water ones – are likely to be impacted. Main threats could be salinity ingress in water bodies and inundation of low lying areas, with resultant loss of fertile agricultural lands in coastal areas. However, aquatic biodiversity like fisheries resources may provide opportunity for adaptive livelihood measures for food security in the coastal area.
- Forest profile and biodiversity resources are likely to be impacted. However, resultant change of pace of impact on forest profile cannot be predicted as of now. An optimum, resilient forest can absorb the shock of change and facilitate slower pace of transformation into more adapted life forms in the changing environment. On the contrary degraded state of forests can cause sudden deterioration of profile, thereby leaving no room for natural adaptive evolution. As the forests form catchments for water resources besides being the life support systems for neighboring communities, maintenance of optimum productivity for sustainable use and resilience of forests is important for slowing down the impacts of climate change on human well being eventually.
- The rapidly expanding infrastructure development in the state as well as large proportion of goods and traffic movement through road transport has been a cause of increasing quantum of carbon based emissions in the state. Transport management is a potential area for management of carbon emissions in the state.
- Like the country, Kerala is also going through a phase of high pace of infrastructure development. While this pace has all the potential of impacting the natural resource base and state of the environment in the state, the demand for energy consequent to high urbanization in the wake of high population density runs a risk of high carbon footprints if green technologies are not integrated in the development process.

### **Opportunities and initiatives in Kerala**

Strong public health infrastructure, steadily improving knowledge infrastructure and the ongoing efforts in the fields of habitat sustainability and energy management represent our sustainable human development strategy. Initiatives on energy efficiency at community level can go a long way in reducing the carbon footprints at societal level.

High potential growth rate of forests and perennial agriculture in Western Ghats provides high resilience against mild climatic variations. At the same time, high human population density and high biomass productivity are the factors which drive the use components of the management and in such circumstances; sustainable use becomes an inevitable component of the conservation. The high productivity, high species diversity and high regeneration capacity lend credence to the capacity of these forests of catering to the societal needs while being capable of sustaining their profile, maintaining resilience in turn. Thus optimum profile of forests and optimum agricultural productivity can help the state in withstanding the environmental shock of climate change.

Tropical climate provides conducive atmosphere for faster variations and evolution of life forms for the changing climatic regimes. Thus the evolving life forms as a result of changing climate can further enrich the genetic resource base to help the country in working for genetically more desirable crop varieties in the changing environment. Already several rain fed area paddy varieties are available in the state which can be suitably used for developing more water stress tolerant varieties.

#### **Actions relevant to climate change**

- In line with the concept of sustainable habitats, work is in progress for adopting the provisions of the Energy Conservation Building Code (ECBC) 2007, suitable for the state. Energy Management Centre, established in Kerala way back in 1996, is the focal point for energy efficiency. This institution is also pursuing the National Mission on Energy Efficiency in the state. Department of Environment is organizing capacity building activities with EMC for adopting the ECBC.
- Local self governments in Kerala are quite aware about the imperatives of scientific waste management in the urban civic management. Many of the village habitations are also highly urbanized. Waste minimization and treatment of municipal waste is a priority and Kerala Suchitwa Mission is providing technical back up to the local self governments for attaining scientific waste management capability. Special focus has been provided by Department of Environment for this aspect in the neighbourhood of wetlands in the coastal plains.
- Kerala has been working on a strong renewable energy and energy efficiency strategy. Hydroelectricity potential is being planned to be attained in a sustainable manner by small hydroelectricity generating systems avoiding loss of forests. About 500 MW is planned for the coming times in this way, for which CDM benefits will also be claimed. About 66 million units

have been generated by 41 wind energy projects in the state. Work is on to reduce T&D losses at a rate of 1.5 -2% annually. It is aimed to save about 300 MW by propagating replacement of incandescent lamps by CFLs.

- For augmenting the greenery of the state, social forestry has been given a thrust by introducing innovative programmes in schools, colleges, coastal area, and roadside by labour unions etc. This will also help improving the profile and productivity of the forests. Kerala has won Indira Priyadarshini Vriksha Mitra Award for 2008 and 2009 for this initiative. This has also been recognized by UNEP under the Billion Trees Campaign.
- Kerala has initiated plan programmes on ecorestoration of wetlands and river action plan for identifying vulnerabilities and designing interventions for conservation of its water resources. Setting up of river management authorities is also on anvil for ensuring sustainable use and conservation of rivers.
- A New Directorate of Environment and Climate Change has been set up for coordinating government programmes on environment with various agencies responsible for managing civic amenities and use of natural resources. The organisation has also initiated a study of the carbon emission reduction potential of the public sector industrial units of the state to demonstrate the resolve of government for working for carbon emission mitigation in public sector.
- Scientific institutions in Kerala under the leadership of the Centre for Earth Science Studies have proposed setting up of an impact monitoring Network in an east west transect across the Western Ghats covering up to Lakshwadeep islands in the west. This network will provide information on identified climatic, physical and biological parameters in time and space.
- There are several important institutions in the state under the aegis of Kerala State Council for Science and Technology, working on the various aspects of climate change. Centre for Earth Science Studies, Centre for Water Resource Development and Management, Kerala Forest Research Institute, National Transportation Planning and Research Centre are some of the institutes especially equipped for relevant work.

