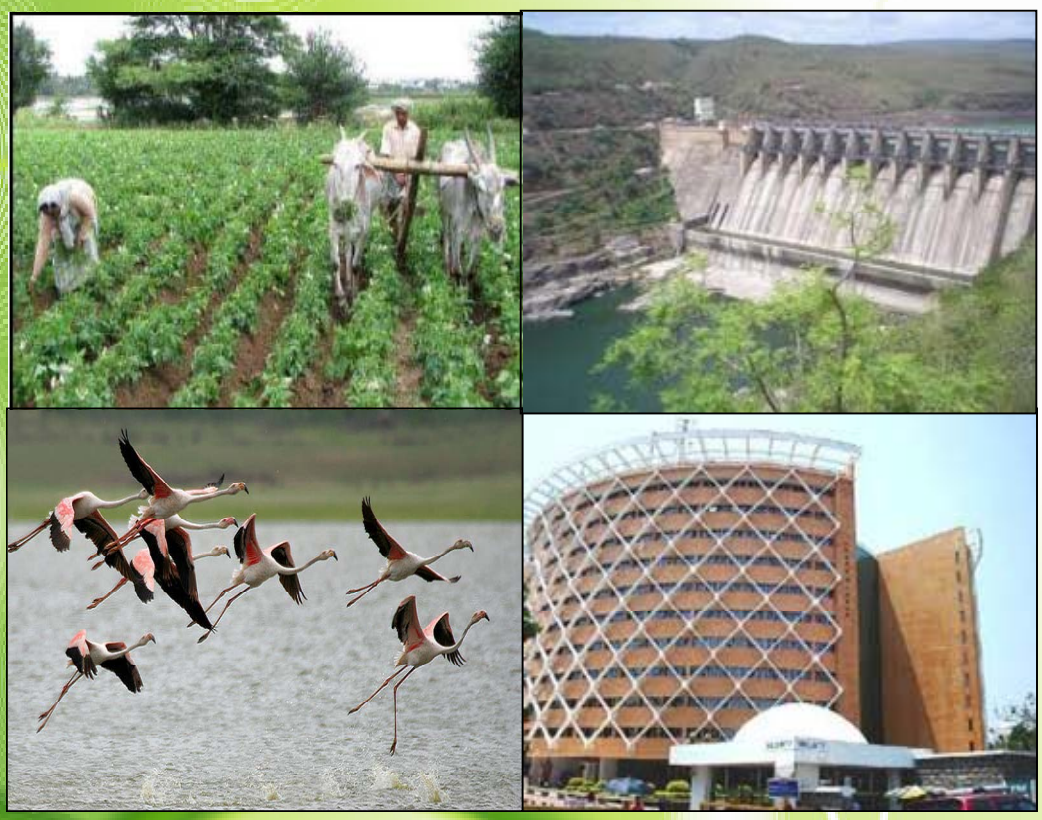
# STATE ACTION PLAN ON CLIMATE CHANGE
# FOR
# TELANGANA STATE



**Submitted**

**to**

**Ministry of Environment, Forests and Climate Change**
**Government of India, New Delhi**

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# Foreword

Government of Andhra Pradesh has notified the Environment Protection Training and Research Institute (EPTRI) as a Nodal Agency for Clean Development Mechanism (CDM) and Centre for Climate Change vide G.O Ms. No. 101 EFS&T (Env. Dept) dated 19.11.2001.

In 2009, the Ministry of Environment and Forests called upon the States to prepare the State Action Plans on Climate Change (SAPCC) consistent with the strategy outlined in National Action Plan on Climate Change.

EPTRI has prepared the SAPCC for combined Andhra Pradesh, which was endorsed by National Steering Committee on Climate Change, Ministry of Environment, Forest and Climate Change (MoEF & CC) in2013.

In view of the bifurcation of the State, as the Environmental setting, land forms, sloping pattern in respective river basins and drainage pattern, Agro climatic Zones, soil patterns and other conditions, are different for both States of Telangana and Andhra Pradesh,Mo E F &C C informed Government of Telangana to bifurcate the SAPCC report. Environment Forest, Science and Technology (EFS&T) Department, Government of Telangana, directed EPTRI to prepare the SAPCC for Telangana, vide its letter dated February 11, 2015.

EPTRI has prepared the SAPCC report forTelangana and presented in this report.

Director General

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[1]Directorate of Economic & Statistics, Telangana. and C.S.O., New Delhi

## ABBREVIATIONS

| | |
|---|---|
| AOGCMs | Atmosphere-Ocean-General Circulation Models |
| ATR | Action Taken Reports |
| BMTPC | Building Materials and Technology Promotion Council |
| BRT | Bus rapid transit |
| CAD | Command Area Development |
| CC | Climate Change |
| CCAP | Climate Change Action Plan |
| CDM | Clean Development Mechanism |
| CFLs | Compact Fluorescent Lamps |
| CFM | Community Forest Management |
| CMAP | Combined Merged Analysis of Precipitation |
| CNG | Compressed Natural Gas |
| COMAPS | Coastal Ocean Monitoring & Prediction Systems |
| COPD | Chronic Obstructive Pulmonary Disease |
| CRIDA | Critical Research in Digital Architecture |
| DCA | Drug Control Administration |
| DDA | Delaware Department of Agriculture |
| DH | Directorate of Health |
| DPAP | Drought Prone Areas Programme |
| EBIC | Environmentally Balanced Industrial Complexes |
| EFS&T | Environment, Forests, Science & Technology |
| EPTRI | Environment Protection Training and Research Institute |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| GISs | Geographical Information Systems |
| GoAP | Government of Andhra Pradesh |
| GSDP | Gross State Domestic product |
| HadCM3 | Hadley Centers Regional Climate Model |
| HDI | Human Development Index |
| HUDA | Hyderabad Urban Development Authority |
| IAEP | Integrated Afforestation & Eco-development Project |
| IAS | Invasive alien species |
| ICDP | Integrated Cotton Development Programme |
| ICRISAT | International Crops Research Institutes for the |

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|---|---|
| | semi-Arid Tropics |
| ICT | Information and Communication Technology |
| ICZM | Integrated Coastal Zone Management |
| IITM | Indian Institute of Tropical Meteorology, Pune |
| IMD | India Meteorological Department |
| INCCA | Indian Network for Climate Change Assessment |
| INCOIS | Indian National Center for Ocean Information Service |
| INDC | Intended Nationally Determined Contributions |
| INM | Integrated Nutrient Management |
| IPCC | Intergovernmental Panel on Climate Change |
| IPM | Institute of Preventive Medicine |
| ISOPOM | Integrated Scheme for Oils, Pulses, Oil Palm and Maize |
| IT | Information Technology |
| IWMI | International Water Management Institute |
| JFM | Joint Forest Management |
| JFPC | Joint Forest Protection Committee |
| JGSY | Jawahar Gram Samridhi Yojna |
| JI | Joint Implementation |
| JNNURM | Jawaharlal Nehru National Urban Renewal Mission |
| JRA-25 | Japanese Reanalysis |
| LEDs | Light Emitting Diode |
| LPG | Liquid Petroleum Gas |
| LULUCF | Land use , Land use change and Forestry |
| M&E | Monitoring & Evaluation |
| MA & UD | Municipal Administration & Urban Development |
| MARSIS | Marine Satellite Information Service |
| MoEF | Ministry of Environment & Forests |
| MoEF CC | Ministry of Environment Forest and Climate Change |
| MoHA | Ministry of Home Affairs |
| MPEMA | Mission for Elimination of Poverty in Municipal Areas |
| MS | Mandal Samakhya |
| MW | Mega Watt |
| NAIS | National Agriculture Insurance Scheme |
| NAPCC | National Action Plan on Climate Change |
| NBA | Nirmala Bharata Abhiyan Scheme |
| NCAR | National Centre for Atmospheric Research |

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| NCEP | National Centre for Environmental Prediction |
| NDMA | National Disaster Management Authority |
| NE | Northeast |
| NFSM | |
| NGO | Non Governmental Organization |
| NMT | Non Motorized Transport |
| NSAP | National Social Assistance Programme |
| OECD | Organization for Economic Co-operation and Development |
| P&T | Postal and Telegraph's |
| PAT | Performance Achieve and Trade |
| PCPIR | Petroleum Chemical and Petrochemical Investment Region |
| PHCs | Primary Health Centers |
| PJTSAU | Professor Jayashankar Telangana State Agricultural University |
| PRECIS | Providing Regional Climates for Impacts Studies |
| PWD | Public Works Division |
| REIA | Rapid Environmental Impact Assessment |
| RKVY | Rashtriya Krishi Vikas Yojana |
| RWA | Residential Welfare Association |
| SAPCC | State Action Plan on Climate Change |
| SCCL | Singareni Collieries Company Limited |
| SELMAM | Sea Level Monitoring and Modeling |
| SEZ | Social Economic Zone |
| SGRY | Sampoorna Grameen Rozgar Yojana |
| SHG | Self Help Group |
| SRES | Special Report on Emission Scenarios (A1, A2, B1, B2 and A1B) |
| SRI | System of Rice Intensification |
| SSP | Social Security Pensions |
| SVPs | Sector Vulnerability Profiles |
| SW | Southwest |
| TERI | The Energy and Resource Institute |
| TRLP | Telangana Rural Livelihood Project |
| TS | Telangana State |
| TSGENCO | Telangana State Power Generation Corporation |
| TSPCB | Telangana State Pollution Control Board |
| TSRAC | Telangana State Remote Sensing Centre |

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|---|---|
| TSRTC | Telangana State Road Transport Corporation |
| ULB | Urban Local Bodies |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nation Framework Convention on Climate Change |
| VO | Village Organization |
| VSS | Vana Samraksha Samities |
| WHO | World Health Organisation |
| WMO | World Meteorological Organization |
| WRP | Work Participation Rate |

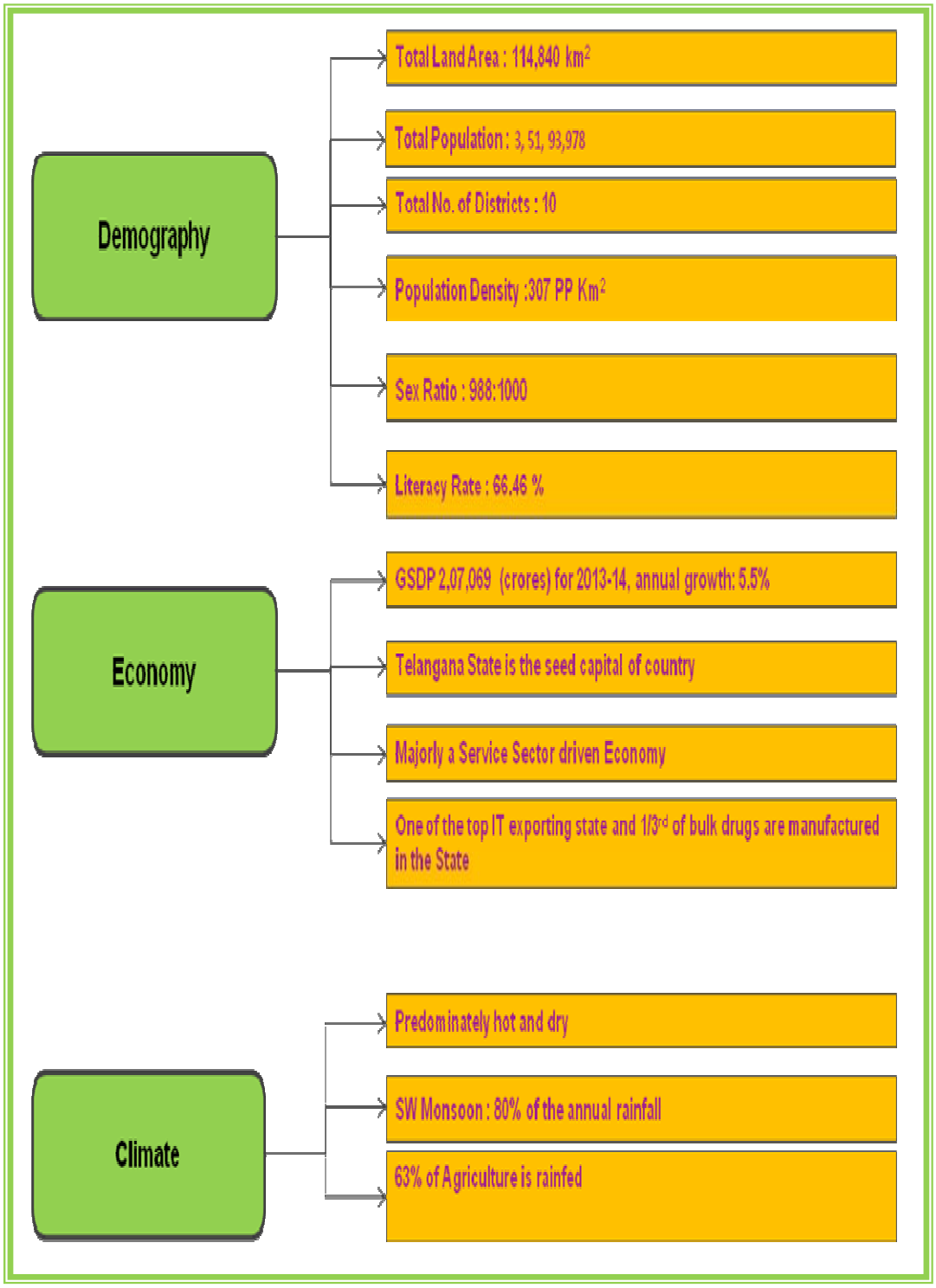
# EXECUTIVE SUMMARY

## Background

Living and coping with the impacts of climate change is no longer a choice; it is essential for our survival. Climate change poses a challenge to sustainability of social and economic development, livelihoods of communities and environmental management in India. India has pursued a strong domestic agenda to adapt to climate change while maintaining its growth objective and engaging constructively with the international community. The Government of India released the National Action Plan on Climate Change (NAPCC) in 2008 as part of an ambitious domestic action plan to address climate change. The NAPCC focuses on adapting to climate change (CC) and protecting the vulnerable sections of society through an inclusive and sustainable development strategy that also enhances ecological sustainability and innovation. It identifies eight missions in the area of Solar Energy, Enhanced Energy Efficiency, Sustainable Agriculture, Sustainable Habitat, Water, Himalayan Ecosystem, Green India and Strategic Knowledge on CC. In line with the NAPCC, India's Five Year Plans intend to include a strategy for sustainable growth which will help the country to transform to a low carbon economy.

Although the Central Government is the key authority in shaping the climate change policy and creating the institutional mechanism necessary for its implementation, involvement of the State Governments in this process is crucial. With the formulation of a national policy on CC, it has become imperative to achieve coherence between strategies and actions at national and State levels. Most of the adaptation challenges such as droughts, Heat Waves, adverse effect on human health, depleting water resources, are experienced at the State level and programmes aimed at improving the adaptive ability are also undertaken and implemented at State level. For certain sectors like industries and energy, part of the solution lies in implementing mitigation interventions at the State level. In this context, the State Government of Telangana has taken this initiative to prepare the State Level Action Plan on Climate Change (SAPCC) to enable it to address existing and future climate risks and vulnerabilities.

## Baseline Profile of Telangana[1]




[1] Statistical year, 2015 Telangana

## Objectives of SAPCC

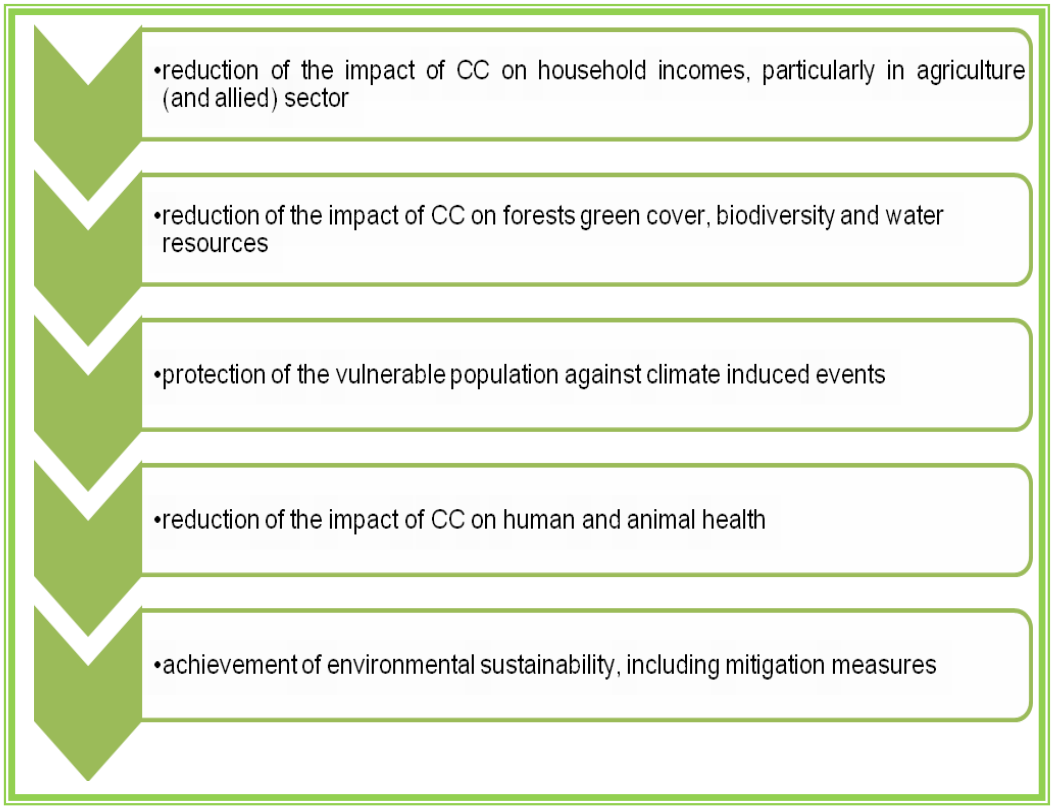
- Inclusive and sustainable development of the State that protects the vulnerable sections of society from adverse effects of CC.
- Improved ecological sustainability.
- Provide a framework to undertake actions that deliver benefits for growth and development while mitigating and adapting to CC.
- Prioritize adaptation/mitigation options for the State and identify financing options.
- Engineering new and innovative policies/mechanisms to promote sustainable development.

### SAPCC in context to Telangana

Major CC issues for the State arise in the agriculture and forestry sectors and in relation to the droughts and heat waves. Agriculture is severely affected by variability in rainfall and temperature patterns. Besides these, other critical areas of concern are food security, increasing number of climate vulnerable habitats (like slums or village dwellings) and climate vulnerable infrastructure (like roads and bridges which may be washed away by floods).

The SAPCC has been designed around the existing policies of the State Government by taking into consideration ongoing programmes and schemes being implemented at the State level, as well as the NAPCC. The existing policies of the State Government include ISOPOM (integrated scheme for oils, pulses, oil palm and maize), Intensive Cotton Development Programme (ICDP), Polambadi, National Agriculture Insurance Scheme (NAIS), Rashtriya Krishi Vikas Yojana (RKVY), Jalayagnam, Integrated Rural Development Program, Rajiv Awas Yojana, Mission Kakatiya and Haritha Haram etc. The SAPCC would be integrated into the State level planning process, so that the resource allocation for implementation of the identified adaptation/mitigation interventions can be made with the objective of achieving the development goals of the State Government.

## Goals of SAPCC




The SAPCC is a dynamic and flexible policy framework which will follow a continuous and interactive process to reflect the changes and developments happening at the national, State and local levels. The stakeholders consultation process is an important aspect of SAPCC. Stakeholder engagement and consultation align them into the planning framework, and broadens and deepens perspectives and involvement in implementation of the State Action Plans for building a climate resilient economy. This SAPCC has been designed following stakeholders concerns and issues.

The SAPCC has followed a structured approach to formulate and implement adaptation strategies, policies and measures to ensure human development in the face of climate variability and change.