#### **Natural Resource Management related issues**

- Considering larger dependence of the state on its natural resource based socio-economic profile, strategic orientation of development policies may need specific consideration of

climate change implications. An efficient mechanism for assessment of such implications will have to be developed.

- Natural resource management regimes will need to consider the climate change vulnerabilities and evolve management strategies accordingly. Coastal and inland water resources will be the important sectors in this category.
- In forest management sector, the recent focus has rightly been on improving the tree cover through social forestry programs with involvement of the local self governments and important sections of the society like students and communities. The forest estate management has the focus on productivity improvement of plantations. In the natural forests, a series of investments have been made for improvement of profile after the moratorium on fellings in 1986. It can be presumed that the impact of these efforts on the biodiversity profile and growth parameters of the forests has been tremendous and the forests are capable of maintaining the ecological services and biodiversity along with sustainable use.
- The state has been working on preparedness for disaster management in a focused manner. The preparations will be important for dealing with the extreme climatic events expected to occur frequently in the vulnerable tracts of the state.
- With focused monitoring and consideration of the impacts of climate change on the natural resources, and consequent accumulation of knowledge and information in this regard, a workable strategy for Information, Education and Communication will be needed to facilitate awareness and capacity building of the stakeholders ranging from public sector to the people of the state.

### **3. Scope of action in the selected sectors**

Though the information and knowledge base about causes and consequences of the global warming and resultant climate change are building up generally, the assessment of impacts on the living environment can only be understood by understanding of pattern of impacts and the actions in response can only be planned by internalizing the understanding in all the spheres of public order.

Action on the national missions proposed under the National Action Plan on Climate Change has already been on way in the guidance of the respective Ministries of Government of India. The nodal agencies are in place and capacity building activities are in progress. However, Kerala specific actions have to be planned and pursued as integral part of the development strategy for the state. The activities are likely to be chosen based on the detailed assessment of situation in various sectors. However, the present action plan will lay down basic outline of the actions which might be required and pursued in sustainable development context in the background of climate change impacts.

The enabling environment for an approach to sustainable development is the key to evolve appropriate responses. Keeping this in view the sequence of the following aspects of responses is proposed as a strategy for response to climate change.

#### **3.1. Enabling Environment through General Policy and Governance**

##### **Emission Optimization**

Air and land resources are the foremost victims of the climate change impact. Therefore, minimizing pollution can be the only foremost strategy for not only sustenance of these but the whole environment. While optimizing the efficiency of the sources of GHGs is a primary mitigation action, resultant clean air and sustainable land use become important adaptive actions for survival of human beings. Low load of GHGs results in low retention of heat in air, thus rendering it more helpful for sustenance of life.

1. Existing enforcement mechanisms for ensuring compliance of pollution norms and standards to be made meaningful by establishing new, augmentation and strengthening the existing mechanisms. This will include the State Pollution Control Board, State Department of Environment and Biodiversity Board. More empowerment and capacity building of decentralized democratic institutions will be critical for ensuring strict enforcement.

- a. District level units of Department of Environment will be set up to assist and equip the local self governments for monitoring compliance of clearances and approvals to the agencies under environmental regulatory statutes.
  - b. Local self governments will be empowered and their capacity will be built for taking up monitoring and legal cognizance of violation of Environment Protection Act and Panchayat Raj/ Municipality Acts.
2. Environmental compliance in industries will be encouraged by incentivizing carbon economics. Strategy under the PAT component of the National Mission on Energy Efficiency will be adopted and mechanism will be set up in the State for this purpose. Fiscal instruments like tax incentives will be used to encourage green technologies, low carbon intensity activities and to discourage wasteful use of fuels and energy.
  3. State will provide low interest capital assistance for adoption of green technologies through public sector financial institutions. Non compliance will be linked to (dis)incentives. Incentives for industrial development will be withdrawn if environmental standards are not adhered to.
  4. Dedicated Industrial estates with adequate environment management facilities will be organized by the state for setting up industries. The responsibility can be borne in a Public Private Partnership model enterprise.
  5. Transport sector to work on strategies for reducing emissions by encouraging public transport, fuel efficiency, preference to low carbon and renewable fuels, ensuring smooth and signal free traffic. While stronger public transport will support mitigation, adequate availability and quality of the service becomes critical for lowering per capita carbon footprint by avoiding private conveyances.
    - a. Mass rapid transport will be promoted for north-south coastal corridor and the city of Kochi.
    - b. In the Public road transport, state of art stage carriers will be deployed. The initiatives taken under the JNNURM for urban transport will be augmented for the whole state.
    - c. For cargo transport, water transport system will be utilized to the extent possible. Scope will be explored and number of vessels and ports facilities will be augmented accordingly.
    - d. Fiscal regulations will be adopted for encouraging use of public transport and cleaner private conveyances. It may include tax incentives for electric and hybrid cars, high taxes on the private conveyances using subsidized diesel and high taxes on use of parking facilities for private conveyances.

6. Land use policies will be revisited to favour optimization of capacity utilization for food security, carbon sinks (forests primarily) and water resource management (water storage and channels). Thus surface water resources including wetlands and ponds/lakes will be classified as specific water resources to be managed sustainably.
7. Vertical expansion for housing and construction will be favoured subject to local conditions and seismic risks. This will facilitate use of land for more adaptive and mitigative activities.