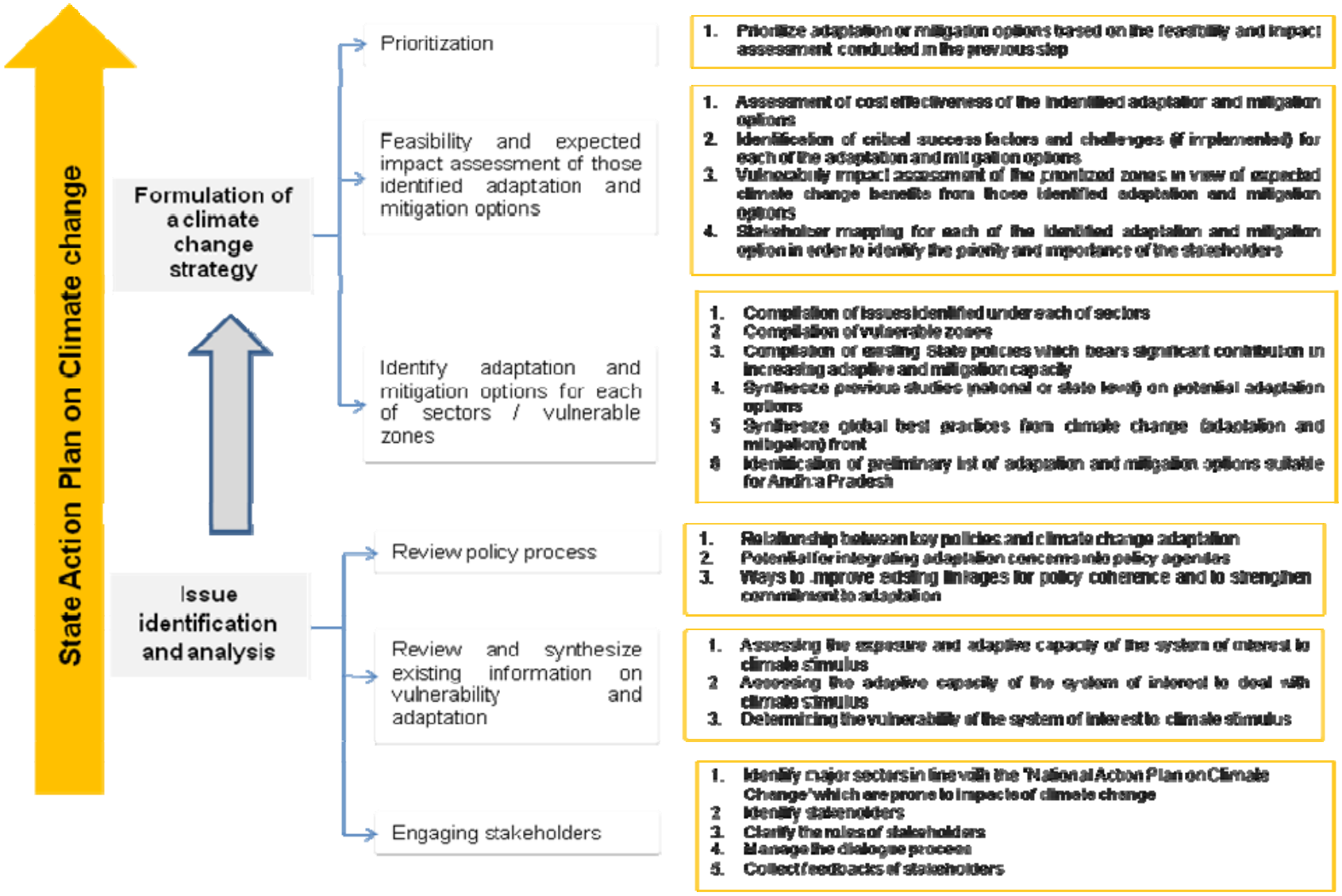
## Principles of SAPCC

- Adaptation to short-term climate variability and extreme events serves as a starting point for reducing vulnerability to longer-term climate change.
- Adaptation policies and interventions are assessed in the State developmental context.
- Adaptation occurs at different levels in society, including the local level.
- The adaptation strategy and the process by which it is implemented are equally important.
- Mitigation measures, in line with the NAPCC, are proposed in certain key sectors.

Implementing the SAPCC in Telangana will be characterized by:

- Strong stakeholder engagement and capacity development at all levels of the society to enable better acceptance and implementation of CC mitigation and adaptation measures
- Assessing the vulnerability of districts and enhancing their adaptive capacity.
- Analysis of adaptation/mitigation options to cope with current and future climate change.
- A programme to monitor, evaluate and improve the impact of the adaptation/mitigation activities.

## Approach followed to develop State Action Plan on Climate Change



A detailed diagnostic study, following the UNDP methodologies (UNDP Adaptation Policy Framework and Human Development Index) has been performed to assess the climate change vulnerability profile of Telangana. It is based on the basic hypothesis that climate change vulnerability of a region is a function of two key variables:

- physical exposure of the region to climatic events
- adaptive capacity of the region

An index has been developed to estimate these two parameters. 10 major sectors which are seriously impacted by CC have been identified for the State. The issues, concerns and specific interventions for these sectors have been discussed. Adaptation interventions have been designed for these sectors such as agriculture, rural development, transportation, tourism, forestry and biodiversity, urban development, health and family welfare, while mitigation options have also been identified for energy, industry and transport. Research or knowledge development on climate change specific to Telangana has also been identified as a sector which should be developed to support data on mitigation and adaptation for the other 9 sectors. This technical / knowledge support on the subject can be provided and coordinated by a cell or department in one of the research institutes like EPTRI. An indicative list of sectoral concerns, adaptation/mitigation interventions and corresponding challenges has been tabulated here.

## Key Sectors identified for SAPCC

1. Agriculture and allied sectors
2. Forestry & Biodiversity
3. Energy
4. Industries (including mining)
5. Transportation
6. Health
7. Urban development
8. Tourism
9. Rural Development
10. Research in Climate Change

| Critical Sectoral Issues | Key Interventions |
|---|---|
| **1. Agriculture and allied sectors** | |
| • Temperature fluctuations affect Rabi crops severely<br>• Decrease in area under crops on account of insufficient rainfall, particularly in the South- West Monsoon period.<br>• Dryland areas (parts of Mahabubnagar and Nalgonda) exist in the State where annual rainfall is less than 500 mm in Mahabubnagar whereas in Nalgonda annual rainfall is 560 mm and rain fed farming is not viable.<br>• Loss in fertility of soil in many areas due to excessive use of fertilizers and pesticides. | • Development of crop varieties resilient to heat, cold and water stress including breeder seed production.<br>• Replacement of inorganic fertilisers by bio-fertilisers<br>• Assured credit facility, including for tenant farmers<br>• Insurance against crop failures (not just for the bank loan component)<br>• Extension work for change of cropping timings and patterns, efficiency of water use, weather advisories to farmers, information on market prices etc.<br>• Intensive research work on stable agriculture in the context of climate change, in all its aspects<br>• Establishment of field centres, data banks and germplasm banks.<br>• To disseminate the price forecast information.<br>• Standardization of fuel efficient irrigation pump sets.<br>• Retrofitting existing pump sets for higher energy efficiency. |
| **2. Forestry and Biodiversity** | |
| • Deforestation, degradation of forests and excess of soil erosion in degraded forests<br>• Disturbance in the timing of flowering and appearance of | • Soil and Water Conservation in forest lands<br>• Afforestation and eco-development through community based programmes |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| pollinators and excessive use of pesticides/insecticides, loss of forests, air pollution etc have also decreased the appearance of pollinators | (like Joint Forest Management)<br>• Creation of forests in degraded/public lands, including such lands in and around cities and towns<br>• Documentation of biodiversity, including genetic fingerprinting Preservation of rare/threatened germplasm. |
| **3. Energy** | |
| • Increasing use of fossil fuel by energy sector<br>• Lack of Incentives for cleaner energy technologies<br>• Inadequate Promotion of renewable energy in the State<br>• Less emphasis on demand side management to reduce consumption<br>• Lack of Subsidy for new clean technologies | • Improve the efficiency of thermal power generation<br>• Improve the efficiency of transmission, including elimination of pilferage<br>• Improve the efficiency of electrical equipment, including water pumping equipment used in agriculture<br>• Promotion of affordable alternative energy sources i.e. solar home systems, solar street lights, solar thermal systems.<br>• Rationalization of power tariff for currently subsidized sectors<br>• Electricity generation using non-conventional sources. |
| **4. Industries (including Mining)** | |
| • Increasing fossil fuel consumption and GHG emissions from the industries<br>• Increasing number of industries in state and their improper waste management practices<br>• Fisheries sector is highly | • Enforce 'cleaner production processes' and waste minimisation across industries, in partnership with the Central and State Pollution Control Boards<br>• Assess the vulnerability of major industrial hubs to |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| vulnerable to climate change effects and extreme weather conditions.<br>• Agro-business and food processing industries are vulnerable to extreme weather events like rainfalls, heat waves etc.<br>• Depletion and degradation of surface water, aquifers and leaching from dumps causing acid mine drainage<br>• Land degradation and large scale deforestation, noise and vibration, destruction of habitat, loss of bio-diversity<br>• The activities in open cast mining like blasting, drilling, excavation, truck loading and transportation are responsible for the increase of suspended particulate matter in the air<br>• Dislocation of human communities and health impacts on the community living in close proximity to the Industries. | climate related risks<br>• Protect agro industry through mapping and shifting the supply chain towards less climate change vulnerable zone<br>• Protection and disaster mitigation works to minimise risks to industrial hubs (e.g. alternate rail and road access, improving drainage, alternate water supply sources etc.)<br>• Minimise environmental damage including GHG emissions, caused by industrial and mining activities<br>• Promote diversified and dispersed industries, including small/medium scale agro processing, to stabilise agricultural livelihoods<br>• Intensive research for the biological methods of metal extraction from mine spoils to prevent acid mine drainage<br>• Pollution prevention measures to reduce prevent air pollution during open cast mining activities<br>• Implementation of resettlement and rehabilitation plans for affected population<br>• Compensatory afforestration activities on a large scale. |
| **5. Transportation** | |
| • Growth of cities and large-scale rural-urban migration has increased the population | • Enhance the share of public transport in the total transportation mix |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| and density, thus vehicles density<br>• The share of public transport is low in State, far below the global best practices<br>• Road congestion resulting in poor fuel economy<br>• Penetration of alternate fuel usage is negligible in transport sector<br>• Lack of organized efforts to promote fuel efficiency improvement and eco-driving habits for 'vehicles in use' among drivers or owners of the vehicles (private or governmental). | • Enhance the share of low emission/fuel-efficient vehicles and vehicles that run on alternate fuels<br>• Encourage non-motorised transport like walking and cycling<br>• Design or redesign road networks so as to facilitate smooth traffic movement<br>• Interlink private and public transport modes so as to minimise the use of private transport. |

## 6. Health and Family Welfare

| | |
|---|---|
| • The changing patterns of rainfall, temperature and humidity are increasing the cases of vector borne diseases in the State.<br>• Excess of air pollution in towns is increasing the respiratory problems and lung infection cases.<br>• Health problems due to extreme heat and cold climate. | • Undertake longer-term studies to investigate links between climate change and disease patterns, as also between pollution loads and disease patterns<br>• Strengthen detection and early warning systems for outbreaks of diseases<br>• Public education on prevention of diseases related to climate change and resulting from environmental pollution<br>• Health Surveillance.<br>• Research on development of low cost vaccines, particularly those related to vector borne diseases<br>• Development of rapid response capabilities to handle the impact of climate change related events. |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| | like heat waves. |
| **7. Urban Development** | |
| • Drainage of cities not adequate to accommodate the precipitations during incidents of heavy rains<br>• Demand on water resources due to the growth in the urban population and therefore increased pressure on the water supply infrastructure<br>• Generation of large quantity of sewage<br>• Generation of huge quantum of solid waste<br>• Increased private transportation leading to huge pressure on the road infrastructure and increased emissions in urban areas | • Safe water supply as per norms to the entire urban population<br>• 100% coverage of sewerage and sanitation for the urban population<br>• Study and remodel existing water supply, sanitation and sewerage systems to reduce climate change vulnerability<br>• Protection and restoration of existing water bodies in urban areas, creation of new water bodies<br>• Scientific management of municipal solid waste in all municipalities and corporations<br>• Restoring efficiency of drainage network of all municipalities to enable quick evacuation of water and to avoid flooding<br>• Mandatory rainwater harvesting in Government buildings, larger homes and apartment blocks, commercial establishments, offices, schools/colleges, academic/research establishments and industrial units<br>• Incentives for rooftop solar power generation and provision of grid connectivity<br>• Rail based MRTS in emerging cities and expansion of existing MRTS<br>• Provision of safe footpaths, cycle |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| | tracks etc to promote non-motorised transport<br>• Recovery of phosphates nitrates etc. from wastewater |
| **8. Tourism** | |
| • Habitat loss and degradation, caused by logging for firewood and timber materials, are major threats to restricted-range species<br>• Poaching, hunting and unsustainable exploitation threaten both flora and fauna Changes in species and ecosystem services, damage to infrastructure, water shortages and water contamination. Tourism transportation and usage of high carbon intensive fuels in resort/tourist spots cause high levels of $CO_2$ emissions which increase the pollution levels | • Promote low emission/fuel-efficient mass transportation, to and within tourist areas e.g. battery operated vans<br>• Promote energy efficiency lighting, climate control equipment etc. in hotels and other areas where tourists congregate<br>• Promote eco-tourism to enhance environmental consciousness<br>• Enforce cleanliness in tourist areas<br>• Protect both built and natural heritage area and structures against climate related damage. |
| **9. Rural Development** | |
| • Deterioration of natural water resources and other ecological resources impacting the livelihood of rural population<br>• Due to lack of opportunities in the rural areas, there is large migration of rural population to urban areas, is in turn putting pressure on the urban infrastructure | • Safe Water Supply as per norms to the entire rural population and entire coverage of sewerage and sanitation for the rural population<br>• Study the climate change vulnerability of existing water supply and sewerage/sanitation systems<br>• Remodel or strengthen existing water supply and sanitation/sewerage systems to reduce vulnerability to climate |

| Critical Sectoral Issues | Key Interventions |
|---|---|
| | change<br>• All-weather road connectivity to all habitations for access to goods and services, and for evacuation in emergency<br>• Increasing energy efficiency in street lighting and water pumping by Panchayats<br>• Micro credit facility for subsdising livelihood<br>• Creation of new water bodies and restoration of existing water bodies<br>• Public education on climate change and its impacts.<br>• Identifying villages for developing as role models in climate adaptation and sustainable livelihood. |

## 10. Research in Climate Change

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|---|---|
| • Higher vulnerability of the State towards climate change.<br>• The river basins are prone to climate change impacts due to changing precipitation and temperature patterns.<br>• Industrial hubs are prone to climate change impacts due to unscientific construction and water and electricity scarcity.<br>• Majority of rural and urban population is not aware about the climate change issues and impacts.<br>• Lack of Climate Change knowledge center in the State | • Setting up of Climate Change knowledge center at EPTRI<br>• Climatic vulnerability studies in major river basins of the State<br>• Climatic and socio-economic vulnerability studies in industrial hubs prone to floods, erosions and scarcity of water and electricity.<br>• Climatic baseline studies in ULBs and municipal corporation.<br>• Demonstration projects at ULB and major Gram Panchayat levels |

The SAPCC for Telangana State provides a common and generic framework to usher an era of climate resilient sustainable development for the State. The five key strategies for the State can be summarized as:

- Address State specific priority issues while creating appropriate environment for implementation of NAPCC at State level
- Mobilize stakeholders/institutions to work in a collaborative manner towards an integrated solution to CC through inter-departmental consultations, stakeholder involvement, regular planning and budgetary processes
- Mainstream CC Adaptation into State level planning and development in order to enhance climate resilience of the State economy
- Give importance to key economic drivers, food security, health and human settlements
- Safeguard natural resources and biodiversity from CC impacts

Interventions have formed significant parts of the programmes of State Departments of Agriculture, Rural Development, Urban Development, Forest and biodiversity, Irrigation and water etc. for years if not for decades. However, these interventions have always been viewed more from the social and economic impact on communities and classes of people, rather than the adaptation to climate change.

Interventions would be seen as contributors to the adaptation to climate change, in addition to their social and economic impacts. It is possible that the change of view would cause some modifications to the designs of the various programmes and more importantly, require faster or more intense implementation, to be of use for adaptation.

Department wise summary of the budget estimates for two plan periods i.e. 2012 – 17 and 2017 – 22 are given below:

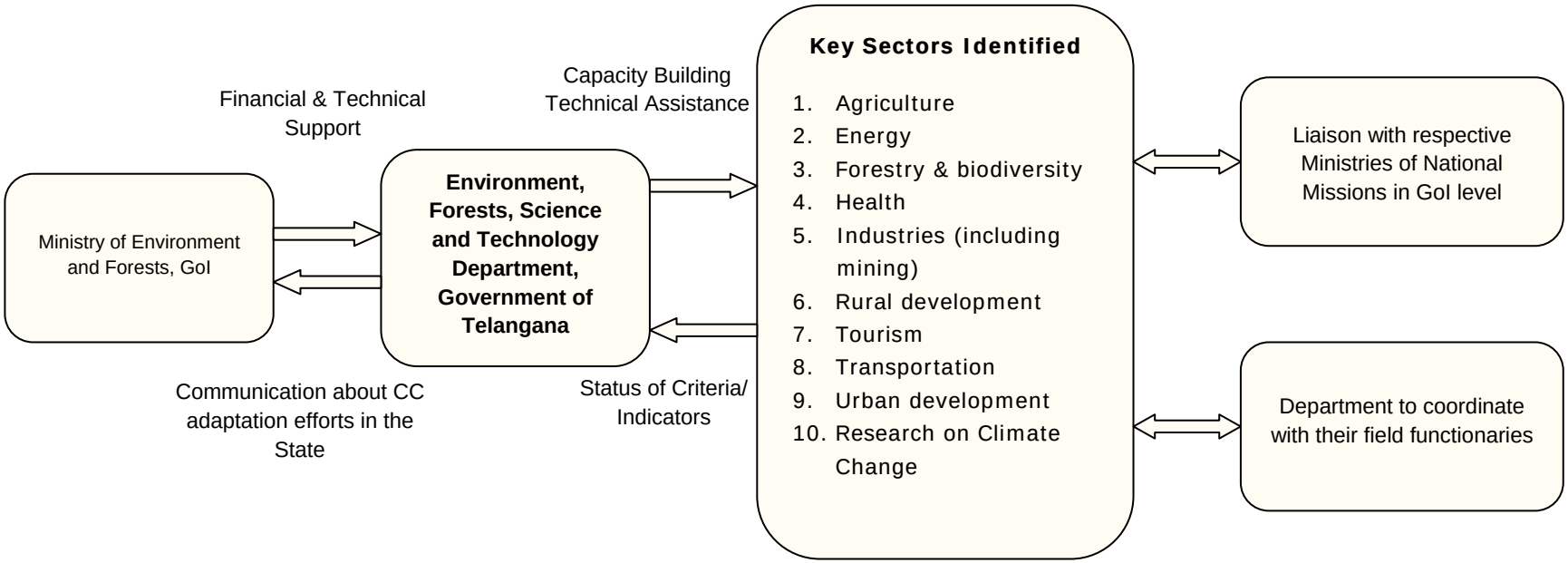
**Summary of the Budget for interventions**

| Sl. No. | Sectors | *Estimate for 2012-17 (INR Crores) | Estimate for 2017-22 (INR Crores) |
|---|---|---|---|
| 1 | Agriculture and allied | 140575.8 | 169554.2 |
| 2 | Irrigation and CAD | 50337.47 | 113355.4 |
| 3 | Forest and Biodiversity | 552.57 | 1175.00 |
| 4 | Energy | 22591.26 | 20728.85 |
| 5 | Industries (including mining) | 23.6 | --- |
| 6 | Transportation | 1082.99 | 1824.916 |
| 7 | Health and Family welfare | 114.70 | 114.70 |
| 8 | Urban Development | 1424.37 | 1542.85 |
| 9 | Tourism | 63.26 | 92.35 |
| 10 | Panchayat Raj and Rural development | 37012.22 | 70598.92 |
| 11 | TSPCB | 23.00 | 17.00 |
| 12 | Setting up of Climate Change Knowledge Centre at EPTRI | 12.38 | 13.87 |
| 13 | Research Studies in Climate Change | 92.40 | 103.49 |
| | **Grand total** | **253906.02** | **379121.5** |

* Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

The last chapter of the SAPCC is the Monitoring and Evaluation (M & E) which is the key for measuring the implementation of SAPCC. M&E would enable appropriate short-term and mid-term changes to the identified adaptation and mitigation strategies, correcting past mistakes and improving practices. Monitoring indicators, in the nature of output or outcome, have been selected and listed for each of the interventions, in the SAPCC. Monitoring frequency appropriate to each of the monitoring indicators, in so far as the SAPCC is concerned, has also been suggested. A flow diagram of M & E of SAPCC is as under:

## A Flow Diagram of Monitoring and Evaluation of SAPCC




Coordination between local Panchayati Raj Institutions, District Administration, State Departments and Central Government would ensure successful implementation of adaptation and mitigation interventions and meet the objectives of the NAPCC at the State level.