### **Infrastructure**

Infrastructure represents the human adaptation for efficient use of the natural environment. Infrastructure development growth at the same time inflicts tremendous pressure on the environment. Therefore, factoring in environmental costs in infrastructure development for long term sustainability needs to be a critical feature in adaptation to climate change.

1. In the road networks, signal free and smooth traffic will be facilitated for optimizing fuel efficiency. Highways to have full macadam surfaced sides to avoid accumulation of particulate matter and erosion and establishing suitable avenue plantations would provide adaptive capacity against noise, particulate matter and excessive GHGs.
2. In coastal areas, possibility of developing elevated carriageways will be considered as preventive measures from flooding and erosion of land and thus making it available for other adaptive uses like sustainable agriculture and carbon sinks.
3. Water transport will be promoted for the simple fact that the environmental cost of water transport in terms of energy use and emissions is far less than that in land or air transport. Time factor can be leveraged by adequate planning for translocation. All the 1687 km of inland waterways including the National Waterway no. 3 to be made fully functional.
4. In urban areas, vertical growth of housing will be integrated with solar energy utilities to minimize the need of external energy supply. Green building concepts will be made mandatory for maximizing the benefits of ambient environmental opportunities. Environmental clearance, CRZ clearance, wetland management rule clearance etc., wherever applicable, will be made mandatory for grant of building permits by the local bodies. Necessary amendments in the Building rules and relevant laws will be affected accordingly.

5. Water use efficiency will be ensured by treatment and recycling of water for non potable use, separating the supply network of recycled water from that for drinking water. Disincentives for use of drinking quality water for non potable use can be integrated within the supply system. These strategies can be started in corporations in all the existing water supply projects and elsewhere in the new projects.
6. Land use/ Landscape plans will be laid down for all the local bodies including the municipalities and panchayats, in the line of town plans for the major cities of the state. Town planning will be based on landscape ecology. It will take into account the state of conservation of natural resources like water sources, green belts, paddylands and wetlands and will incorporate concepts of minimization of energy needs for maintenance of civic amenities and cluster approach for different classes of developmental uses like commercial areas, industrial estates, waste treatment plants etc.
7. Waste management strategy for the local bodies will be provided earmarked support and will be focused on waste minimization by recycling and decentralized treatment, preferably at homestead/ colony levels so that only inert waste is directed for disposal in the sanitary landfills and the problem of high volume of (inert) waste for disposal is in control.

## **Power**

The most important basic input required for any kind of adaptation for human beings is energy. Out of the present energy resources, fossil fuels have been the foremost, while several alternative resources are being explored. National Action Plan for Climate Change proposes a national mission on solar energy to augment the power resources to some extent. However, in view of the higher requirement of power for adaptation strategies, all the opportunities of green and clean power generation need to be tapped. Kerala sources 71.29% of its power from hydel and almost rest from thermal resources. The present annual demand supply gap of about a 1000 MW is likely to keep increasing in the times to come. Therefore efforts to harness all possible sources would be critically important.

1. Though most clean in carbon economics terms, the green nature of the hydel power is contested for the forest submergence involved in generation projects. Technologies and scales need to be leveraged for improving hydel opportunities of the state on a sustainable basis. This may include improving the capacity utilization of the existing projects, avoiding submergence

by rationalizing the size and strong environmental protection components in the future proposals.

2. Biofuels can be blended with conventional fuels upto 10-20% without any change in the existing engine technologies. As any oil can be used for biodiesel manufacture, use of oil from naturally occurring non edible oil bearing species from forests or agro forestry resources can be promoted.
3. High biomass production potential in agriculture as well as social forestry and forest resource sectors provides a strong scope for development of biomass based decentralized energy systems. It may include biomass gasification for domestic use as well as power generation based on biomass through efficient technologies. A programme for popularization of this aspect will be undertaken at pilot stage.
4. The Energy Management Centre in the state has been spearheading the National Mission on Energy Efficiency. Agency for Nonconventional Energy Resources and Technology has been working for the National Mission on Solar Energy. A Total Energy Security Mission has been working at Local Self Government level. A coordinated approach for all these activities will be taken for capacity building of communities on energy conservation and generation and use of available opportunities for non conventional energy.

### **3.2. Governance for sustainable human development**

The capacity of human adaptation to the changing environment is based on the capacity to use the environmental resources in a judicious manner. Obviously the state of societal response to climate change will depend upon the state of human development. Building up the capacity to respond to climate change thus would require a strategy oriented towards educational, economic and health attainment aspects of the society and building up a societal behaviour for sponsoring judicious use of environmental resources. Following policy reforms will be considered for this purpose.

1. The capacity for adapting to the changing environment will be based on the capacity of appreciating the impacts of change and understanding of the adaptive principles. Thus the educational and health attainment targets can be the basic adaptation, for affecting the management of change. Economic capacity building based on educational and health attainment will be the foremost objective of human development so that the cost of adaptation

can be borne by communities. Therefore, high priority will be accorded to improvement of the quality of public sector education and health infrastructure in the state.

2. Community welfare measures to be oriented towards capacity building and creation of economic assets for the have-nots, to ensure sustenance of the state of human development, thereby ensuring their contribution in adaptation. Thus setting up of hubs of artisanal activities, technology upgradation, skill development and marketing support for local skills will be the priorities of community development / welfare programs.
3. Disaster risk assessment and local level disaster management mechanisms is to be the primary focus and to be developed and kept in prime state of functional capability. The State Disaster Management Authority and Institute will be strengthened to have strategically located disaster management teams to ensure effective use of the disaster management / relief infrastructure.
4. Contribution of the society for adaptation to be ensured by a vibrant fiscal environment so that the resources for meeting the cost of organizing basic actions for adaptation can be mobilized and cost of sustainability can be built in the developmental processes.

A green fund will be set up with the resource mobilization by way of contribution from the users of various environmental and energy resources and public infrastructure. The fund can be utilised for financing the green technologies, maintenance of water resources and for environment management in local bodies where resource availability is a constraint in this aspect. A law will be enacted for this purpose.

5. Government processes need to be made more energy and time efficient. An eight hour working day with five day week will be considered which may result in more than 15% saving of energy in government offices and without loss of working hours, with availability of officials for public business for longer time of the working days.

### **3.3. Monitoring and Strategic Knowledge Management**

Kerala State Council for Science Technology and Environment is mandated with the task of coordinating knowledge management in terms of organizing research and promoting scientific and technological advances through its institutions and universities and other scientific institutions in the state. The Centre for Earth Science Studies Thiruvananthapuram has been identified by the Council as the nodal institute for organizing monitoring network and researches on climate change. It will take the following action in this context.

1. It will establish multidisciplinary monitoring programs for climate change covering the natural resource sectors including weather, biodiversity, soil moisture, hydrology, human migration, geological and seismic dynamics, air quality parameters including Green House Gases etc. Initial programs have already been identified to by CESS to be launched on sea level rise, monitoring of land use and land cover changes, monitoring of solar UV radiations and atmospheric trace constituents and assessment of green house gases.
2. It will establish interface with the Indian Network on Climate Change Assessment so that the national and regional level GHG inventories and other such assessments are undertaken on comparable parameters and principles.
3. It will provide with periodic reports to the Council for validation and onward transmission to the government through the Department of Environment and Climate Change for analysis and putting in appropriate proposals before the government for any proposed action on policy, legislative or programmatic fronts as a response to the observations or the knowledge gathered.
4. The nodal institution CESS will work on development of a dedicated unit for climate change primarily for allocation and coordination of research, monitoring and modeling for projections of impacts in the state.
5. Development and promotion of green technologies and ways for achieving green economy can be pursued by the Council through the various institutions within and outside its purview.

### **3.4. Natural Resource Sectors**

The state of natural resources is a function of the state of climate and any impact on water, forests and land resources has direct bearing on the human life by way of the effect on economic activities like agriculture, fisheries, livestock etc. In the circumstances, it is imperative to make arrangements for assessment of the impacts of climate change and take suitable actions for avoiding the impacts or for coping up with those. Following will be the line of action based on detailed location specific assessment of circumstances in the NRM sectors.

#### **1. Water Resources**

From the 44 rivers yielding about 70000 million cubic meters of annual water discharge in the state, about 42700 million cubic meters is estimated as the utilizable surface water. Considering the fact that the water sources of the state depend on rain fed catchments and high gradient ensures rapid drainage into the sea, availability of water is the most important

vulnerability in climate change scenario. Catchment profile is the most important determinant of the recharging capacity, perennality and consequent availability of water. At the same time, catchments constitute the respective command areas also. Therefore the adaptive strategy should focus on spreading the benefit of the harnessed water to the maximum extent.

According to the 4 x 4 assessment projections, in parts of Karnataka and Kerala Western Ghats the water resources show a decrease of up to 10% in water yield by 2030. Similar reduction in water yield is projected for the western coastal region. Kerala coast yield is determined by the yield of western ghats. Therefore, an overall decrease can be expected. In the circumstances actions on demand as well as supply management, along with adequate conservation measures will be important. Following actions will be planned based on assessment.

1. In view of need of supply augmentation, integrated basin plans for water resources will be formulated. Catchments will be maintained to minimize surface run off for facilitating percolation and ground water recharge and also for minimizing erosion and siltation. This must ensure optimum vegetation cover and stabilized surface soil cover. This strategy will be taken up in forestry sector and will help sustaining the ground water resources for the lean period.
2. As most productive areas of the state lie in midland areas, scope of establishing a network of surface water storage systems in midland areas will be explored for catering to the larger command areas. It will be important to conserve moisture in the midlands, to provide resilience to the land resources against uncertain precipitation.
3. Ecological and environmental flows need to be worked out and maintained in the water courses to ensure self rejuvenation of the rivers against pollution loads and for sustainability of life forms in the related habitats. A water resource assessment and regulatory mechanism will be developed in the Department of Water Resources with mandate as well as capability of assessment and analysis of potential, supply and demand in all the water resources and regulate the resource use regimes accordingly.
4. Development/ sustainable use of wetlands in the midlands and coastal areas and non conventional water resources like tanks, ponds, lakes, springs etc. will be taken up as the water resources and also for conservation of aquatic life forms as a part of food security strategy. This will sustain the genetic resources associated with aquatic habitats, critically important for working on adaptive mechanisms through aquatic resources for food security.