## Telangana State initiatives in addressing the climate change

The Government of Telangana has taken up massively the restoration of tanks through 'Mission Kakatiya' programme for addressing the Agriculture sector. The programme of massive plantation through 'Haritha Haram' for addressing the Forestry and Biodiversity. Both these programmes plays key roles in addressing the interventions in other sectors like Health, reducing emissions of Industries, Energy and Transportation sectors, reduction of Carbon Dioxide, improving eco tourism and overall rural and urban development.

## Mission Kakatiya (MK)

Telangana is centrally located in Deccan Plateau where lots of undulations, hillocks, rivers, rivulets, streams etc are found. Telangana area is blessed with ample rainfall of around 900 mm. These geographical conditions invariably led to the construction of water shed structures i.e tanks to catch hold rain water in monsoon season. Villages were established on the higher part of a stream / rivulet and an earthen bund was constructed across the stream to store water and agricultural activities were carried out downstream of tank. Realizing the importance of reclamation of tanks for growth in the state, the Government of the Telangana State have taken up the programme of restoration of the minor irrigation sources under the title **"**Mission Kakatiya" (Our Village – Our Tank**)** with community participation for ensuring sustainable water security in Telangana State, to retrieve the lost glory to minor irrigation in the state.

The Government has prioritized to take the restoration of minor irrigation tanks to restore them to store their original capacity and to effectively utilize 255 TMC of water allocated for Minor irrigation sector under Godavari & Krishna River basins.

## Objectives of Mission Kakatiya (MK):

The objective of Kakatiya Mission is to enhance the development of agriculture based income for small and marginal farmers through sustainable irrigation resources by accelerating the development of minor irrigation infrastructure, strengthening community based

irrigation management, adopting a comprehensive programme for restoration of tanks.

In July 2014 Irrigation & Command Area Development Department, Govt of Telangana carried out census of Minor Irrigation (MI) sources in Telangana for the first time in history which include M.I tanks constructed and maintained by Irrigation Dept. , M.I Tanks constructed by Panchayat Raj Dept. and later transferred to Irrigation Dept., Percolation Tanks, Forest Tanks, Private owned tanks, Anicuts , Check dams. As per the enumeration, total number of tanks found to be around 46531. It is planned to restore all the 46,531 minor irrigation sources in the state in next five years, taking up 20% of the tanks each year, 9195 tanks for the current year, 2015-16.

**Benefits from the Restoration of Tanks:**

- Expected gains from irrigated area expansion by covering gap ayacut
- Fisheries development;
- Livestock improvements
- Improving ground water levels and water quality there by lands beyond command areas can be brought under bore well irrigation. Power savings due to the reduced need for well irrigation that are currently used to supplement the insufficient tank water

The minimum ayacut that can be irrigated with the above allocated water is about 18 to 20 lakh acres.

**TELANGANAKU HARITHA HARAM**

**Telanganaku Haritha Haram (TKHH)**, a flagship programme of the Telangana State Government envisages to increase the tree cover of the State from present 24% to 33% of the total geographical area of the State. This is objective is sought to be achieved by a mutli-pronged approach of rejuvenating degraded forests, ensuring more effective protection of forests against smuggling, encroachment, fire, grazing and intensive soil and moisture conservation measures following the watershed approach. Apart from the above, major fillip is sought to be given to Social Forestry by taking up massive plantation activities

outside Forest areas including multi-row road-side avenues, river and canal bank, barren hill, tank bunds and foreshore areas, institutional premises, religious places, housing colonies, community abandoned lands etc. The Greening efforts will be taken up involving all stakeholders. This approach would be duly supported by the needed reforms in policy, law and administrative matters.

As a part of this programme, in the coming three years 230 Crore seedlings are proposed to be planned in the State. Out of this, 130 Crores seedlings are proposed to be planted outside the notified forest areas (10 Crore within HMDA limits, and the remaining 120 Crores in rest of the State). It is also proposed to rejuvenate 100 Crore plants inside the notified forests by way of intensive protection of the forests and encouraging the live rootstock.

**Benefits of Haritha Haram**

- Improving green cover and Bio diversity
- Maintaining ecological balance
- Ensuring sustainable livelihoods
- Ensuring good rain fall
- Reducing Carbon Dioxide emissions by approximately 10 million tonnes

**Swacch – Bharat Mission**

**Mission Objectives**

- Elimination of open defecation
- Eradication of Manual Scavenging
- Modern and Scientific Municipal Solid Waste Management
- To effect behavioral change regarding healthy sanitation practices.
- Generate awareness about sanitation and its linkage with public health
- Capacity augmentation for ULB's.

### LED Street Lighting – Conversion from conventional lighting

Commissioner and Directorate Municipal Administration, Government of Telangana made an Agreement with M/s Energy Efficiency Services Limited (EESL), Government of India undertaking for conversion of the existing street lighting into LED based systems in 12 ULBs on pilot basis.

### Smart Cities Mission

In the approach of the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is on sustainable and inclusive development and the idea is to look at compact areas, create a **replicable model which will act like a light house to other aspiring cities**. The Smart Cities Mission of the Government is a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country. The core infrastructure elements in a smart city would include:

- adequate water supply,
- assured electricity supply,
- sanitation, including solid waste management,
- efficient urban mobility and public transport,
- affordable housing, especially for the poor,
- robust IT connectivity and digitalization,
- good governance, especially e-Governance and citizen participation, sustainable environment,
- safety and security of citizens, particularly women, children and the elderly, and
- Health and education.

# Chapter -1

# INTRODUCTION

## 1.0 Background

Climate change refers to a change in the state of the climate that can be identified by changes that persist for an extended period, usually decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. Climate Change resulting from carbon dioxide ($CO_2$) and other greenhouse gas (GHG) emissions viz. methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride is the gravest environmental challenge ever faced by the humanity.

The global atmospheric abundance of $CO_2$ was 395.5 ppm in 2011 which is 40% greater than 1750. Consequently, the average surface temperature has increased by 0.85 degree Celsius over the period from 1880 to 2012. GHG needs to be cut by 40-70% by 2050 from the year 2010 level and fossil fuels should be phased out completely in power generation by 2100[1].

IPCC Fifth Assessment Report projects that even if the concentrations of all greenhouse gases and aerosols are kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected under different SRES emission scenarios[2]. Scientists warn that the impact of this increase on the ecosystem and human welfare would be severe, especially in the developing countries. With these facts in the background, the world is currently negotiating the targets and the burden-sharing mechanism to reduce the global GHG emissions post 2012[3].

## 1.1. Climate Change and Global Initiatives

The first major step taken globally in the year 1988 was setting up of panel '*Intergovernmental Panel on Climate Change (IPCC)'*. This panel was set up by the United Nations and World Meteorological Organization (WMO) to assess the technical issues that were being raised in debates on climate change, so that the policy makers are armed with facts from collective scientific endeavor. The IPCC

[1] IPCC 5thAssessment, Chapter 3 and 5.
[2] IPCC 5th Assessment Chapter 2
[3] Low carbon city concepts in India, Chandra Bhushan, Center for science and Environment

comprises representatives from about 195 Governments to take into account the scientific knowledge currently known about climate change and it publishes reports that provide Governments with a sound summary of knowledge and facts.

The other notable global action in this direction was Rio Earth Summit in 1992. After summit, 195 countries ratified the Convention, who are called Parties to the Convention and consequently *United Nations Framework Convention on Climate Change (UNFCCC)* came into force on 21st March 1994.

The Convention aimed at the stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (man-made) interference with the climate system. This 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 sustainable economic development. The convention concluded with the framing of the Kyoto Protocol.

The Kyoto Protocol talks focused on setting up binding targets for 37 industrialized countries and the European Community for reducing greenhouse gas (GHG) emissions. This amounts to an average of five per cent against 1990 levels over the five-year period 2008-2012.

*The Kyoto Protoco*l was adopted in Kyoto, Japan, on 11th December 1997 and entered into force on 16th February 2005. The Kyoto mechanisms are the major attraction of the protocol and have attained importance, attention in the market economy. The Kyoto Protocol offers means of meeting targets by way of three market-based mechanisms -'Emissions Trading' – known as "the carbon market", 'Clean Development Mechanism' (CDM) and 'Joint Implementation' (JI). The mechanisms stimulate green investment and help Parties meet their emission targets in a cost-effective way.

In Doha, Qatar, on 8th December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1stJanuary, 2013 to 31st December, 2020;

- A revised list of Green House Gases (GHG) to be reported by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020.

The United Nations Climate Change Conference (COP 20) was held at Lima, Peru, from 1st to 12th December, 2014. Apart from others, the outcome of the summit was launching a web-based portal by UNFCCC for submissions by parties of their Intended Nationally Determined Contributions (INDCs). The UNFCCC Secretariat will prepare a report on the aggregate effect of INDCs communicated via the portal a month in advance of the Paris Climate Change Conference, scheduled to take place in November - December 2015.

## 1.2. India's Response to the Global Initiatives

The total net GHG emission from India in 2007 were 1727.71 million tons of $CO_2$ equivalent of which (with LULUCF)

- $CO_2$ emissions were 1221.76 million tons;
- $CH_4$ emissions were 20.56 million tons; and
- $N_2O$ emissions were 0.24 million tons

- India is vulnerable to climate change, among other causes because of the existence of a large and densely habituated costal belt.
- GHG emissions from Energy, Industry, Agriculture, and Waste sectors constituted 58%, 22%, 17% and 3% of the net $CO_2$ eq. emissions respectively.
- India is dependent on agriculture and forest resources.
- The monsoons are shifting westwards making central India drier. The number of rainy days is decreasing and amount of rainfall in a single day is increasing.

- The mean and maximum temperatures analyzed for 12 of the major Indian cities show an increase, as do the sea temperatures and the droughts, which have increased over the past 3 decades. The projections for the last quarter of the 20$^{th}$ century show more variations in Northern India and over Himalayas that puts the Himalayan glaciers at threat.

India has in place a number of statutes, institutions, policies and programs that provide a framework for GHG abatement. However, there is no single comprehensive low carbon policy or programme but there are policies and programs which address Climate Change issues directly or indirectly.

Many of these policies are contained in the Five Year Plans developed by the Planning Commission to guide economic policy in India. India has already taken decisive steps in this regard. Over the Eleventh Plan Period, it initiated the National Action Plan on Climate Change (NAPCC), which is monitored by a body no less than the Prime Minister's Council for Climate Change. It has voluntarily announced a domestic goal for reducing the emission intensity of its GDP.

During the Twelfth Plan, financing of climate change related actions will be a major challenge. Low carbon strategies will particularly require enhanced deployment of renewable and clean energy technologies, and capital finance for improvements in technology.[4]

Agriculture is the provider of livelihood for nearly half of India's working population. Studies done at the Indian Agricultural Research Institute indicate the possibility of loss of 4–5 million tonnes in wheat production for every 1$^{o}$C rise in temperature throughout the growing period. Losses for other crops are uncertain, but are expected to be smaller for the kharif crops. Agriculture sector contributes 18 per cent of the total GHG missions in India.[5]

The Energy Efficiency in Industry is an important policy thrust area. PAT (Perform, Achieve and Trade) scheme is only suitable for certain large industries (called 'designated consumers' under the Energy Conservation Act). To facilitate efficiency improving technology interventions in the industry at large, an Energy Conservation Fund needs to set up under the aegis of the Bureau of Energy Efficiency. Similarly, Advanced Coal Technologies, Dedicated Freight Corridors and Improved Urban Public Transport are the critical policy thrust areas that can

[4]Twelfth Five Year Plan, Planning Commission, Government of India, 2013
[5] Twelfth Five Year Plan, 2015

go a long way in saving the scarce fossil fuels for the country and therefore, need a focused attention at the highest level.

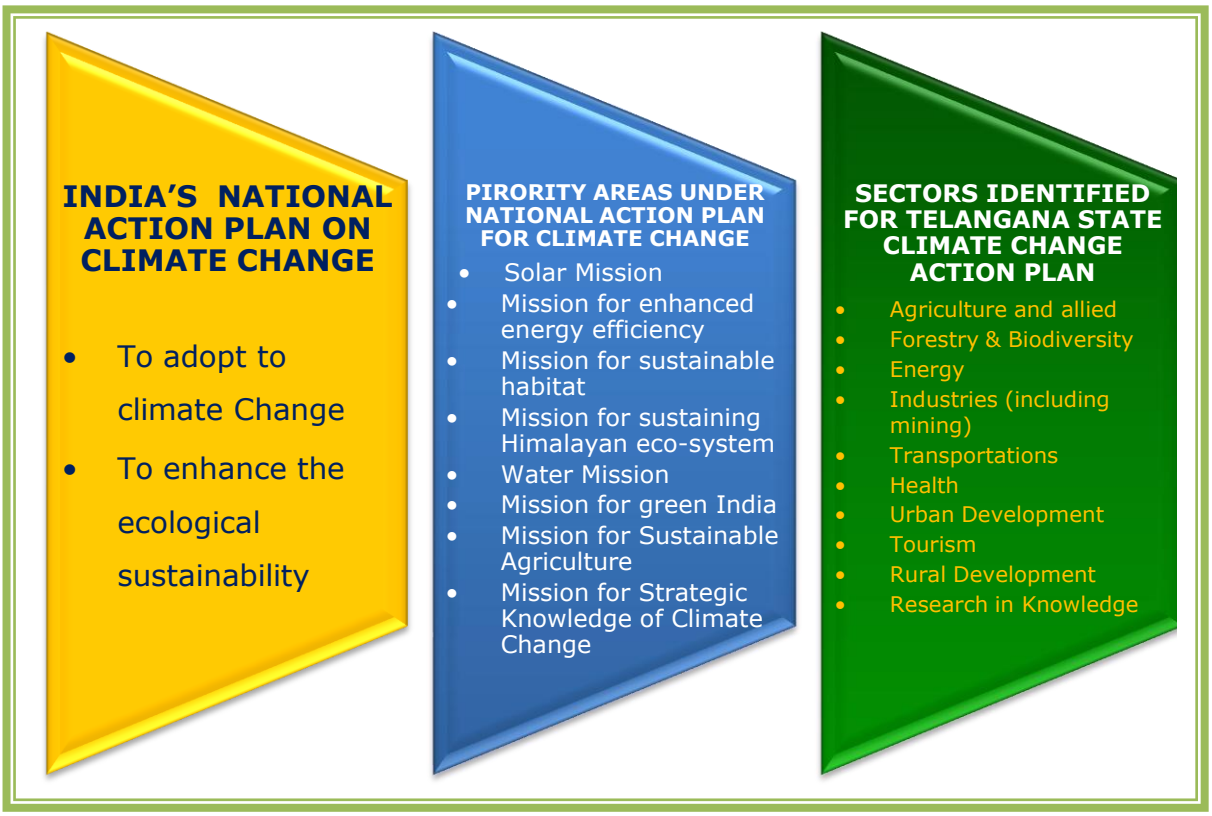
Transition of industries to a more energy efficient and lower carbon energy based operation is a more fundamental issue that is key to sustainable growth. However, this needs to be supported by availability of technological and financial resources. The key issue in this regard is the adoption of appropriate technologies that may help the industrial units in saving energy, improving energy efficiency and conserving natural resources without affecting their competitiveness. This will need to be addressed through a well thought out lower carbon strategy for inclusive growth.

## 1.3. National Action Plan on Climate Change

India has a strong domestic agenda to counter climate change while constructively engaging with the international community to address global warming. However, in doing so India is facing the challenge of sustaining its rapid economic growth rate. India's National Action Plan on Climate Change, released on 30$^{th}$ June, 2008, was the first major milestone to achieve the objectives of a socially inclusive and sustainable economic growth. The primary objective of this national action plan was to maintain a high growth rate, while protecting the poor and vulnerable sections of society and achieve ecological sustainability.

The NAPCC identifies eight National Missions to provide a multi-pronged and integrated framework for addressing climate change. The focus of NAPCC is on adaptation and mitigation, energy efficiency and natural resource conservation and capacity building/stakeholder involvement on climate change issues. The eight missions under NAPCC are shown in exhibit 1.

**Exhibit - 1: Priorities under NAPCC**




## 1.4. State Action Plan on Climate Change (SAPCC)

Involvement of States is critical in building capacity at local levels to address climate change and to protect local communities that are vulnerable. During the Twelfth Plan period, attempt would be made to create capacity at the State level, and to provide some resources to incentivize state action in the area of adaptation and mitigation. MoEF & CC has already initiated the process of preparing State Action Plans on Climate Change (SAPCC). The SAPCCs are to be finalized with assistance of experts and through a process of consultations. It would identify vulnerable areas and communities that need to be insulated against the adverse effects of climate change.

The Government of Telangana is in the process of developing SAPCC. In doing so, prioritization blocks have been identified. A snapshot of priorities is presented in Exhibit 1, depicting focus areas under national action plan and corresponding areas identified for Telangana where State Government could contribute substantially.

Some of the priority blocks are major contributors to climate change, where policy intervention is needed to mitigate climate change. At the same time there are a few priority blocks which are exposed to the physical risks of climate change and State Government has to be proactive in developing adaptation strategies. Strategy formulation has to be preceded by identification and analyzing the issues.

The aim of preparing the SAPCC for Telangana is to get an idea about how the State's key sectors would be affected due to Climate Change and what adaptation/mitigation interventions need to be taken.

## 1.5. Objectives of SAPCC

- Inclusive and sustainable development of the State that protects the vulnerable sections of society from adverse effects of CC.
- Improved ecological sustainability.
- Provide a framework to undertake actions that deliver benefits for growth and development while mitigating and adapting to CC.
- Prioritize adaptation/mitigation options for the State and identify financing options.
- Engineering new and innovative policies/mechanisms to promote sustainable development.

## 1.6. SAPCC: Steering Committee

The Steering Committee on the SAPCC was headed by the Chief Secretary, Telangana with the following members:

| | | |
|---|---|---|
| 1. | Chief Secretary | Chairman |
| 2. | Principal Secretary, EFS&T Department | Member |
| 3. | Principal Chief Conservator of Forests Department | Member |
| 4. | Principal Secretary, Agriculture & Cooperation Department | Member |
| 5. | Principal Secretary/Secretary, Energy Department | Member |
| 6. | Principal Secretary, Animal Husbandry and | Member |

| | | |
|---|---|---|
| | Fisheries | |
| 7. | Principal Secretary, Health, Medical and Family Welfare | Member |
| 8. | Principal Secretary, Finance Department | Member |
| 9. | Principal Secretary, Industries and Commerce | Member |
| 10. | Principal Secretary, TR&B Department | Member |
| 11. | Principal Secretary, MA&UD Department | Member |
| 12. | Principal Secretary, Irrigation and Command Area Development | Member |
| 13. | Principal Secretary, Youth Advancement, Tourism & Culture Dept | Member |
| 14. | Principal Secretary, Planning Department | Member |
| 15. | Commissioner, Disaster Management & E.O. Principal Secretary | Member |
| 16. | Member Secretary, T.S. Pollution Control Board | Member |
| 17. | V.C. Prof. Jayashankar Telangana State Agricultural University | Member |
| 18. | Director General, EPTRI | Member Convener |
| 19. | Any other experts/invitees with the consent of the Chief Secretary | |

The Steering Committee finalized and approved the sectors to be covered in the Action Plan on Climate Change, and gave their valuable guidance.

The Working Group headed by the Director General, EPTRI with the following members:

| | | |
|---|---|---|
| 1. | Director General, EPTRI | Chairman (Convener) |
| 2. | Additional Principal Chief Conservator of Forest | Member |
| 3. | Principal Secretary, Planning Department (or his representative) | Member |
| 4. | C & MD, TSGENCO | Member |
| 5. | Director, Animal Husbandry | Member |
| 6. | Commissioner of Industries | Member |

| | | |
|---|---|---|
| 7. | Director, Public Health & Family Welfare | Member |
| 8. | Commissioner of Transport | Member |
| 9. | Commissioner of Rural development | Member |
| 10. | Commissioner & Director Municipal Administration | Member |
| 11. | Director of Mines and Geology | Member |
| 12. | Director, Central Research Institute for Dryland Agriculture | Member |
| 13. | Director, Indian National Centre for Ocean Information Services | Member |
| 14. | ICRISAT Representatives | Member |
| 15. | Member Secretary TSPCB or his representative | Member |
| 16. | Principal Scientist Prof. Jayashankar TS Agricultural University | Member |
| 17. | Special Invitees (Subject specialist from EPTRI) | Member |

The Working Group is responsible to chalk out the plan of work with timelines, guide the field functionaries on identification of institutions/organizations working in the State / country on Climate Change for collection of data, data analysis and report writing. The Working Group also reviewed the progress of work and provided inputs for completion of SAPCC.