5. Optimization of use of water in the habitations for demand side management – recycling and reuse of grey water, which after treatment for suitable uses would further help managing supply which tends to become scarce with growing per capita need and falling availability. A programme for segregation of pipe network for conveyance of treated grey water will be taken up in municipal corporations of Kerala during the 12<sup>th</sup> Five Year Plan.
6. A mission mode programme for adoption of ground water recharge technologies and processes will be taken up at local self government level in over exploited, critical and semi critical revenue blocks.
7. An assessment project will be launched for vulnerability assessment of areas to flood and drought so that such areas can be prioritized and adequate measures for moderating the impacts can be planned.
8. On the policy front, tariff regimes for water supply should factor in the cost of the water as a public (state) commodity and also the price of water resource development in addition to the cost of service for distribution and supply. This way the prices will appropriately reflect the relative scarcity and total value of water resources and will contribute towards the prevention of environmental degradation. This will help taking up water conservation as the most important adaptation strategy for water management.

## **2. Forests Resources**

Forests form the basic resource for adaptation in climate change owing to their capacity of carbon sequestration, providing means of keeping the carbon trapped in long term use as wood, harbouring genetic resources and providing ecological services in terms of soil and water conservation. It is observed that carbon storage in forests of India can grow by 10% (6622 million tons (2005) to 7283 million tons of carbon) till 2015.

Kerala with a green cover of 44.58% of its land area and forests with an availability of 0.036 ha per capita, with about 45% forests in tropical evergreen and semi-evergreen category, is in a position to leverage its ecological and biodiversity strengths for its nutritional and health security. Thus the forests, if used sustainably, can not only provide environmentally friendly wood based and non wood products for human use, but also sustain the water resources, reduce pollution load and maintain soil qualities considerably.

In the 4 x 4 assessment report, it has been concluded that the forest vegetation type of the Western Ghats region, as elsewhere, is vulnerable to projected climate change in the short term, that is, in 2030s, even under a moderate climate change scenario. Net Primary Productivity is projected to increase on average by 20 to 30% till 2030. Following actions will be pursued in the sector.

1. As a capacity building measure, the existing mechanism for assessment and inventories of forests, namely Working Plan establishment will be modernized into a state of art technical wing equipped with ICT modules including geomatic and database management systems, professional services of ecologists, sociologists, information technologists including satellite imagery interpretation and forest/ biodiversity inventory experts. Assessment of the state and potential of carbon sequestration in the forests will be undertaken on priority and strategy will be formed for attaining the potential.
2. Documenting and monitoring protocols will be developed and established for tracking changes in the biodiversity profile and carbon storage of the forests in the Working Plan and Research wing of the Department.
3. State/ zone level forest landscape plans will be put in place for guiding the forest management planning for management units like forest divisions or protected areas.
4. A moratorium on harvesting of wood from natural forests was imposed in the state in 1986. Assessment of the impact of this moratorium on the state of forests will be undertaken to review the conservation strategy for the forests including sustainable use.
5. For augmenting the forest profile to bring the standing volume of natural forests to optimum for attaining optimum resilience towards changing environmental regimes, following management strategies will be adopted.
  - a. Plantations showing suboptimal growth rate will be reverted back to natural forests.
  - b. The forests showing poor growing stock than normal will be marked and taken up for improvement interventions including augmentation of crop within the natural profile.
  - c. Ecologically important biomes will be identified surveyed and notified for preservation. Such areas will be earmarked only for ecological services and research/ monitoring for biodiversity/ climate change/ ecological services.

6. Scientific models will be evolved for working on thresholds of forest profiles necessary for maintaining ecosystem services so that sustainable material benefits can be assured without impacting the ecosystem services.
7. Models and protocols will be developed in order to integrate Ecosystem services, biodiversity profile and sustainable harvesting of forest products in the forest management planning. It is essential for the reason that carbon is sequestered in net terms only by the forests of young profile with a high growth rate. Old forests become emitters (source) of carbon.
8. Mandate of social forestry will be redefined as management wing of ecology for facilitating conservation of ecosystems outside government forest domain and augmenting/ optimizing the economic benefits from the forest products grown outside forests. This may include mangroves, sacred groves, wetlands, forested revenue lands and the areas notified under the Ecologically Fragile Areas and Preservation of Trees Act etc.
9. Fiscal and marketing mechanisms will be used to encourage growing of wood and use of wood products for structural purposes as carbon trapping substitutes for metal and plastic materials to the extent possible. This may include organizing the markets for the wood grown on private lands by support price mechanisms, simplifying depot sales of wood and facilitating trading in open market. Possibility will be explored of mandating the Kerala Forest Development Corporation and building its capacity for taking up marketing of wood products from outside forests based on a support price mechanism.
10. The State Forest Development Agency will develop a value addition and marketing mechanism for the forest products appropriated to the Vana Samrakshana Samitis, based on the AMUL model. A programme will be developed for training of members in scientific harvesting, processing, value addition, storage and marketing in order to develop entrepreneurship within the VSS members. Automation and technological support will be provided for this purpose.

### **3. Agriculture**

The most important adaptive mechanism in human beings is the capacity of manipulating the environmental resources for sustaining the human life processes. Proportion of irrigated to net sown area in the state is 19%. Much of the irrigated land is located in coastal and lowland area, which is very vulnerable to rising sea level, salinity ingress and ground water depletion.

As per the 4x4 assessment, productivity of rice is likely to decrease by 4% but with slight gain in northern Kerala. Coconut yields are projected to increase as much as 30% due to CO<sub>2</sub> enrichment and low increase in temperature. More heat stressed days in western ghats is projected as likely to lead to thermal discomfort to livestock and decreased productivity.

In the changing climate scenario, the need of evolution of agricultural crops suitable for changed conditions will be critical. Keeping these facts in view the following actions will be pursued.

1. A mission mode program for assessment of the existing biodiversity resources will be taken up for use as genetic material suitable for the traits like water use efficiency, drought and temperature stress tolerance, pest resistance and tolerance to salinity etc for integrating in the agricultural crops. The mission mandate will include development of suitable cultivars for rainfed conditions and perennial alternatives for the annual agro crops vulnerable to the smaller variations in the environmental regimes.
2. Network of smaller water harvesting structures in midland and lowland areas will be maintained in order to manage the high precipitation in monsoon time and to maintain minimum moisture in the soils to perpetually sustain the vegetal cover and rain fed crops.
3. A programme will be taken up for assisting farmers for taking up environmental modification measures like sprinkle irrigation, suitable landscape modification and soil enrichment/ improvement for supporting rainfed agriculture.
4. Principles of conservation agriculture and organic agriculture will be promoted for long term sustainability of the environmental resource support systems. This may include the concepts and practices for water use efficiency, integrated nutrient management including VAM (Vesicular Arbuscular Mycorrhizae), modern techniques of System Rice Intensification (SRI), minimum tillage etc. A programme will be launched for building up a strong network of agricultural extension workers with an intensive training facility for them.
5. Strengthening and capacity building of the agricultural extension system with intensive trainings on available options in agriculture will be the top priority. This would include crop calendars, agronomic practices keeping with the extant weather pattern, prescriptions for pest and stress management in the agriculture crops and establishment of 'Agriclinics' as farm health clinics to enable farmers to find solutions to their farm related problems.

6. Pest and disease surveillance and forecasting should be made an integral part of agriculture extension. Appropriate infrastructure for this can be developed involving the Agriculture university.
7. Assessment of potential of marine as well as fresh water aquatic resources will be taken up in providing food security in terms of direct nutrition and support for the agriculture and animal husbandry sectors: aquaculture and algal resources for fertilizers, cattle feeds and components of edible products.
8. The existing crop insurance scheme with the state support for dealing with crop failure crisis in the time of extreme events will be strengthened for widening the coverage network.
9. A mechanism will be set up for use of secondary manufacturing technologies for maximizing use of cultivated or natural products in food chain for direct or indirect uses such as cattle feeds, fertilizers, improving shelf life, simplification of processing and minimizing wastages.
10. A network of agro processing and cold storage structures will be set up in the state to facilitate value addition and avoiding wastage of the produce in post harvest stages.

#### **4. Fisheries and Coastal ecosystems**

The special feature of the water environment is that it can absorb much heat without showing high temperature variations. However, changes have been observed and some of the observed changes can be taken as opportunities in short term for long term adaptations. Based on the data on different parameters during 1967 – 2007, the annual sea surface temperature is known to have increased by  $0.15^{\circ}$  C per decade.

Kerala contributes about 25% of the total catch of the country. The 4x4 assessment has projected increased recruitment of oil sardines in post south west monsoon season. Indian mackerel populations are projected to decrease. In general, better catch may be expected in cooler months of October – March.

1. Post 1995, western coast of India (Arabian sea) has shown higher sea fish sardine biomass. Similar patterns need to be studied and utilized for addressing food security concerns.

2. Utilization potential of aquatic biomass resources in food, health, energy and other possible uses will be assessed and adopted.
3. Fish sanctuaries will be established in the potential areas for conservation of biodiversity, maintaining healthy germplasm and ensuring supply of fish seed for augmenting availability as and when required.
4. Adequate measures will be taken for upgrading the mechanized boats used for fishing to energy efficient and low emission engines. Similar provisions will be ensured through the industrial estates as mentioned earlier for the processing industry and related infrastructure.
5. Vulnerability assessment for the low land coastal areas facing flooding and salinity ingress will be undertaken and scope of aquaculture development with development of associated ancillary activities for value addition and longer shelf life will be studied.
6. Plans will be formulated for addressing the flooding and salinity ingress possibilities in vulnerable coastal areas by taking up artificial landscape developments like elevated seashore anti erosion walls reinforced with coastal plantation shelterbelts, regulation of flow of water, elevating the levels of channels by bunds and construction of barrages for seasonal regulation of water flow so that natural disasters can be avoided.
7. Long term plans for saving low lying areas from erosion, inundation and salinity intrusion will be needed in view of high vulnerability of certain areas towards sea level rise. Plans for engineering methods for controlling sea erosion and reclamation of eroded sea coast will be taken up in identified areas. These aspects will be integrated in the Coastal Zone Management Plan of the state.
8. The coastal wetlands of the states will be revived and maintained as aquatic resources for sustainable use for their hydrological, biomass production and livelihood functions. As private ownership systems may not be practically feasible, public ownership for management under designated institutional mechanisms to be explored.