### 1.7. Effective Adaptation Strategies:

The climate change strategy and adaption plan have been based on the 4 key sectors:

*Agriculture:* Change in land use management, development of resource conserving technologies, development of crop varieties that can withstand climate stress, effective risk management through early warning, credit insurance support to farmers and better nutritional management of dairy animals.

*Water:* Framework for mapping hydrological units, assessment of water utilization to address inter - sectoral competition, research to support policy improvements in water use management and to improve understanding of linkages within the ecosystem.

*Forests:* Forest planning and development of programmes that will minimize the adverse impact of climate vulnerability and change, implement REDD+ activities programme.

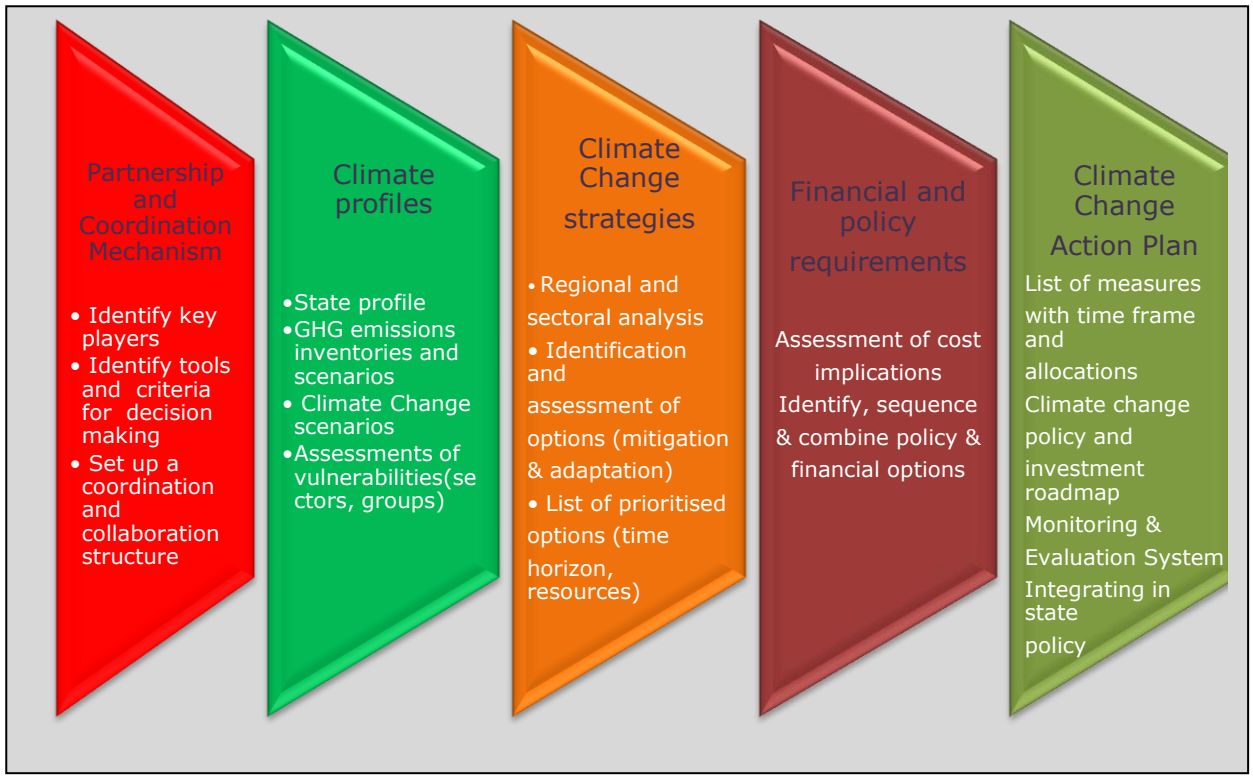
*Health:* R & D and clinical management of vector borne respiratory, cardiovascular diseases and corneal diseases.

The State Action Plans will include a strategy and a list of possible sectoral actions that would help the States to achieve their adaptation and mitigation objectives.

Thirteenth Finance Commission has recommended grants to the State Governments for environment action, which also cover some of the activities under the NAPCC. Even then, resources are likely to fall far short of what is required, and international assistance will need to be mobilized through bilateral and multilateral channels.

A common framework for the preparation of SAPCC was developed to harmonize National and State level actions. The common framework drew largely on the principles of territorial approach to climate change which focused on sub national planning, building capacities for vulnerability assessment and identifying investment opportunities based on the State's priorities. The framework provided broad, systematic and stepwise process is shown in Exhibit–2 for the preparation of SAPCC and advocated a participatory approach so that states have enough ownership for the process and the final Plan. The recommended approach retained a level of flexibility in order to integrate state level variations in ecosystems, geographic conditions, socio-economic scenario, and other factors.

**Exhibit – 2 Logical Frame work for Preparing SAPCC**



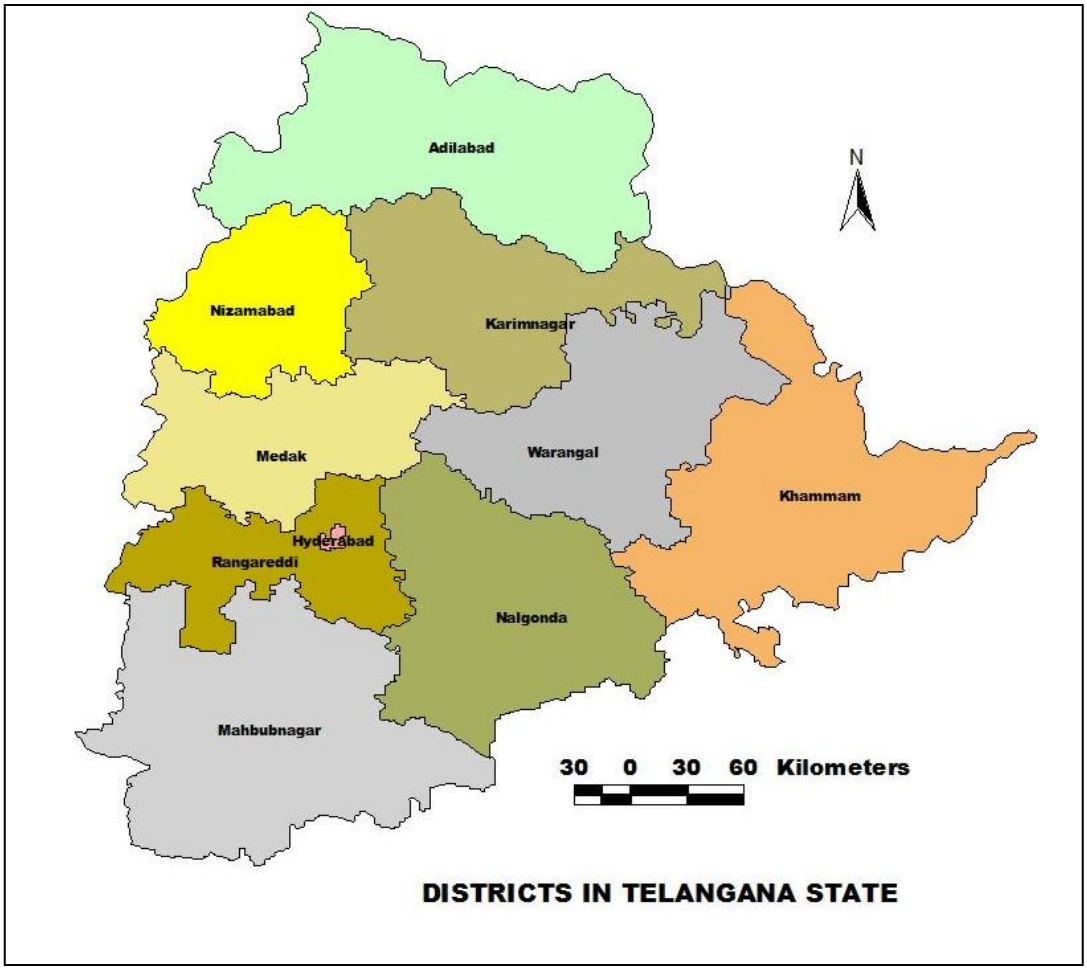

Success and sustainability of the investments are of critical importance. All of the thrusts of Telangana State development framework show vulnerabilities to climate change. Adaptive measures will be necessary to ensure their long term resilience and sustainability in the face of climate change. In order to effectively align Telangana State developmental objectives with the sustainability agenda, this strategic action plan aggregates findings across sectors, and addresses them in an integrated manner which reflects the national priorities articulated through the NAPCC.

## 1.8. State Profile

Telangana is the 29$^{th}$ state of India, formed on 2$^{nd}$ June, 2014. Telangana is situated on the southern part of India. It is India's twelfth largest State in terms of both area and size of population. Its capital and largest city by population is Hyderabad. The most commonly spoken languages of the state are Telugu, Hindi, English and Urdu. Administratively, the state is divided into 10 districts, 459

mandals and around 10434 revenue villages[6]. The district map of Telangana is given in Exhibit 3.

**Exhibit - 3: District Map of Telangana**




### 1.8.1. Geography and Climate

Telangana lies between 15° 46' and 19° 47' N latitude and 77° 16' and 81° 43' E longitude, and is bordered by the states of Maharashtra in the north and north-west, Karnataka in the west, Chhattisgarh in the north-east and Andhra Pradesh in the south and east. The average annual rainfall is about 906 mm, 80% of which is received from the South-west monsoon. The State is strategically located in the Deccan Plateau in a semi arid zone. The climate is predominately hot and dry[7].

[6] Statistical year 2015, Telangana (excluding the mandals clubbed in AP in Khammam district)
[7] Statistical Year, 2015 Telangana State

### 1.8.2. Demographic Overview

Telangana state occupies a total land area of 114,840 Sq.km. The State has a total population of 3, 51, 93,978 (2011 census). The population density is 307 persons per sq.km. The male population is 17,704,078 and the female population is 17,489,900 forming a sex ration of 988:1000. The literacy rate of the State is 64.46%.

### 1.8.3. Ecological overview

#### *1.8.3.1. Natural Resources*

Telangana region has rich natural resources. 20 per cent of the country's coal deposits in the country are found here. The Singareni Collieries Company Limited (SCCL) excavates coal from these mines for industrial needs and thermal power stations. Telangana is also rich in limestone deposits that cater to cement factories. Telangana has other mineral resources like bauxite and mica. Perennial rivers Godavari and Krishna enter Telangana before flowing down through other regions and ending up in the Bay of Bengal. Musi, Bhima, Kinnerasani and Pen Ganga are the smaller rivers that flow in Telangana.

- *Forests*

Forests constitute one of the major natural resource of the State. The 'forest area' is the area recorded as forests by the Government as per revenue records. The State has 29,242 Sq. Kms as forest area including social forestry, which amounts to 25.46% of State area. Out of 29,242 Sq.kms, Reserved Forest area is 21,024 Sq.Kms, Protected forest forms 7468 Sq.Kms and the rest of 750 Sq.Kms are unclassified.

Telangana State has rich flora and fauna with its varied geographic features, has diverse habitats, harbouring several and unique flora and fauna. The Main Forest types found in Telangana are Tropical Moist Deciduous, Tropical Dry Deciduous, Littoral and Swamp, Tropical Thorn, Dry Evergreen.Telangana State has declared Spotted Deer (Axis axis) as State animal, Indian Roller (Coraciasbenghalensis) as State bird, Jammi (Prosopis cineraria) as State Tree and Tangedu (Sennaauriculata) as State flower.

Exhibits 4 below give the forest distribution across the State. Timber, Bamboo, Firewood, Beedileaves, Teak, etc are the major forest products of economic value. Exhibit 5 shows district wise Geographical and forest Area in Telangana.

**Exhibit - 4: Geographical distribution of forests in Telangana.**

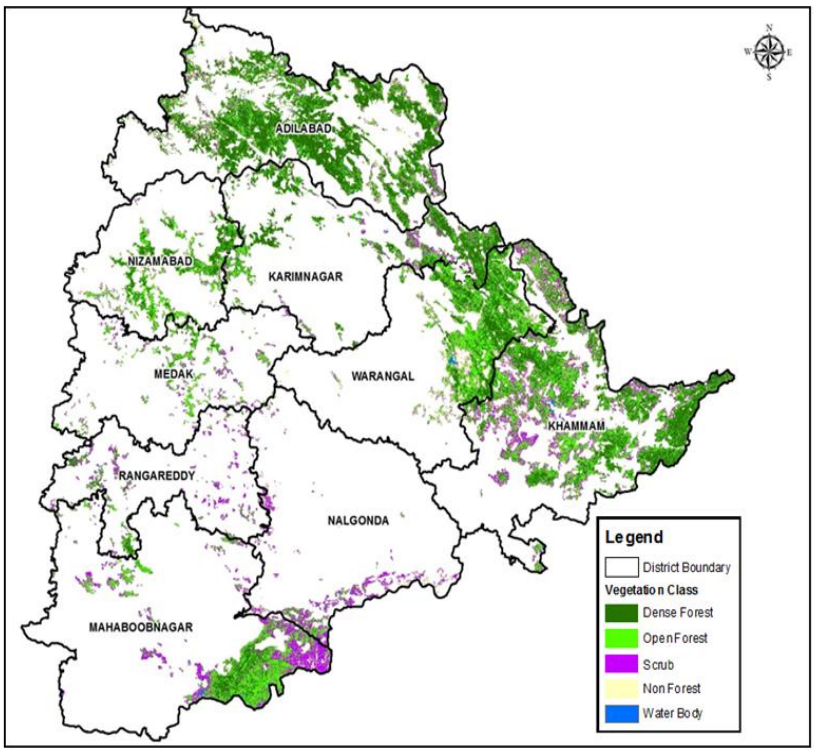
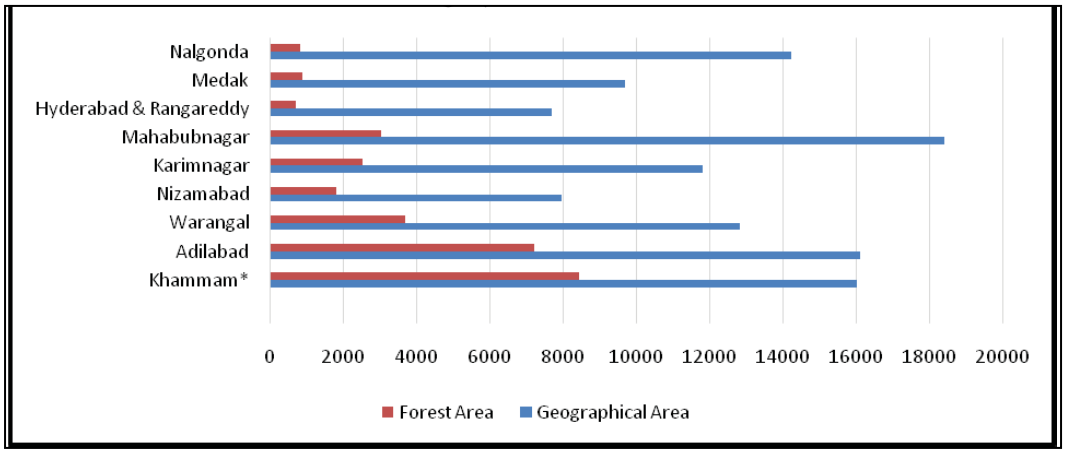



**Exhibit – 5: District wise Geographical and Forest area**




Source: Socio economic Survey, 2015 Telangana

- *Medicinal and aromatic plants*

The State is rich in variety of medicinal and aromatic plants and such plants are cultivated on 8071 hectares of land and production is 21616 MT. Large scale cultivation of plants of Palm Rosa, Annota, Lemon Grass, Citronella, Amla and Coleus are the major medicinal plants cultivated in the State. Some of the medicinal plants in the forest area of the State are Acacia catechu, Acacia nilotica, Acoruscalamus, Adhatodazeylanica, Aeglemarmelos, Agave Americana, Ailanthus excelsa, Albizialebbeck, Aloe vera, Anacardiumoccidentale, Anthocephaluscadamba, Asparagus racemosus, Azadirachtaindica, Chlorophytumtuberosum, Cymbopogonflexuosus, Decalepishamiltonii, Feronialimonia, Ficusbenghalensis, Meliaazedarch, Moringaoleifera, Murrayakoenigii, Phyllanthusemblica, Pterocarpussantalinus, Rauvolfia serpentine, Vetiveriazizanioides, With aniasomnifera.

- *Flora and Fauna*

The State of Telangana is endowed with rich diversity of flora and fauna with over 2939 plant species, 365 bird species, 103 mammal species, 28 reptile species and 21 amphibian species in addition to large number of Invertebrate species. Important endangered species found in the state are Tiger, Panther, Indian Gaur, Four Horned Antelope, Black Buck, Marsh Crocodile etc. The state is also bestowed with dense Teak forest along the banks of river Godavari right from Nizamabad through Adilabad, Karimnagar, Warangal up to Khammam district. These forests are home for several deciduous species like Nallamaddi, Yegisa, Rose wood, Narepa, Bamboo in addition to Teak.

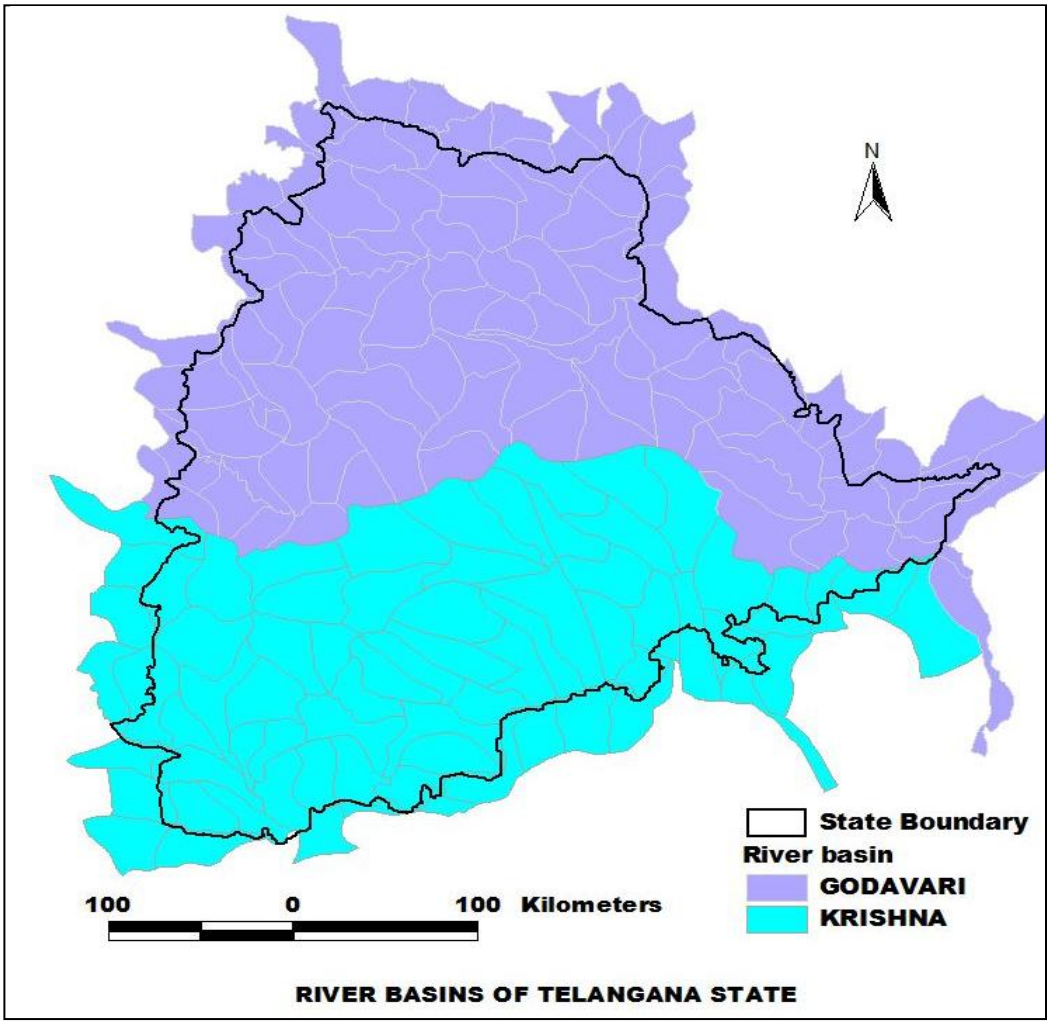
With the objective of preserving the biodiversity the Government has declared 12 protected areas which include three National Parks and nine sanctuaries which includes two Tiger Reserves and covering an area of 5692.48 Sq. Kms which is 19.73% of the forest area of Telangana State. The network of protected areas include important wetlands like Manjeera Wildlife Sanctuary and Siwaram Wildlife Sanctuary which are home for endangered Marsh Crocodile also called Mugger.

The State has two tiger reserves namely Amrabad Tiger reserve in the Nallamalla hill tracts spreading over Mahboobnagar and Nalgonda districts and the other Kawal Tiger Reserve has forest areas which are contiguous to Tadoba Andheri Tiger Reserve in Maharashtra and Indravathi Tiger Reserve in Chattisgarh.

### *1.8.3.2. River Basins*

Nearly 73.5% of the State's territory is covered by the basins of two major rivers – Godavari and Krishna. The river Godavari is flowing on the North and the river Krishna is flowing on the South in Telangana region. Apart from the major rivers, there are other small rivers such as Bhima, Dindi, Kinnerasani, Manjeera, Manair, Penganga, Pranahita, and Peddavagu and Taliperu. The catchment area of the Godavari lying in the State is 79% and that of the Krishna is 68.5%.

**Exhibit - 6 River basins of Telangana State**



### *1.8.3.3. Agro Climatic Zones*

The State experiences tropical climate with slight variations depending on the elevation and maritime influence and varies according to the rainfall, type of soils and cropping pattern. The rainfall is received from both the South-West and North- East monsoons, predominantly the former, but precipitation varies across the State.

The districts of the State can be divided into 3 agro-climatic zones, as shown in Table-1.

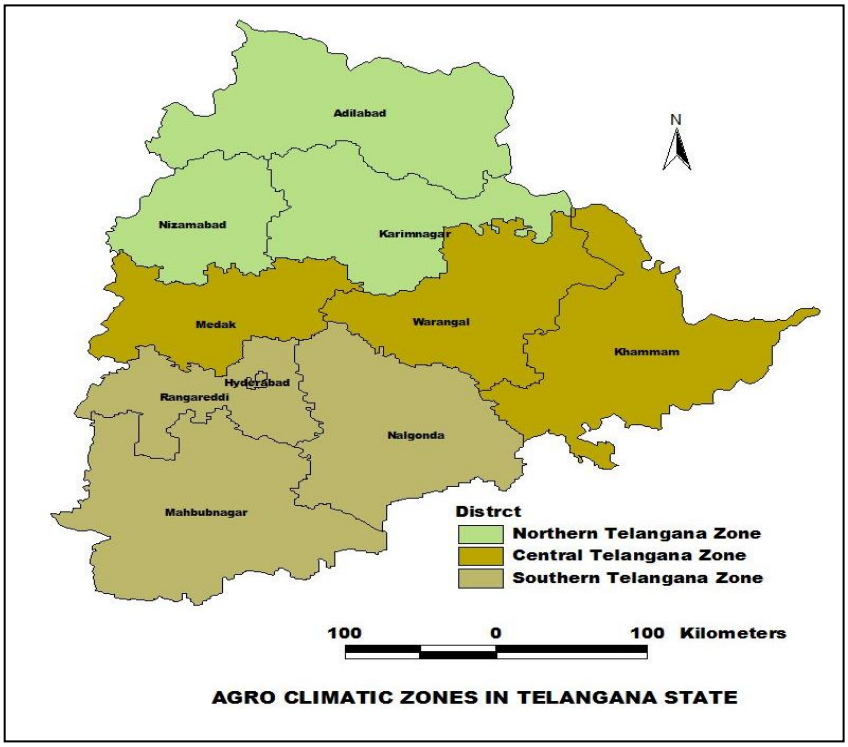
**Table - 1: Agro-climatic zone wise division of the State**

| Sl. No. | Name of the Zone | Districts | Geographical area (lakh ha) | No. of Mandals |
|---|---|---|---|---|
| I | Northern Telangana Zone | Karimnagar, Nizamabad, Adilabad | 35.5 | 144 |
| II | Central Telangana Zone | Warangal, Khammam, Medak | 30.6 | 132 |
| III | Southern Telangana Zone | Mahabubnagar, Nalgonda, Rangareddy (+ Hyderabad) | 39.3 | 164 |

It is an agriculturally-prosperous State and has districts rich in mineral resources, with a gross irrigated area of over 62.88 lakh hectare.

The three agro-climatic zones based on the agro-ecological conditions are illustrated in Exhibit 7.

**Exhibit - 7: Agro Climatic Zones of Telangana**[8]




### *1.8.3.4. Land Use Patterns*

Land use pattern change influence the environment, and thus plays a major role in determining the climatic change impacts of a State. The land-use patterns in the State in last decade are given in Table 2.

[8]Department of Agriculture, Telangana

**Table - 2: Land utilization in Telangana from 2008-2014 (Area in Lakh Hectare)**

| Land Use | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 |
|---|---|---|---|---|---|---|
| Total Geographical Area | 114.84 | 114.84 | 114.84 | 114.84 | 114.84 | 114.84 |
| Forest Area | 27.43 | 27.43 | 27.43 | 27.43 | 27.43 | 27.43 |
| Barren Land | 6.26 | 6.18 | 6.17 | 6.17 | 6.17 | 6.15 |
| Land put to Non-Agricultural Purposes | 8.19 | 8.24 | 8.71 | 8.82 | 8.86 | 8.95 |
| Permanent Pastures | 3.09 | 3.08 | 3.03 | 3.02 | 3.02 | 3.01 |
| Miscellaneous Trees | 1.16 | 1.16 | 1.14 | 1.14 | 1.14 | 1.14 |
| Culturable Waste | 1.71 | 1.70 | 1.67 | 1.65 | 1.74 | 1.78 |
| Other Fallows | 7.88 | 8.08 | 7.80 | 8.26 | 7.91 | 7.17 |
| Current Fallows | 16.79 | 19.38 | 13.97 | 12.36 | 12.03 | 9.60 |
| Net Sown Area | 42.33 | 39.59 | 44.92 | 45.99 | 46.54 | 49.61 |

The above table clearly depicts that the land put to non-agricultural use increased from 8.19 Lakh ha in 2008-09 to 8.95 lakh ha in 2013-14. The current fallows decreased from 16.79 Lakh ha to 9.60 lakh ha in the same period. As per the Land Utilization Statistics for the year 2013-14, out of the total geographical area of 114.84 Lakh hectares in the State, Net Area Sown including fish culture was 49.61 lakh hectare and area under forest was 27.43 Lakh hectare.

### 1.8.4. Economic overview

The GSDP of the State for the year 2013-14 (Provisional estimates) at constant (2004-05) prices is estimated at Rs. 2,07,069 crores as against Rs. 1,96,182 crores for the year 2012-13 (First revised Estimates) reflecting a growth of 5.55% which is lower than the all India average GDP growth rate of 8.04% during 2011-12. The sectoral growth of GSDP comprises 4.58% in Agriculture sector, 2.70% in Industries sector and an impressive growth of 7.15% in the Services sector[9]. The State has performed well, overcoming all odds like global recession and natural calamities like heavy and untimely rains, floods etc and is targeting a higher average annual growth target of 10.2 per cent.

[9]Reinventing Telangana, Socio-economic outlook, 2015

**Exhibit- 8: GSDP of Telangana State and Per capita of all India constant (2004-05) Prices[10]**

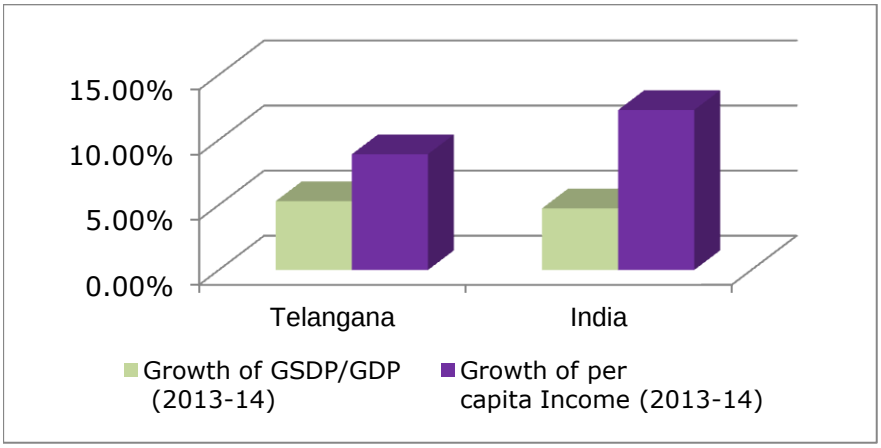



**Table - 3: Growth Rate of GSDP of Telangana at Constant (2004-05) Prices**

| S. No. | Sector | GSDP | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2009-10 | 2010-11 | 2011-12 (TRE) | 2012-13 (SRE) | 2013-14 (FRE) | 2014-15 (AE) |
| 1. | Agriculture Sector | -12.5 | 19.4 | -0.4 | 11.5 | 8.4 | -10.3 |
| 2. | Industry Sector | 2.3 | 16.8 | 5.7 | -4.1 | 0.1 | 4.1 |
| 3. | Services Sector | 4.8 | 18.3 | 12.5 | 6.3 | 5.9 | 9.7 |

TRE: Third Revised Estimates, SRE: Second Revised Estimates, FRE: First Revised Estimates, AE: Advance Estimates Source: Directorate of Economics and Statistics, Hyderabad.

### *1.8.4.1. Sectoral Performance*

- *Agriculture sector*

About 55.49% of the State's population is dependent on some form or the other on farm activity for livelihoods. In view of this there will be greater impacts from the Climate change on livelihoods. As per the GSDP of 2014-15, agriculture sector expected negative growth of -10.3% recorded in agriculture and allied sectors, attributed mainly to the adverse seasonal conditions. Agriculture per seasons was badly hit due to climatic conditions and recorded negative growth of -21.3%, which was partially compensated by the positive growth trends in Live

[10]Directorate of Economic & Statistics, Telangana. and C.S.O., New Delhi

Stock (6.5%), Forestry & Logging (2.7%) and fisheries (11.4%). Consequently, the contribution of Agricultural sector declined to 12.8% from 15.1% in the previous year. Agriculture sector experienced a decelerating trend in the State in recent years, but it continues to remain a priority sector for the State because of its high potential of employment generation, food security, inclusiveness and sustainability of growth.

- *Industry Sector*

Industry sector comprising Mining and Quarrying, Manufacturing (Registered and Unregistered), Electricity, Gas & Water Supply and Construction, registered a growth rate of 4.1% during 2014-15. Among the sub-sectors, Mining and Quarrying, Construction and Registered Manufacturing showed relatively better growth rates. In the State, industries like Pharmaceuticals, Iron & Steel, IT Industry, Travel and Tourism, Food and Beverage and various other types of industries are coming to the forefront. Table- 4 shows the distribution of various manufacturing/industrial establishments in State.

**Table - 4: Distribution of Manufacturing/Industrial Establishments in Telangana**

| Type | Numbers |
|---|---|
| Number of Registered factories in the State | 13,656 |
| Large scale enterprises | 2,091 |
| Micro and small enterprises | 40,894 |
| Industrial Estates/development areas | 150 |

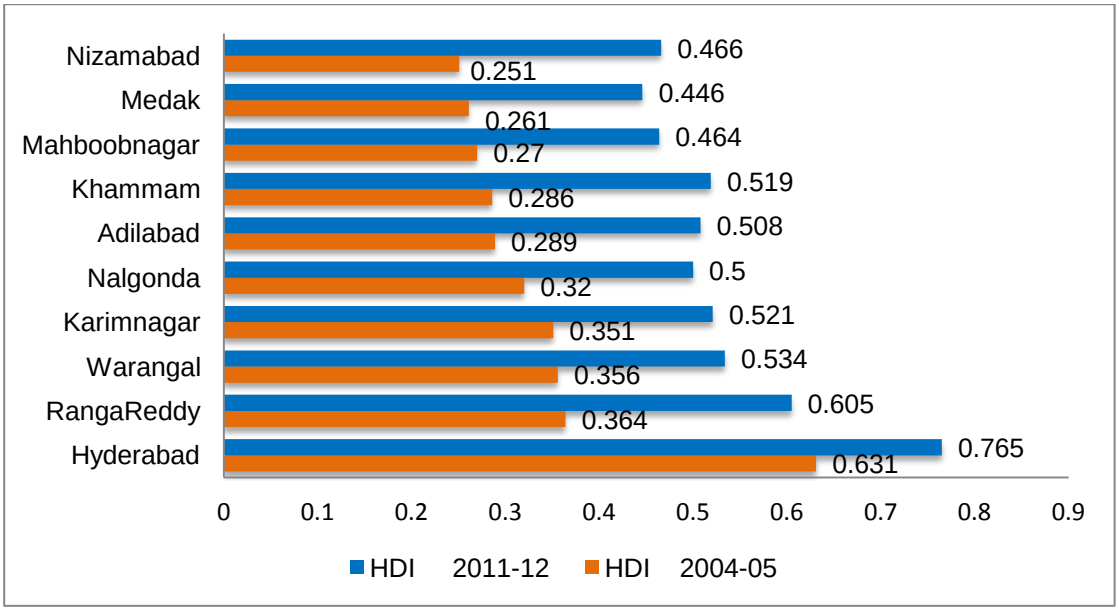
*(Source: Socio economic outlook, 2014)*

District wise data analysis shows that the highest numbers of factories are registered in Rangareddy district. During the decade 2004-05 to 2014-15 the State registered an average growth rate 7.8 % at constant prices (2004-05). However, the growth path of the State exhibited greater fluctuations than that of all India. Manufacturing sector growth across districts indicates that seven districts other than Medak, Rangareddy and Hyderabad require specific strategies and policy interventions. The growth in sub-sectors indicates a fall in the unregistered manufacturing sector represented by the micro and small enterprises, electricity, gas & water supply and construction.

➢ *Service Sector*

Trade, Hotels and Restaurants, Transport by other means and Storage, Communications, Banking and Insurance, Real Estate & Business Services and Community, Social and Personal services which falls under Service Sector, registered a growth rate of 9.0% during the year 2014-15. Among the subsectors, Public Administration, Real Estate, Ownership of Dwellings and Business Services and Transport by other means and storage have shown significant growth. Within the service sector, employment in information and communication technology (ICT) related activities have been growing fast in Telangana State. More than 90% of the employment generated in this sector (ICT) is located in urban areas, especially in big cities like Hyderabad. The estimated growth in GSDP for the Trade hotels & Restaurants, Real Estate, Ownership of Dwellings and Business, Banking and Insurance Sector during 2013-14 is 15.07%, 12.55% and 7.86% respectively. The contribution from Public Administration is expected to rise due to the increase in Government expenditure on salaries and wages.

**Exhibit - 9: District wise Human Development Index of districts of Telangana**




Source: CESS Report,2014

It is now well established that besides economic development, human development is very important. The outcomes of human development depend on several factors such as the social and macroeconomic policies of the union

government in a federal context in general, policies and strategies of the State Governments particularly with respect to health and education besides the specific historical factors. The goal of the human development approach is to place people at the centre of development debate, policy and advocacy. The United Nations Development Programme (UNDP) launched Human Development Report in 1990 with the sole objective of advocating this approach to development policy. The Human Development Report (HDR), released annually, used a simple composite measure called Human Development Index (HDI) to gauge the overall status of different countries and rank them. The HDI combines three dimensions of development - such as long and healthy life, knowledge and decent standard of living. Following the UNDP methodology, HDI has been computed for districts of Telangana for the years 2004-05 and 2011-12.

The HDI values across the districts are shown in the Exhibit - 9. The values of HDI at district level also show considerable increase, indicating good progress in human development. In both the years (2004-05 and 20011-12), Hyderabad, Rangareddy, Warangal and Karimnagar ranked at the top in descending order. Medak, slipped from 9th to 10th and Mahabubnagar slipped from 8th to 9th from the period 2004-05 to 2011-12. Correspondingly, Nizamabad district improved its position from 10th to 8th. Among middle ranking districts, Nalgonda district slipped its rank from 5th to 7th, while Khammam improved its position from 7th to $5^{th}$. While the overall HDI ranking in Telangana state has shown positive trends, the data reveals the need for emphasis in certain areas. Out of the critical instruments to achieve, this is to improve the delivery mechanism at field levels, for which democratic decentralization can be an effective strategy.

# Chapter-2
# PAST AND ONGOING CLIMATE CHANGE TRENDS & ACTIONS TAKEN

## 2.0 Background

Managing climate risks is a major challenge of today and for the future. Climate-related disaster risk is increasing. The number of reported hydro-meteorological hazards (droughts, heat waves, wind storms, forest fires or landslides) has significantly increased in recent decades, causing deaths and economic losses. Extreme climate events affect multiple sectors including agriculture, food security, water resources and health. Climatic variability can trigger crop failures, shortages of water for irrigation, food insecurity and hunger. Impacts of extreme events such as droughts and heat waves frequently accumulate into setbacks to development gains and towards achieving the MDGs related to poverty, hunger and human health.

The emerging patterns of climatic hazard risk are presumably associated with climate change. The study of the past and ongoing trends become essential as these help us in understanding the trend of these events and their impacts on the environment.

## 2.1. Observed Climatic Changes

### 2.1.1. Climate and Temperature

Telangana is a semi-arid zone and has a predominantly hot and dry climate. The areas covered by the Deccan Plateau are characterized by hot summers with relatively mild winters. In Telangana region, the mean maximum temperature varies between 40$^{o}$C and 43$^{o}$C in May and the mean minimum temperature is 13$^{o}$C to 17$^{o}$C in December and January. The minimum temperature falls rapidly after October, and less than 10$^{o}$C has also been recorded on certain days.

### 2.1.2. Rainfall

The State receives rainfall from South-West (June–September) and North–East (October–November) monsoons; however, there is large variation in the distribution of rainfall. Telangana generally receives modest rainfall. The average annual rainfall in the state is about 906 mm, 80 percent of which is received from the South-West monsoon (June-September).

**Table - 5: Season-wise rainfall data, 2013-14 (in millimeters)[11]**

| District | South West Monsoon (June –September) | | North-East Monsoon (October-December) | |
|---|---|---|---|---|
| | Actual | Normal | Actual | Normal |
| Mahabubnagar | 560.3 | 446.6 | 212.7 | 120.8 |
| Ranga Reddy | 634.7 | 587.8 | 254.0 | 132.0 |
| Hyderabad | 671.9 | 562.1 | 257.4 | 152.0 |
| Medak | 762.3 | 675.8 | 217.1 | 132.4 |
| Nizamabad | 991.0 | 849.1 | 155.5 | 134.1 |
| Adilabad | 1391.1 | 984.2 | 181.5 | 116.7 |
| Karimnagar | 981.4 | 794.6 | 243.8 | 113.6 |
| Warangal | 962.7 | 799.1 | 263.1 | 119.9 |
| Khammam | 903.4 | 890.3 | 223.8 | 130.4 |
| Nalgonda | 598.9 | 561.7 | 391.1 | 139.7 |

### 2.1.3. Humidity

In Telangana, humidity is as high as 80% during monsoon months (July-September). In the dry months of March, April and May, humidity is generally low with an average of 25 to 30%.

### *2.1.4. Heavy Rains*

Due to low pressure system which developed in West Central Bay of Bengal and adjoining areas there were torrential and incessant rains in the districts of Mahabubnagar and Nalgonda in the year 2009,2012 and 2013.

[11] Source: Statistical Abstract, Telangana, 2015

### *2.1.5. Floods*

Floods by nature depend on several factors; one being incessant rains; rains in a short period of time crippling natural drainage. However, other factors such as nature of the collecting basin, nature of the streams, type of soil, natural and man-made vegetation, amount of rainfall, obstruction to natural drainage etc. determine the type and extent of floods. Khammam district in Telangana region is most prone to monsoon floods.