### **3.5. Information, Education and Communication (IEC)**

With expectation of a complete paradigm reorientation in context of climate change, capacity building of the stakeholders becomes very important. The appreciation of the patterns and impacts, their implications in day to day life and long term will need to be ensured through an

effective IEC strategy. The stakeholders include public, officials, students, scientists, academicians and policy makers.

The existing systems of environmental information and education include the ENVIS network of MoEF, National Green Corps in schools and the Environment Education, Awareness & Training (EEAT) Scheme of MoEF. Following steps will be considered as a strategy in IEC.

1. Use of Information and Communication Technology (ICT) will be the hallmark of the IEC strategy of the state.
2. Information management mechanisms will be established at sectoral levels and will be networked for effective use of the knowledge and information available on related aspects and generated by the institutions for scientific and socio-economic researches in the fields related to climate change. A component of 2% of the total sectoral plan allocation will be earmarked for all sectors for management with regular updation of the Information Management mechanisms. The processed information will also be provided in a separate portal in public domain. The databases will be provided with spatial and temporal attributes which are relevant and sensitive to changing environmental parameters.
3. A Nodal centre for monitoring the patterns of climate and impacts on natural resources will be established in the S & T sector in the state. It can have linkages with the Indian Network on Climate Change Assessment (INSSA) set up by MoEF and other agencies within and outside state for organizing information and knowledge in this respect.
4. An IEC strategy will be formulated taking into account the capacity and imperatives of corporate sector, education sector and ICT sector for flow of information for use of stakeholders and for awareness about the implications of various actions and proposals regarding the natural resources of the state.

#### **4.Targets and costs**

The activities identified in the above paragraphs need to be specifically quantified in terms of quantum, time and cost. This can only be done by the respective line organizations based on the available information, ground assessment and capacity / potential of the establishment to take up the task. The task of assessment of these factors therefore, will be undertaken consequent of

approval of this strategic plan by the government, after further refinement based on detailed consultations, appraisal and integration with the five years plans.

However, for initial assessment and to indicate the dimensions of the time and financial resources required for internalizing the concerns of climate change in overall development, some indicative time and cost estimates are provide in the Annexure table. The figures provided are very tentative and are subject to correction after further consultation and formulation of specific proposals for the indicated activities.

Apart from the costs of the activities in which no estimates can be provided without detailed assessment, initial cost for taking up the tasks has been estimated as Rs 6178 crore over a period of 15 years. Most of the activities are needed to be started within the 12<sup>th</sup> Five Year Plan period and will extend beyond 13<sup>th</sup> Five Year Plan. While some of the items can be undertaken within the Five Year Plan of eh state, some others will be proposed to be supported under the provisions of the National Action Plan on Climate Change within the programs of central government. The tasks taken up and establishments created will need to be supported with recurring costs and capacity building will need to be continued for keeping the momentum of the services contemplated.

## **5. Monitoring Mechanism**

The activities contemplated within the individual sectors are envisaged as part of the respective plan programmes of the sector. However, for compilation and understanding of cumulative impact of these in the climate change context will require a specific monitoring mechanism.

It has been agreed that the existing Empowered Group on Climate Change under the chairmanship of the Chief Secretary of the State will function as the State Advisory Group also. This State Advisory group will function as the monitoring group also. The flow of information on progress and impacts in this context will be managed by the group on strategic knowledge within the Centre for Earth Science Studies in the Kerala State Council for Science Technology and Environment and will be facilitated by the Department of Environment for presentation and coordinating the implementation of recommendations.

A periodic publication of reports on plan implementation, review by the State Planning Board and a public domain portal for display of information for public will be the other aspecvts of monitoring mechanism.

## ANNEXURE

**Table: Proposed activities, time and cost estimates**

(\*Asterix in costs column show that the amount will be worked out when activities are assessed in details)

Sector	Sub sector	Activity	Time (Years)	Cost (Rs cr)	Departments
Enabling Environment	Strengthening Enforcement mechanisms	Strengthen district level mechanisms for Environment Department	5	25	DoECC
		Strengthen establishment of LSGs for enforcement	5	500	Dept LSG
		Capacity Building of LSGs	10	100	Dept LSG
	Land use policy	Land use plans for Panchayats	5	*	State Gov.
		Housing policy reforms	5	*	State Gov.
	Adaptive Capacity Building	Improve public sector education and health infrastructure	10	*	State Health, Education Dept.
		Skill development for economic capacity building	10	*	LSG, Industry, Technical Education
		Disaster risk assessment, management and local centres	5	100	KSDMA, Rev. Dept.
		Legislation, operation and management of Green Fund	5	500	State government
Energy Efficiency	Industries	Implement PAT and other components of NMEE	5	15	Finance Dept, Power Dept (EMC)
Sustainable Habitat	Green economy	Incentives for green technologies	10	250	Env./ Fin DePts.
		Industrial estates	10		Industries/Fin./ Env. Depts
	Transport	Set up MRT in coastal corridor/Kochi	10	*	State gov.
		Upgrade quality of stage carriers	10	*	Transport
		Upgrade Water Transport for cargo	10	*	Transport
		Incentives for green transport, vice versa	5	*	Finance/Transp./ Env.
	Infrastructure	Improve road quality	15	*	State / LSGs
		Elevated roads in coastal areas	20	*	State gov.
		Improve inland waterways	10	*	State gov.
		Adopt green building code	5	*	State gov.
		Reform building rules for EC, CRZ etc. clearances	5	*	State/ LSGs
		Infrastructure for treatment/ recycling of grey water	10		State/ LSGs
		Land use plans in LSGs like town plans	10	*	State/ LSGs
		Earmark funds for waste management	5	*	State Gov.
	Power	Improve capacity utilization of hydel projects	10	*	State government
		Formulate environmentally sound hydel projects	10	*	State
		Mission on biofuels from natural non edible oilseeds	5	100	Forest, industry, LSGD, ANERT
		Mission on Biomass energy	5	200	Forest, LSG, EMC/ ANERT
Monitoring Climate	Science and Technology	Developing nodal centre for climate change monitoring at CESS	5	50	KSCSTE/ CESS