#### *2.1.5.1. Flash floods in Hyderabad*

City of Hyderabad experienced unprecedented flooding in August 2000 leading to massive property damages and some human loss. City of Hyderabad with a population of around 3.82 million (2001 census) and spread over an area of 55 Sq.Km has severe floods in September 1908, August 2000 and August 2008. Property losses and human lives lost along with extent of people affected in these floods are presented in Table –6 below. The current water drainage capacity of Hyderabad is to handle 12mm/hour rainfall. Clogged up drains, unauthorized encroachments of Moosi river beds and development along river banks that block natural drains further reduce storm water drainage capacity of the urban areas.

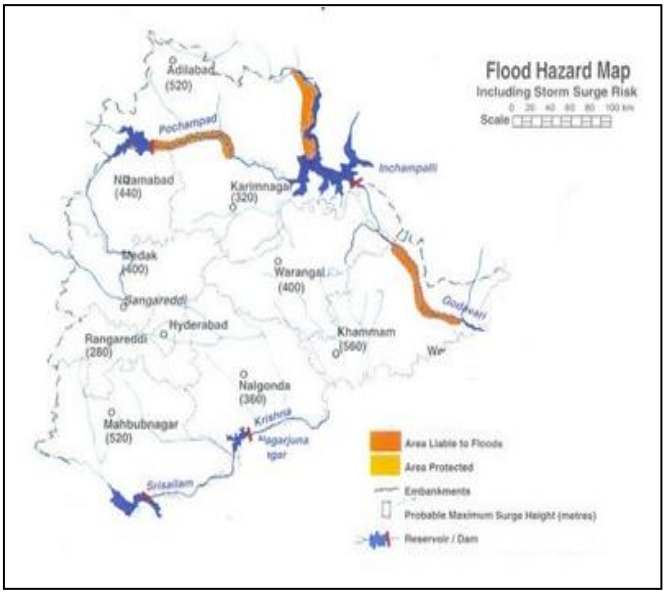


**Table -6 Property and other losses in Hyderabad due to floods**

| Details | 28/29 February 1908 | 23/24 February 2000 | 8/9/10 August 2008 |
|---|---|---|---|
| Rainfall | 430 mm | 240.5 mm | 237 mm |
| Property loss/worth | 80,000 homes | 35,693 homes Rs.135.0 lakhs | Rs.49.2 lakhs |
| Human lives lost | 1,500 | 26 | Nil |
| Population affected | 6,00,000 | 2,00,000 | 1,50,000 |

*Source: IMD, New Delhi*

### *2.1.6. Droughts*

The Central Water Commission defines drought as a situation occurring when the annual rainfall is less than 75% of the normal (defined over 30 years average). Drought is a normal, recurrent feature of climate. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another.

The table 7 & 8 shows district wise total no. of mandals affected from droughts in year 1995-96 to 2011-12. It shows that Telangana has historically been prone to drought conditions especially in Rangareddy, Mahabubnagar and Nalgonda districts. Climate is projected to increase drought occurrence in the districts like Nalgonda and Mahabubnagar which would impact not only water resources but also have a cascading effect on other dependent sectors. Increased drought conditions can also severely affect agricultural and pastoral livelihoods and increase vulnerability and risks for farmers, and people depending on such livelihoods. For farmers who are strongly dependent on rainfall for agricultural activities, crop failure caused by drought can lead to household food insecurity. For pastoralists and agro-pastoralists whose livelihoods and food security depend on livestock, drought conditions can cause malnutrition or disease in livestock because of insufficient fodder.

**Table -7: District- Wise, Year-Wise No. of Mandals Declared as Drought Affected (1995-96 to 2004-05)[12]**

| District | Total Mandals | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-2000 | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mahabubnagar | 64 | 15 | 10 | 64 | - | 64 | - | 64 | 64 | 19 | 64 |
| Karimnagar | 57 | - | - | 56 | - | 24 | - | 39 | 57 | 41 | 56 |
| Nizamabad | 36 | - | - | 36 | - | | - | 36 | 36 | 21 | 32 |
| Nalgonda | 59 | - | - | 53 | - | 53 | - | 53 | 59 | 23 | 55 |
| Ranga Reddy | 37 | - | - | 35 | - | 34 | - | 34 | 36 | 5 | 34 |
| Khammam | 46 | - | - | 41 | - | 7 | - | 38 | 46 | 0 | 5 |
| Adilabad | 52 | - | 7 | 52 | - | - | 30 | 51 | 52 | 7 | 51 |
| Medak | 46 | - | - | 45 | - | 33 | - | 45 | 45 | 19 | 46 |
| Warangal | 51 | - | - | 51 | - | 30 | - | 46 | 51 | 16 | 40 |
| Hyderabad | 16 | - | - | - | - | - | - | - | - | - | 16 |
| **Total** | **464** | **15** | **17** | **433** | **0** | **245** | **30** | **406** | **446** | **132** | **399** |

(All Khammam mandals are included)

[12] Andhra Pradesh National Disaster Risk reduction tool

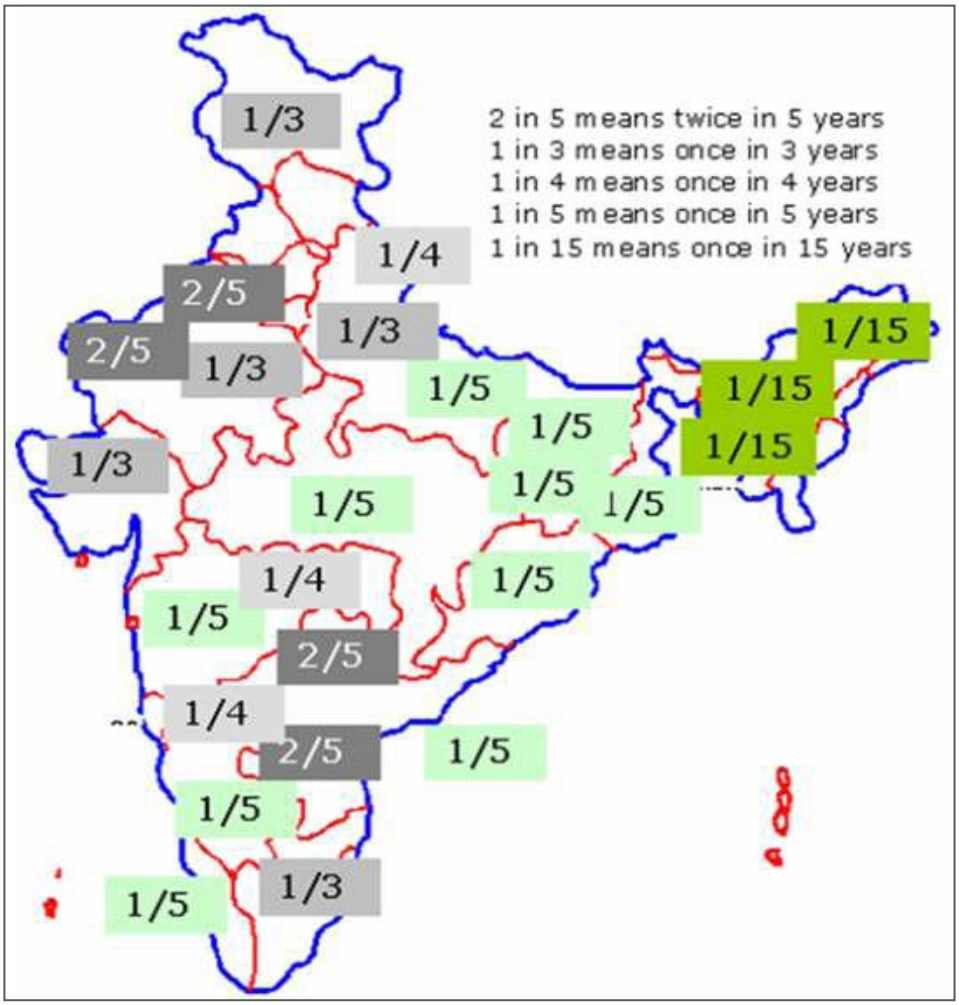
**Table – 8: District- Wise, Year-Wise No. of Mandals Declared as Drought Affected (2005-06 to 2011-12)[13]**

| District | Total Mandals | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 |
|---|---|---|---|---|---|---|---|---|
| Mahabubnagar | 64 | - | 56 | - | - | 64 | - | 64 |
| Karimnagar | 57 | - | - | - | - | 57 | - | 57 |
| Nizamabad | 36 | - | - | - | - | 36 | - | 6 |
| Nalgonda | 59 | - | 32 | - | - | 59 | - | 59 |
| Ranga Reddy | 37 | - | 5 | - | - | 32 | 6 | 37 |
| Khammam | 46 | - | - | - | - | 46 | - | 46 |
| Adilabad | 52 | - | - | - | - | 52 | - | 52 |
| Medak | 46 | - | 10 | - | - | 46 | - | 46 |
| Warangal | 51 | - | - | - | - | 50 | - | 51 |
| Hyderabad | 16 | - | - | - | - | 0 | - | 0 |
| **Total** | **464** | **0** | **103** | **0** | **0** | **442** | **6** | **418** |

(All Khammam mandals are included)

[13] Andhra Pradesh National Disaster Risk reduction tool

**Exhibit - 10: Periodicity of occurrence of Drought in various parts of the country**[14]




### *2.1.7. Heat Waves*

A heat wave is a climatologically extreme event involving abnormally higher temperature relative to normal[15] during the Summer i.e. the months of April-June. During this period the temperatures rise considerably, sometimes touching 47ºC in May month in districts like Khammam, Nizamabad, Nalgonda, Karimnagar and Warangal. During the year 1986-1993, the heat waves were mainly of moderate nature with maximum duration of seven days. The highest maximum temperature of 47°C was recorded at Nalgonda and Ramagundam on 11$^{th}$May, 1998. From 1994 onwards, the frequency of severe heat waves and the duration of heat wave spells have increased significantly. In 1997 (18$^{th}$ May to 5$^{th}$June) and 1998 (23$^{rd}$May to 10$^{th}$June)

[15]Crisis Management Plan - Drought, Ministry of Agriculture, Government of India
[15]Concept note on heat wave

the duration of moderate to severe heat wave spells had extended up to 19 days.

Since Heat wave conditions prevail in several parts of the state during summer season, deaths due to sunstroke occur every year. In spite of various measures taken by Government, 541 deaths due to sunstroke had been reported in the year 2015 (as on 30$^{th}$ May, 2015). The maximum deaths were recorded in Nalgonda, Khammam, Karimnagar and Mahabubnagar districts, where the temperatures have crossed 45° C. The District wise details of deaths due to Heat Waves in Telangana for the period from 2005 to 2014 and 2015 are shown in the Table -9.

**Table – 9: Year wise death cases of Heat waves during 2005-15**

| Districts | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 (as on 30.05.2015) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mahabubnagar | NA | NA | NA | NA | NA | NA | NA | 2 | 27 | 0 | 42 |
| Ranga Reddy | NA | NA | NA | NA | NA | NA | NA | 0 | 11 | 0 | 36 |
| Hyderabad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Medak | NA | NA | NA | NA | NA | NA | NA | 7 | 24 | 2 | 35 |
| Nizamabad | 0 | 0 | 0 | 3 | 7 | 5 | 0 | 2 | 36 | 0 | 18 |
| Adilabad | NA | NA | NA | NA | NA | NA | NA | 44 | 43 | 7 | 26 |
| Karimnagar | NA | NA | NA | NA | NA | NA | NA | 22 | 91 | 0 | 120 |
| Warangal | NA | NA | 15 | 14 | NA | 6 | NA | 25 | 40 | 0 | 20 |
| Khammam | NA | NA | NA | NA | NA | NA | NA | 42 | 35 | 0 | 95 |
| Nalgonda | 11 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 209 | 22 | 139 |
| **Total** | **0** | **0** | **15** | **17** | **7** | **11** | **0** | **144** | **516** | **31** | **541** |

Source: Revenue department

### *2.1.8. Risk Management Actions by State*

The State is active in taking initiatives to overcome climate change impacts. The State has implemented a number of interventions in various sectors for enhancing adaptive and mitigative capacity of the State towards climate change.

#### *2.1.8.1. Implemented adaptation interventions for Health Sector*

- National Vector Borne Diseases Control Programme
- Revised National TB Control Programme
- Maternal and Infant deaths control programme
- Education and literacy are the major adaptation moves

#### *2.1.8.2. Implemented adaptation interventions for Agricultural Sector*

- Financial support to the farmers in the event of crop failure as a result of drought incidence of pest and diseases etc.
- Crop Insurance
- Adoption of inter cultivation practice
- Promotion of System of Rice Intensification (SRI) is an important intervention under National Food Security Mission (NFSM) for increasing production and productivity of rice in the State.
- Stocking of quality seeds[16]well in advance for immediate distribution for re-sowing in the areas affected by drought and floods.
- Encourage the farmers to adopt progressive farming practices, high value in-puts and higher technology in agriculture.
- Insurance is provided to small and marginal farmers since 2000 under National Agriculture Insurance Scheme (NAIS) in order to recover the loss occurred during Kharif season. 20 crops are covered under NAIS insurance.
- Tanks are the main source of irrigation in Telangana for centuries. Over a period of time, due to lack of proper maintenance and siltation, most of these tanks have either shrunk or become defunct. Reduced availability of surface water has resulted in over stress on the available ground water resources. In the state, there are about 46,531 minor irrigation sources. The ayacut that can be irrigated with the above allocated water is about 18 to 20 lakh acres. Keeping this in view, Government of Telangana has taken up major initiative for restoration of tanks in mission mode known as 'Mission Kakatiya'.

[16] Website of Department of Agriculture and Socio economic outlook, 2015

#### *2.1.8.3. Implemented adaptation interventions for Forestry and Biodiversity Sector*

- Soil and Moisture Conservation Programme
- Development of Ecotourism sites
- Joint Forest Management (JFM):3,288 Vana Samraksha Samities (VSSs) are constituted and managing forest area that is around 36% of the forest area of the State.
- Adopted Conservation Methods: 'INSITU' conservation initiatives such as declaring biological heritage sites under section 37 of the Biological Diversity Act, 2002 and 'EXSITU' conservation initiatives such as botanical gardens, crop diversity parks etc. are adopted in the State.
- 'Telanganaku Haritha Haram' a programme being implemented in the state, to make the State Green with coverage of one third of the State geographical area by planting 230 Crore seedlings.
- Government has initiated 'Green Curtain' project in the city of Hyderabad to increase the green cover. Over 1,000 kilometres are planned to be covered under the project and to start with, 50 locations have been identified, of which, plantations have been completed in 15 locations.

#### *2.1.8.4. Implemented adaptation interventions for Habitats (rural and urban) Sector*

- Subsidized housing for the rural and urban poor
- Water supply and sanitation schemes (Nirmala Bharata Abhiyan Scheme (NBA)
- Reasonably priced housing for the middle class
- Integrated Management of Municipal Solid waste
- Mission for Elimination of Poverty in Municipal Areas (MPEMA)
- Livelihoods for the rural and urban unemployed
- Swatch Bharat Mission – Telangana government has been a fore runner in implementing the Swatch Bharat Mission.

### *2.1.8.5. Implemented adaptation interventions for Transportation Sector*

- Telangana State Road Transport Corporation (TSRTC) has been selected to pilot-test the new fuel-efficiency guidelines which have been developed in collaboration with World Bank
- Telangana State Road Transport Corporation is using bio-diesel for their fleet.
- Green Taxes are imposed on transport vehicles which have completed 15 years from the date of registration
- Hyderabad Metro rail project is designed as an elevated transit system to be financially viable and to reduce carbon foot print in the city. It is a simple mass transit system, but is being used as an opportunity to redesign Hyderabad as friendly green city. The elevated stations are being designed as green building stations with emphasis.
- Use of alternate fuel (replacing diesel with LPG in auto rickshaws, cars).
-

# Chapter-3
# ASSESSMENT OF VULNERABILITY OF STATE TO CLIMATE CHANGE

This section addresses the assessment and enhancement of the adaptive capacity of both the social and physical systems of the different districts of the State, so that these systems are better equipped to cope with climate change, including variability. The assessment of adaptive capacity would help the system to cope with the vulnerabilities arising out of the climate change.

## 3.0 Assessment of Adaptive Capacity of the State

Adaptive capacity is the property of a system, either social or physical, to adjust itself and expand its coping range under existing climate variability, or future climate conditions. In practical terms, adaptive capacity is the ability to design, implement and maintain an effective adaptation strategy for each of the social or physical aspects of the system, or to develop the ability to react to evolving hazards. The objective behind enhancement of the adaptive capacity is to reduce the stresses on the system due to the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards. The adaptation process requires the capacity to learn from previous experiences to cope with current climate, and to apply these lessons to cope with future climate change and any other consequences.

## 3.1. Identification of determinants and indicators

The' Adaptive Capacity' for the different districts of the State of Telangana has been developed on the basis of the following key determinants of the adaptive capacity of each district:

- Economic status
- Demographic status
- Infrastructure status
- Education status
- Health status

These key determinants were estimated based on a set of determinants/factors which are already estimated by the Human Development Report, 2007.

### 3.1.1. Economic Status

The economic status is an indication of the capability of a district to adapt to the adverse effects of CC and therefore, higher economic status means higher adaptive capacity. There are a number of separate determining parameters which can give an overview of the economic status of the district. Two parameters were used in this report namely per capita GDP and percentage of agricultural workers.

### 3.1.2. Demographic Status

The Demographic status of the district denotes the position of the district in terms of the area, population, density and percentage of urban slum population. This gives an indication of the difficulty that the district may face to implement any adaptive interventions due to high population or high population density.

### 3.1.3. Infrastructure Status

Development of infrastructure is important to enhance the climate resilience of a district or State. Therefore, with a higher infrastructure facility and better access to these facilities, the district can have a better adaptability to climate change. In this aspect also there are a number of parameters which aggregate to give an overview of the Infrastructure Indices of the district relative to the other districts of the State.

### 3.1.4. Educational Status

Access to education is a major factor to develop CC adaptability through human capital endowment. Higher the literacy rate of the district, the easier is it to disseminate knowledge of climate change and build awareness amongst the population.

### *3.1.5. Access to Health Infrastructure*

Climate change is always associated with a number of health issues. Therefore access to better health infrastructure helps the population to adapt to health problems arising out of the adverse effects of climate change. Therefore, better the health infrastructure and access to health, higher will be the Adaptive Capacity.

### 3.1.6. Other Determinant(s)

Apart from these parameters, there are a number of the other parameters which also contribute to the development of the adaptive capacity, having either a positive or negative impact on the adaptive capacity. Therefore a few pre-calculated determinant(s) have been used for the calculation of the Adaptive Capacity.

**Table – 10: Indicators identified for the aspects of Adaptive Capacity**

| Determinant | Indicator | Explanation |
|---|---|---|
| Economic Status | Per capita GDP of the district | This aspect demonstrates the economic capability of the district. Higher the determinant, higher is the adaptive capacity. |
| | Percentage of Agricultural workers | This determinant helps us to understand the percentage of the total workforce involved in agricultural activities. Since agriculture is highly prone to CC vulnerability, the higher the percentage of agricultural workforce, lower will be the adaptive capacity. |
| Demographic Status | Area of the District | Larger the area, higher the investments required and hence lower is the adaptive capacity. |
| | Population and Population Density | This determines the density of the population in a district. Higher the value of population density, higher the number of affected people and higher will be the requirement of economic resources to fight any event. Therefore, a higher value of this indicator denotes a lower adaptive capacity. |

| Determinant | Indicator | Explanation |
|---|---|---|
| | Percentage of the urban population in slums | The urban population is disaggregated into urban poor and urban resilient. Higher the populations in the urban slums, lower will their access to the infrastructure and basic amenities. Therefore, this will lower the adaptive capacity. |
| Infrastructure Status | Road density | The road density denotes the access of the population to the roadways. This will improve the ways to commute and therefore contribute to a higher adaptive capacity. |
| | Percentage of population which has access to amenities like Bank and Post Office | The access to the basic amenities like banks and post office would improve the adaptive capability of the population by increasing the access to credit, savings and communications. |
| | Percentage of population who have access to telephones | Telecommunication facilities may be used as an effective system for issuing an early warning, providing updated weather information, agricultural information. Therefore, better telecommunication facility will contribute to a higher adaptive capacity. |
| | Percentage of population living in kutcha houses | Better housing for the poor improves the adaptive capacity. |
| Education Status | Percentage of population served by schools. | Higher the schooling and literacy rate of the districts, easier it will be to create climate change awareness. Therefore, the adaptive |
| | Literacy Rates of males and | |

| Determinant | Indicator | Explanation |
|---|---|---|
| | females. | capacity is directly proportional to the literacy rate. |
| Access to Health Infrastructure | Percentage of population served by Primary Health Centers and Hospitals | Access to health care improves the capability of the population to have better health. This therefore improves the adaptive capacity, since the population is equipped to withstand any outbreak of diseases as an effect of climate change |
| Environmental Determinants | Land, Forest, Water | These indices are taken from the Human Development Report 2007 developed by the Govt. of A.P. The higher the indices, better the adaptive capacity of the district. |
| | Safe Drinking Water, Sanitation and Fuel | |

## 3.2. Approach for estimating the Adaptive Capacity

Each aspect of the determinant has been converted to a normalized index value. Each normalized index value of the aspects has been aggregated to obtain the determinant value and these determinant values have been again aggregated into an overall index of adaptive capacity. The main conceptual challenge in such an exercise is the disparate units for each of the individual indicators that make up each determinant. There are various ways for normalizing values of disparate units. One of the most notable was the normalization procedure applied for the Human Development Index (HDI) reported annually by the United Nations Development Programme (UNDP). The HDI combines different indicators of overall index of development.

The procedure for normalization is as follows:

$$\text{Normalized} = \frac{(\text{Value of District} - \text{Minimum Value of the District})}{(\text{Maximum Value of the District} - \text{Minimum Value of the District})} \quad \text{- (1)}$$

In the context of the Adaptive Capacity, the maximum and minimum values of each of the aspects of the determinant have been determined on the basis of

the districts included in the index. This type of normalization process has been adopted due to its simplicity and relevance, particularly for indices whose purpose is to provide relative information.

In the context of climate change vulnerability assessment, such a normalization procedure was used in India by O'Brien et al. (2004). In the context of our adaptive-capacity index, the normalization procedure used is based on the above citations and presented below as equations.

$$\text{Normalized} = \frac{(\text{Value of District} - \text{Minimum Value of the District})}{(\text{Maximum Value of the District} - \text{Minimum Value of the District})} \quad \text{- (2a)}$$

$$\text{NormalizedValue} = \frac{(\text{ValueofDistrict} - \text{MinimumValueoftheDistrict})}{(\text{MaximumValueoftheDistrict} - \text{MinimumValueoftheDistrict})}$$ (Where in the higher the value better the adaptive capacity)

$$\text{Normalized Value} = 1 - \frac{(\text{Value of District} - \text{Minimum Value of the District})}{(\text{Maximum Value of the District} - \text{Minimum Value of the district})} \quad \text{- (2b)}$$

(Where in the lower the value better the adaptive capacity)

The two preceding equations were used to calculate normalized values for each of the determinant indicators relative across the different districts. Each indicator within a determinant was considered to be of equal importance and hence assigned equal weightage. Based on this equal weighting, a single aggregated value for the determinant was arrived as the average of the normalized indicator values. Also, each determinant was considered to be of equal importance in calculating the overall adaptive capacity index for each district. Based on this assumed weighting, adaptive capacity index for each district was calculated as the average of the aggregated determinant values.

The following formula denotes the estimation of the Adaptive capacity based on the averaging method mentioned above:

$$\textbf{Adaptive Capacity} = \frac{\sum_{i=1}^{n} Iij}{n} \qquad \textbf{----- (3)}$$

Where,

Iij – The indicator for the ith Indices for the jth district

n – Total number of the Indices considered for the Adaptive Capacity calculation.

## 3.3. Results

The capacity of each district to adapt to climate shocks and stresses is a major determinant of the sustainable and climate-resilient development of the State. The higher the adaptive capacity, the better the district is equipped to face the climate change exposures. However, the analysis and determination of the Adaptive Capacity is best undertaken from a relative perspective, wherein the adaptive capacity of a district is compared with the rest and also with the physical exposure of the district to climate variation. It is also important to remember that the indicator values are normalized scores of the actual original indicator aspect value i.e., they are scores which are relative to the value of the indicator in all other districts. These scores are numbers between 0 and 1 with a score of 1 signifying that a district has the highest value for this indicator compared to all other districts, while a score of 0 signifies that a district has the lowest indicator compared to the rest.

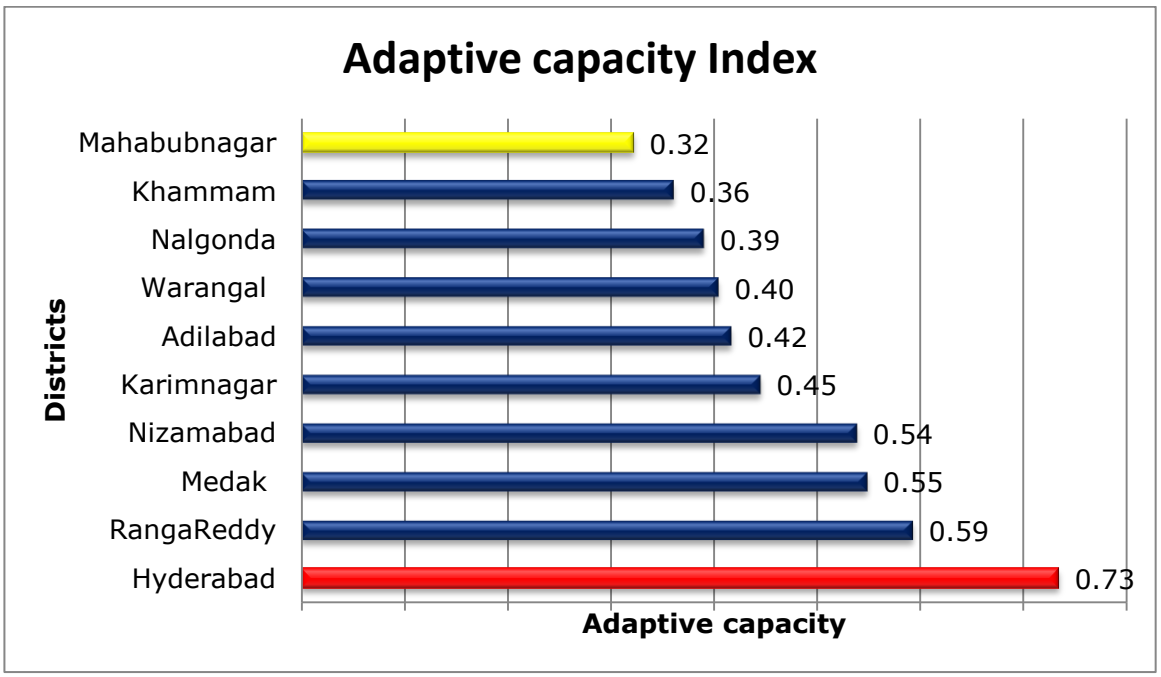
With development of the Adaptive Capacity index of the districts, the risks of the systems have been identified and the same should be considered while designing an adaptation project. For projects using the adaptive-capacity approach, it is possible to develop an adaptive capacity baseline. Since there are few clear, quantitative indicators of adaptive capacity, this baseline can generally be constructed from qualitative indicators. Based on the existing adaptive capacity an adaptation strategy for each district can be developed to improve their coping capability over and above the baseline. Policies should provide individuals, communities and organizations with sufficient flexibility to pursue adaptation strategies appropriate to their circumstances depending on their existing adaptive capacity index. New policies should be assessed in terms of their potential impacts on adaptive capacity, particularly for groups and systems that already exhibit high vulnerability and/or exposure to climate hazards.

## 3.4. District wise adaptive capacity of the State

The adaptive capacity is the measure of the capability of a particular region/State/district to cope with climate change. The ‘Adaptive Capacity’ is however an aggregate of several determinant indices as explained above. The bar chart below indicates that Hyderabad and Rangareddy, have high adaptive capacity; Districts like Mahabubnagar have the least. The ones which have low

adaptive capacity also have large tribal population. The Adaptive Capacity is influenced by a number of parameters and therefore, with hard (i.e. infrastructure) and soft (i.e. social, educational, health related) interventions from the Government, there could be significant change in the adaptive capacity of the district/State.

**Exhibit - 11: Adaptive Capacity Index for Districts of Telangana**




## 3.5. Vulnerability of State to Climate Change

### *3.5.1. Methodology for vulnerability assessment*

Vulnerability varies widely across communities, sectors and regions of the State. Comparisons of vulnerability tend to focus on local indicators, e.g., to groups of less developed regions or communities or to compare progress in human development among regions with similar economic conditions. At State level the vulnerability assessment can contribute to setting development priorities and specifying policy actions.

Sectoral assessments provide detail and targets for strategic development plans. At a local or community level, vulnerable groups can be identified and adaptation measures can be designed and implemented.

Apart from identifying the vulnerabilities of different regions of the State towards exposure to climate change, the sensitivity of different sectors towards climate change was also assessed.

The ordinary use of the word 'vulnerability' refers to the capacity to be wounded, *i.e.,* the degree to which a system is likely to experience harmful effects due to exposure to a hazard. The vulnerability of a socio-economic and environmental system to climate change is conceptualized as a function of a system's exposure to climate change effects and its adaptive capacity to deal with those effects. The more exposed a system is to a particular climate stimulus, the greater the system vulnerability; conversely, the greater the adaptive capacity of the system to a given climate event, the lower its vulnerability.

$V = f(E, A)$ ------ (1)

Where

*V = Vulnerability of system to climate stimulus in a period of time*
*E = Exposure of system to climate stimulus in a period of time*
*A = Adaptive capacity of system to deal with climate stimulus in a period of time*

The emergence of the 'vulnerability' approach coincides with the realization that experiences and lessons learned building resilience to existing climate stresses are important prerequisites for future adaptation. The selection of a framework was also constrained by the availability of data. Primary data collection was not an option, given that the interest lay in analyzing adaptive capacity across all districts of the State and aggregate them to develop the adaptive capacity of the 3 Agro Climatic regions identified. Selection of indicators was therefore constrained by data that already existed in the public domain and official statistical records of the State.

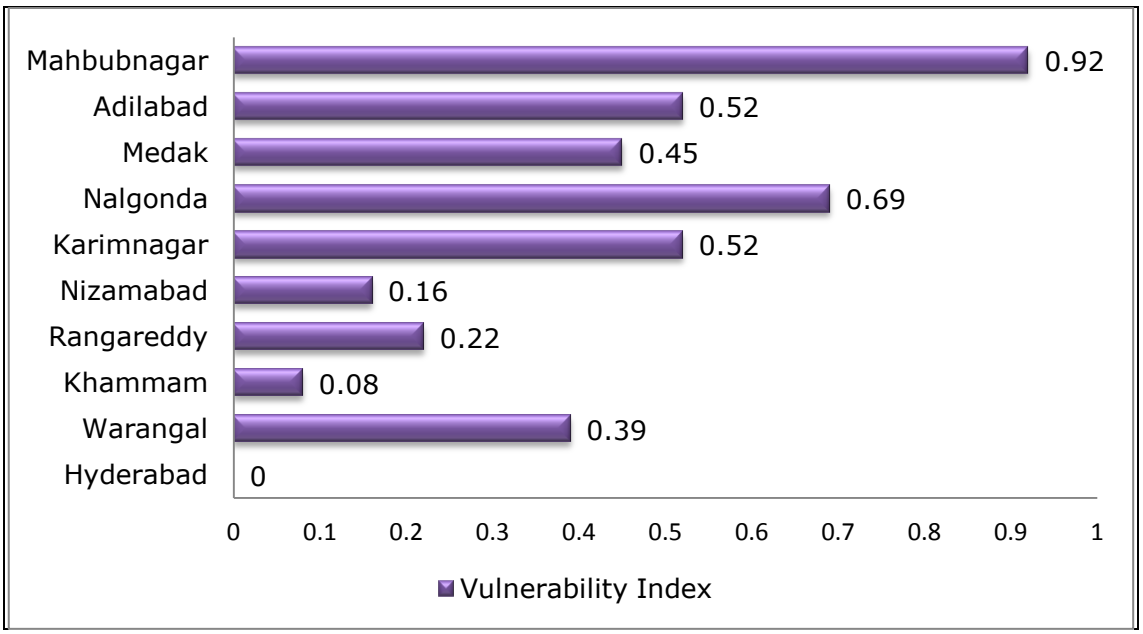
### *3.5.2. Assessment of Physical Exposure*

The physical exposure of the districts for the State of the Telangana is a function of the climate variability, represented by the occurrences of the climatic disorders like drought, floods and heat waves. The physical exposure for the different districts of the State of Telangana was calculated on the basis of the following parameters:

- Normal distribution of Rainfall – The deviation in the rain fall pattern from the normal rainfall distribution calculated for a period of 10 years. The deviation for each of the districts is normalized to develop an index.
- Areas affected by heavy Rainfall – The total area of each district affected by heavy rainfall are obtained for a period of 8 years. It is again converted to a representative normalized index.
- Drought effected Mandals in each Districts – The number of Mandals of each district declared drought affected has been used to analyze the effect of the drought over the entire State of Telangana.

The physical exposure of each district is estimated on the basis of the index developed with the above indicators.

**Exhibit - 12: Districts with high Exposure to Drought**




Some of the districts which have high exposure to droughts are the dry regions like Mahabubnagar and Nalgonda mainly due to their geographic location and the influence of parameters like distribution of rainfall.

# Chapter-4
# PROJECTING CLIMATE CHANGE AND FUTURE SCENARIOS OVER TELANGANA STATE

## 4.0 Introduction

GHGs are now known to cause global warming and lead to climate change. 'Global warming' is the increase of earth's average surface temperature due to buildup of GHGs in the atmosphere, while 'Climate change' is a broader term that refers to a long term changes in climate including average surface temperature, rainfall etc. The IPCC obtained evidence of modern global warming data from surface based recording stations yielding a temperature rise of 0.74°C during the period 1905-2005; it also predicts that warmer planet will alter the tropical monsoon activity and create more frequent extreme weather events. Of the twelve warmest years in India during the period 1901-2009, eight warmest years occurred in last decade only according to the report of the IMD, 2009. The Maplecroft Climate Change Report of year 2010 has indicated that India is the World's most vulnerable country apart from Bangladesh based on the vulnerability index. Indian agricultural production and consequently, the country's GDP show a strong link with monsoon rainfall. Temperature variations play an equally critical role in crop production.

The IPCC places confidence in the ability of AOGCMs to simulate future climate to attribute the observed climate change to the anthropogenic emission of GHGs. The scientific assessments reports (IPCC 1996, 2001 & 2007) have documented the rapid growth in the skills of AOGCMs, whose current versions provide reliable simulation of the features of the present-day climate on continental and global scales. Global atmosphere-ocean coupled models have provided good representations of the planetary scale features but their application to regional studies is often limited by their coarse (~300 km) spatial resolution. For example these models do not represent realistic topographical features (like Western Ghats along the west coast of India and mountains in the Northeast region) and consequently fail to reproduce their predominant influence on the monsoon rainfall patterns. Regional model is helpful by downscaling of AOGCMs output for detecting extreme events due to temperature contrast and variability of monsoon rainfall etc.

The climate of India is locally driven by topography (Eastern and Western Ghats), location and its proximity of the area to the Sea. India is fully exposed

to the hazards of global warming and Telangana is not exempted. An attempt is made in this chapter to study climate change for baseline period and its future scenarios for 2020s, 2050s and 2080s over Telangana as simulated by a PRECIS regional climate model. This model outputs are taken from the IITM, Pune to assess the climate change and their future projections in terms of temperature, rainfall, relative humidity over Telangana State.

## 4.1. PRECIS Model

The PRECIS model is the state-of-the-art regional climate modeling system developed by the U K Met office Hadley Centre; it is composed of atmosphere and land surface model of limited area and with high resolution over any part of globe. It requires prescribed surface and lateral boundary conditions. Surface boundary conditions needs time dependent SSTs and Ice extent, while lateral boundary conditions provide dynamical atmospheric information at latitudinal and longitudinal edges of the model domain. The lateral boundary conditions comprise the standard atmospheric variables of surface pressure, horizontal wind components and measures of atmospheric temperature and humidity. There is no prescribed constraint at the upper boundary of this model.

The model requires five prognostic variables to simulate the distribution of sulphate aerosol. These are incorporated into the sulphur cycle in this model. This atmospheric sulphur cycle and set of additional boundary conditions are included. Next, boundary conditions are updated for every 6 hrs, while surface boundary conditions are updated every day. Thus, dynamics of sulphur cycle and physical parameterization processes play a dominant role in PRECIS model.

This model provides an opportunity to dynamically downscale global model simulations to superimpose the regional model details of specific regional interest (in this case Telangana State). Development of high resolution climate change scenarios help in 1) a realistic simulation of the current climate by taking into account of fine-scale features of topography, 2) detailed prediction of future climate changes taking into account local features and response; 3) representation of detailed regional data to drive other regional-specific models for local-scale impacts. The future climate change simulations are carried out for a set of future GHGs emission scenarios projected by the IPCC. Prominent among the scenarios are based on the projected emissions from the plausible socio-economic scenarios formulated under the IPCC SRES.

## 4.2. Future Climate Projections

A Climate Scenario is the plausible representation of future climate that is constructed for explicit use in investigating the potential impacts. Climate scenarios often make use of climate projections, by the diagnostics of model outputs and evaluating them with the observed climate data. Climate projection is calculated in response of climate system to emissions or concentrations of GHGs and aerosols. The IPCC publishes Reports that summarize the state of the science on Climate Change and Special Reports on specific issues like the Emission Scenarios (SRES). The primary purpose of developing multiple scenario families is to explore the uncertainties behind political trends in global developments and GHG emissions, as well as the key drivers that influence these. The four scenario families below are representative of a broad range of scenarios found.

The **A1** scenario family describes a future world of very rapid economic growth, low population growth and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into four groups that describe alternative directions of technological change in the energy system.

The **A2** scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in high population growth. Economic development is primarily regionally oriented and per capita economic growth and technological changes are more fragmented and slower than in other scenarios.

The **B1** scenario family describes a convergent world with the same low population growth as in A1 scenario family, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability including improved equity, but without additional climate initiatives.

The **B2** scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with moderate population growth, intermediate levels of economic

development, and less rapid and more diverse technological change than in the B1 and A1 scenarios. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

At present, the climate projections are based on regional model using a single socio-economic scenario **A1B** SRES. The A1B scenarios assume significant innovations in energy technologies, which improve energy efficiency and reduce the cost of energy supply. A1B assumes drastic reductions in power generation costs through use of renewable energies. An assessment of impact of climate change is on four key sections of Indian economy, (Agriculture, Water, Natural Ecosystem, Bio-diversity and Health). Presently the climate projections are based on PRECIS regional model using socio-economic scenarios. The main climate change future scenarios are constructed for 2020s (Year 2011 to Year 2030), 2050s (Year 2041 to Year 2070) and 2080s (Year 2071 to Year 2090) in the present study.

## 4.3. Results

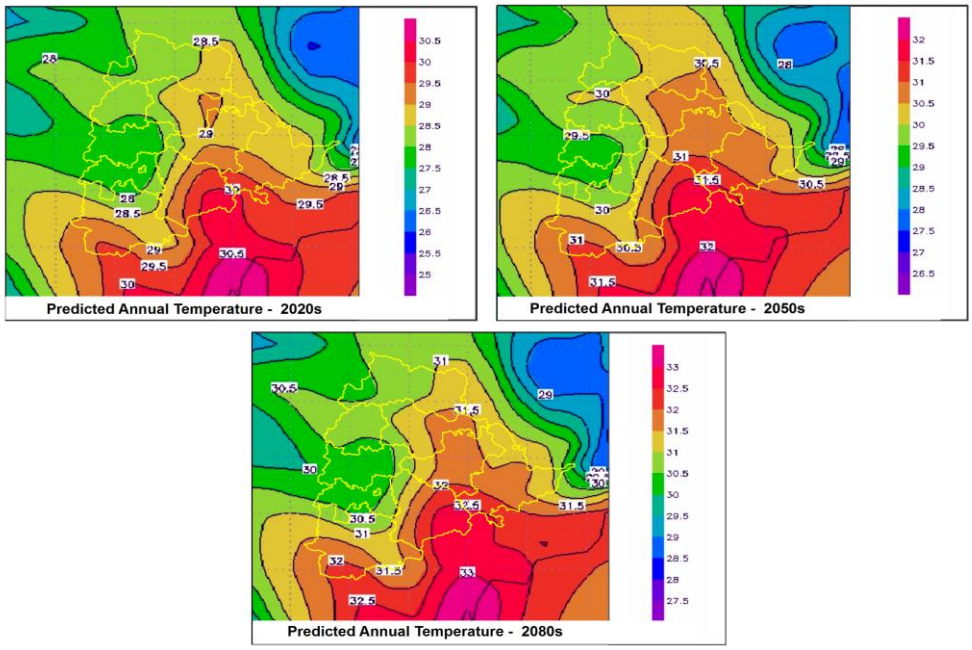
### *4.3.1. Experiment-1: PRECIS A1B SRES scenarios for surface-air-temperatures*

#### *4.3.1.1. Projected mean annual surface-air-temperature variability over Telangana State*

The mean annual surface-air-temperature projections are evaluated by considering mean monthly temperature from January to December. The warming in the annual mean temperature is generally maintained by the post-monsoon and winter seasons. The mean annual surface-air-temperatures are simulated by the PRECIS model is shown in Exhibit 13.