change and Knowledge Management					
		Projects for monitoring, assessment and modelling	15	300	CESS with associates
		Strengthening network of weather stations, observation centres	5	25	CESS with associates
		Assistance to universities/ institutions for capacity enhancement	15	200	KSCSTE
		Assistance for development and promotion of green technologies and establishment of a rural network for it.	5	100	KSCSTE/ LSGD
Water Resources	Water resource assessment	Setting up Water Resource assessment, monitoring and regulatory mechanism	5	50	Water Resource Dept.
		Integrated River Basin plans for river basins.	10	50	Water Res. Dept, KSCSTE
		Project for identification of vulnerable areas to flood and drought.	5	25	Water Res., KSCSTE
	Supply management	Network of water storage systems in midlands	10	500	Water Res., Forest, Revenue, LSGD
		Catchment assessment and treatment plans and actions	10	1000	Forest Dept, Water Res. Dept.
		Management of Wetlands	10	500	Env., Water Res., Forest, LSGD
		Mission for ground water recharge and monitoring	5	100	Water Res. (GW) Dept.
	Demand management	Pilot project for treatment, recycling and supply of used water in 3 cities	5	100	Corporations, Water Res. Dept.
		Establishment of sewerage network and treatment systems in cities and towns	10	*	Water Res. Dept, LSGD
		Reforms in pricing and tariff structure for drinking water supply	5	*	Water Res. Dept.
Forests	Capacity Building	Modernization of inventory and management planning	5	50	Forest Dept.
		Assessment of carbon sequestration state and potential	5	05	Forest Dept/ KFRI/ ICFRE
		Developing protocol for monitoring changes in biodiversity and carbon profile	5	5	Forest Dept/ KFRI/ ICFRE
		State/ zonal landscape plans for forest management	5	5	Forest Dept/ KFRI/ ICFRE
	Improving resilience	Assessment of state of natural forests/ impact of moratorium	5	2	Forest Dept/ KFRI/ ICFRE
		Reversion of poor plantations to natural forests	20	100	Forest Dept.
		Improvement of stock of degraded forests	20	10	Forest Dept.
		Identification & documentation of areas for preservation for ecological importance	10	05	Forest Dept/ KFRI/ ICFRE
		Value addition and marketing mechanism for NWFP community stakeholders	10	50	Forest Dept, industry dept.
	Ecosystems outside forests	Conservation of ecosystems outside forests through Social Forestry	10	20	Forest Department
		Support to Agro-forestry/ farm forestry – market support	10	50	Forest Department
Agriculture	Capacity Building	Mission on integrating biodiversity in adaptation	10	50	KAU, Agric. Dept.
		Developing network of Extension workers for conservation/ organic farming including network for pest and disease surveillance	10	100	KAU, Agr. Dept.

		Facility for training of extension workers	5	50	Agr Dept, KAU
Developing infrastructure		Network of water harvesting structures	10	*	Water Res. Dept.
		Assistance for infrastructure for rain fed agriculture	5	100	Agri. Dept./ KSCSTE/
		Pilot project for use of aquaculture/ algal resource for agriculture support	5	20	KAU/ CUSAT, Agr. Dept.
		Network of agro-processing and cold storage facilities	10	20	Agr. Dept.
		Manufacturing technologies for processing/ secondary products	5	50	KAU/ Ag. Dept.
Fisheries and Coastal ecosystems		Develop system for assessment of fisheries resources and drawing utilization plans.	5	20	Fisheries Dpt.
		Maintaining and creating fish sanctuaries	5	20	Fisheries Dept.
		Development of environmental management systems in the fish landing, handling and processing units.	10	*	Fisheries, LSGD Dept.
		Strict enforcement of pollution norms for mechanized boats and equipments including assistance for upgradation and modernization	5	*	Fisheries, Transport Depts.
		Vulnerability assessment of coastal areas and communities against sea level rise	5	05	Coastal Zone Mgt Authority, Coastal Engineering Department
		Anti sea erosion measures in selected locations	10	300	Coastal engineering, KCZMA, Forest dept., LSGD
		Long term plan for prevention of salinity ingress and erosion	10	*	KCZMA, coastal engineering, LSGD
		Coastal wetland management plans and implementation	10	300	Nodal agency for wetlands.
Information, Education and Communication	State level	KSCSTE led Monitoring system to launch d maintain the climate change portal	5	25	CESS
		Formulation of IEC strategy for the state on climate change	1	01	Dept Environment
		Implementation of IEC strategy	5	25	As proposed in the strategy.
<b>Total</b>				<b>6178</b>	

## Forest map and Physiographic map of Kerala