Over Telangana, the temperature range is 27.5° to 30.0$^0$C for the projected period, 2020s. In 2050s, surface-air-temperature is projected to 29.0° to 31.5$^0$C over the same region. It is interesting to note that Nalgonda district is the hub of heat source in 2050s and it is further strengthened (31.5° to 32.5$^0$C) in 2080s.

**Exhibit -13: Annual Temperature (in $^{0}$C) Projections (2020s, 2050s and 2080s) over districts of Telangana State**

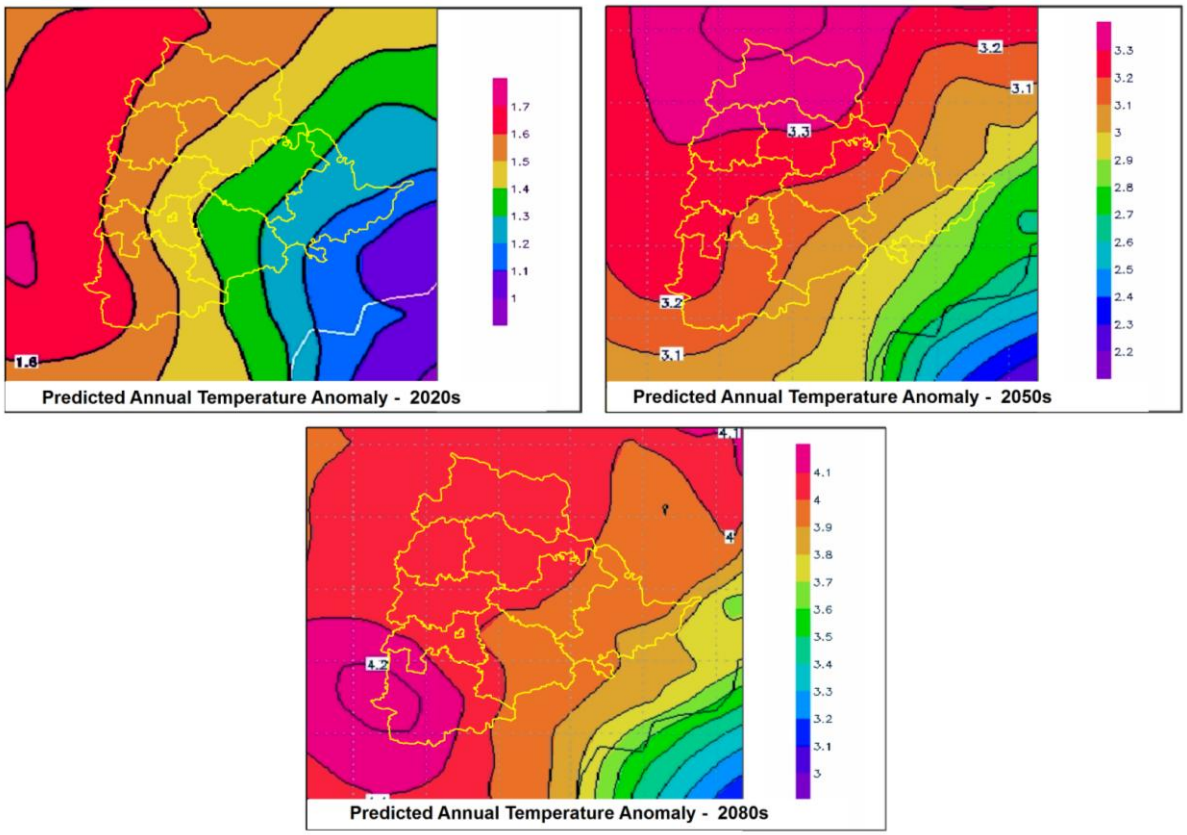



### *4.3.1.2. Anomaly Projected annual temperature over Telangana State*

Anomaly projected annual temperature over Telangana State are simulated by the PRECIS model is shown in Exhibit 14.

Over Telangana State, the projected anomaly of annual temperature is ranging between 1.1° to 1.7°C.Adilabad, Nizamabad and Karimnagar districts are marked as maximum heat sources for 2020s. From 2050s predictions, the anomaly of temperature varied in between 2.9° to 3.3°C with high intensity of temperature over Adilabad, Nizamabad and Karimnagar districts. The annual variation of temperature is in the range of 3.9° to 4.2°C. The highest amount of temperature variation is observed in Mahbubnagar district (>4.1°C rise).

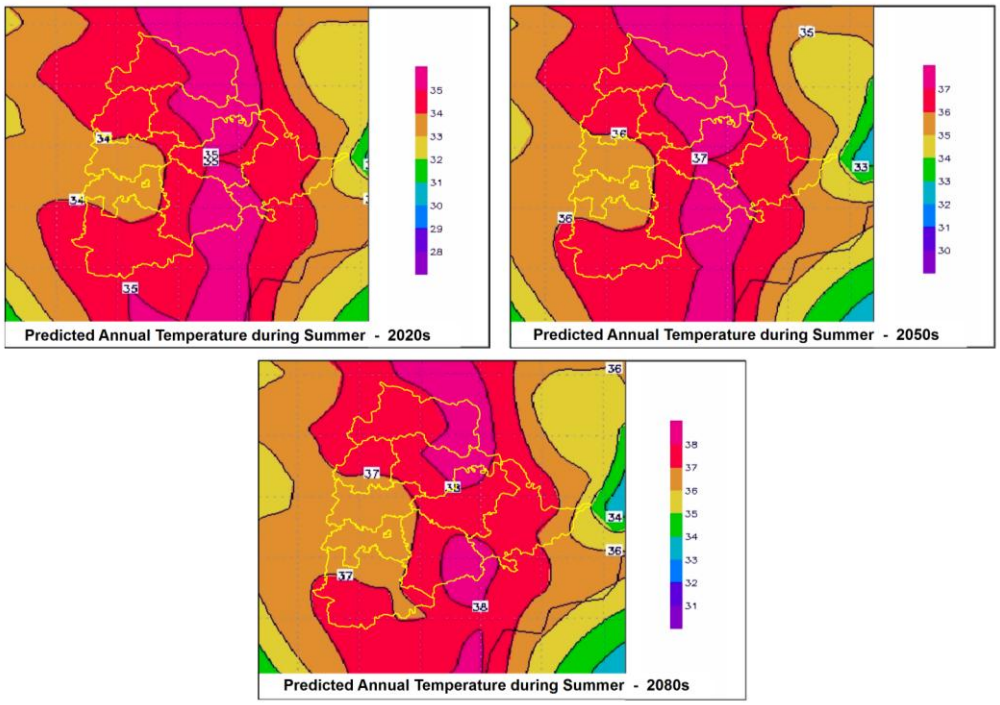
**Exhibit – 14: Anomaly of annual Temperature (in $^0$C) Projections (2020s, 2050s and 2080s) over districts of Telangana State**




### *4.3.1.3. Projected spatial distribution of summer surface-air-temperature over Telangana State*

During summer season (March, April and May), In Telangana State, the temperature projection ranges from 33° to 35$^0$C with maximum concentration over four districts (Adilabad, Karimnagar, Warangal and Nalgonda) for 2020s. The same scenario is further continued for 2050s and 2080s with an increment of temperature upto 3$^0$C. The scenarios are shown in Exhibit 15.

**Exhibit – 15: Summer Period Temperature ( in $^0$C ) Projections (2020s, 2050s and 2080s) over districts of Telangana State**

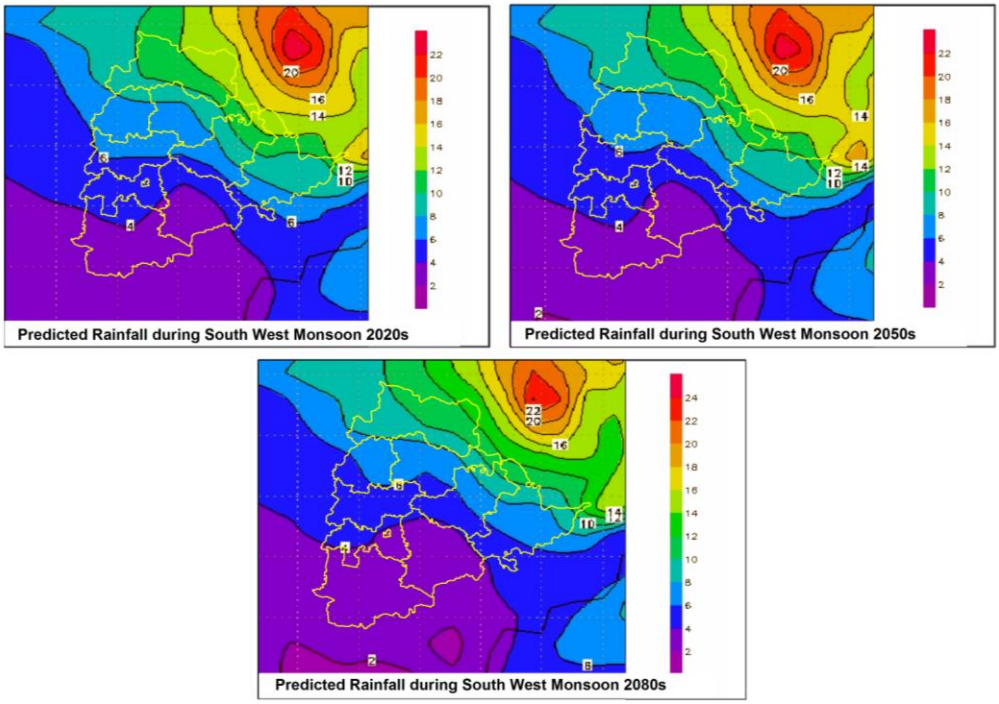



### *4.3.2. Experiment -2: PRECIS A1B SRES scenarios for monsoon rainfall*

#### *4.3.2.1. Projected spatial distribution of Southwest monsoon rainfall*

During southwest monsoon season, the difference of the projected and baseline period (1970s) (which is termed 'anomaly') of rainfall is evaluated. Southwest monsoon rainfall (June to September) for the meteorological region has been analyzed for the projected periods of 2020s, 2050s and 2080s (Exhibit- 16).In Telangana State, southwest monsoon rainfall varies from 2 mm/day (parts of Mahabubnagar district) to 14 mm/day (parts of Karimnagar and Adilabad districts) for 2020s, 2050s and 2080s without much change. However there is an increase in coverage area of 2 mm/day intensity over Mahabubnagar district only. Thus, the projected rainfall indicates possible drought situation over Mahabubnagar district for 2080s.

**Exhibit – 16: Rainfall (mm/day) during South-west monsoon period Projections (2020s, 2050s and 2080s) over districts of Telangana**




### *4.3.2.2. Projected anomaly of Southwest Monsoon rainfall*

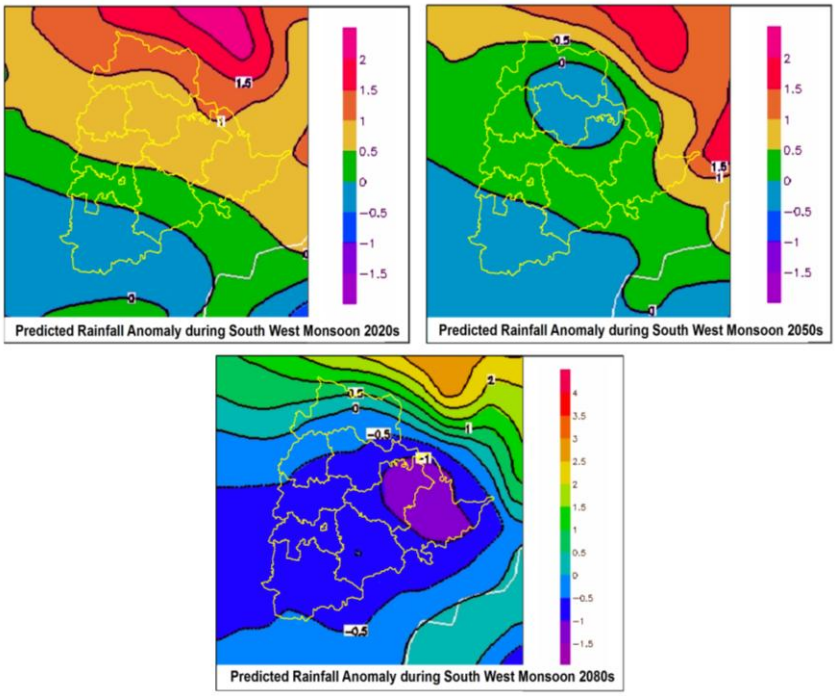
During southwest monsoon season, the difference of the projected and baseline period (1970s) (which is termed 'anomaly') of rainfall is evaluated and presented in Exhibit – 17.

In Telangana State, there is a maximum increase of rainfall (+1.5mm/day) over Adilabad district, while there is an increase in rainfall over Nizamabad, Karimnagar and Warangal districts for 2020s. There is increase of southwest rainfall (+0.5 mm/day) over Adilabad and Karimnagar district for 2050s, while there is decrease in rainfall (-0.5 mm/day) over the same region for 2080s. The worst hit district is Nalgonda in the State (– 1.0 mm/day) during 2080s.

### *4.3.2.3. Projected spatial distribution of Northeast monsoon rainfall over Telangana*

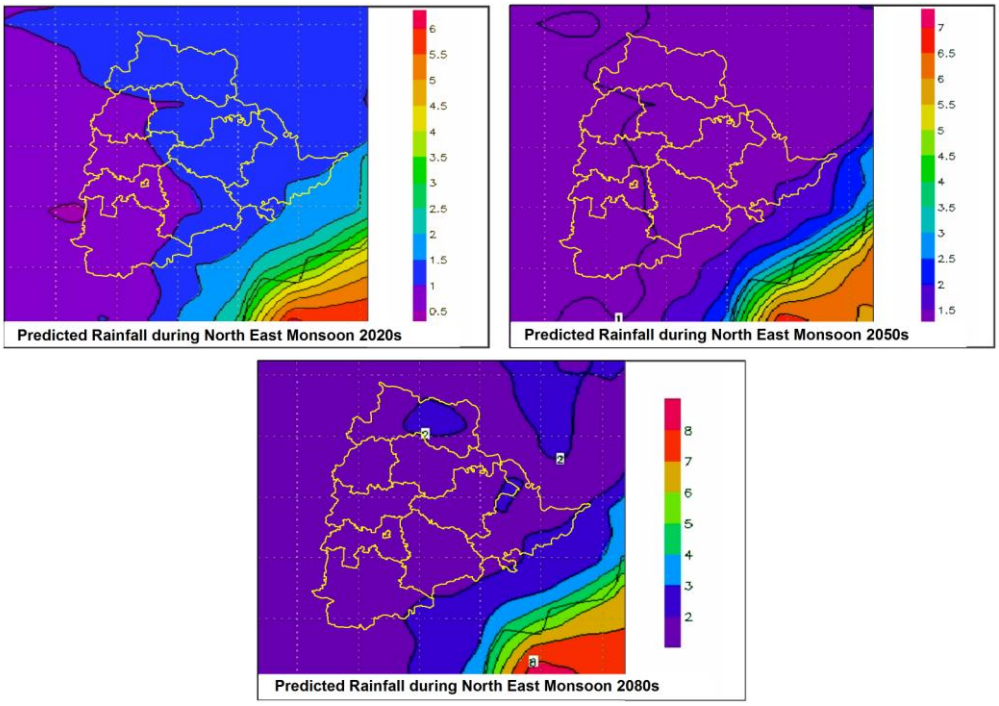
The projected Northeast monsoon rainfall (October through December) over Telangana for projected periods 2020s, 2050s and 2080s from PRECIS model output is shown in Exhibit –17.

**Exhibit – 17: Anomaly of Rainfall (mm/day) during South-west monsoon period Projections (2020s, 2050s and 2080s) over districts of Telangana State**




Over Telangana State, there is slight increase of rainfall by 1.0-2.0 mm/day for the projected periods 2020s, 2050s and 2080s

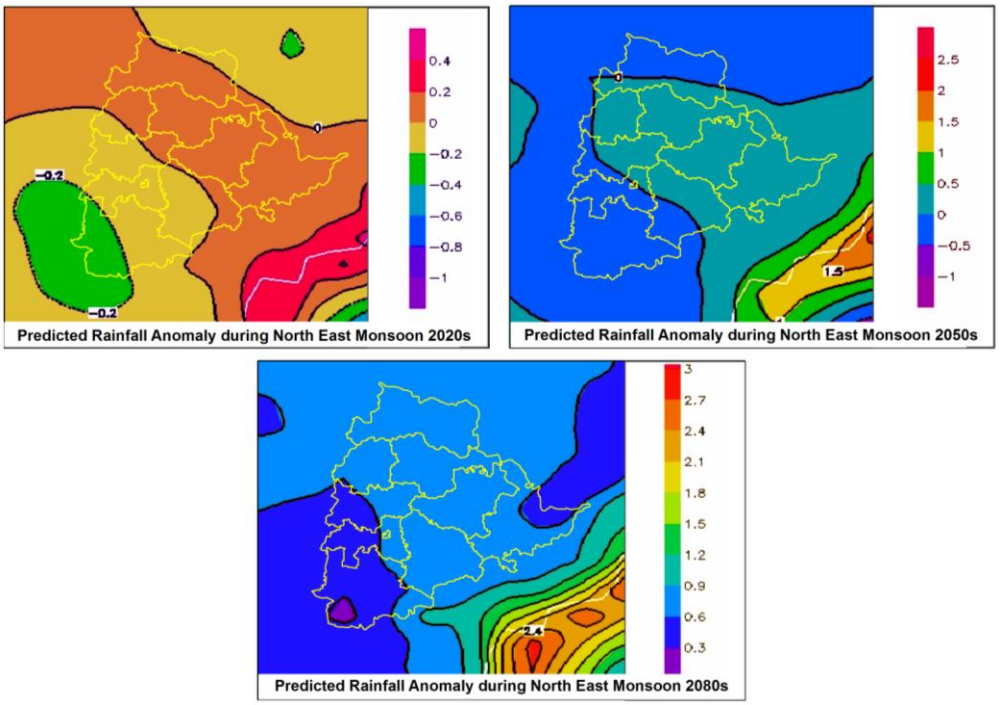
**Exhibit – 18: Rainfall (mm/day) during North-East monsoon period Projections (2020s, 2050s and 2080s) over districts of Telangana State**




### *4.3.2.4. Projected anomaly of Northeast rainfall*

There is an abnormal rise of rainfall for 2080s i.e. by four times when compared with the projections of 2020s in Telangana State (Exhibit –19). There is an increase of rainfall by 0.2 mm/day (northern part) over Telangana State, while a slight decrease (-0.2 mm/day) is observed over southwestern parts of Telangana (Mahabubnagar district) for 2020s, when compared with baseline period. A moderate enhancement of rainfall is observed in 2050s and 2080s in this State.

**Exhibit – 19: Anomaly of Rainfall (mm/day) during North-east monsoon period Projections (2020s, 2050s and 2080s) over districts of Telangana State**




### *4.3.3. Experiment -3: Baseline experiment for 1970s (1961-1990)*

The baseline period is constructed for 30-years from 1961 to 1990. This baseline period of rainfall and temperature is validated with the available datasets. The temperature projection data for annual and summer season are constructed for validation. The study is extended for southwest and northeast monsoon rainfall using PRECIS precipitation data. The annual surface-air-temperature using PRECIS model is in the range of 31°-34°C for baseline period.

The projected temperatures over Telangana State are in the range of 31°-34°C. But JRA-25 reanalysis model shows that the annual variation of temperature is relatively less when compared with the PRECIS model. The PRECIS model overestimates slightly. In summer season, the PRECIS model output has shown that Telangana State received temperature in the range, 29°-34°C, while JRA-25 represents 28°-32°C. Thus, the model overestimates the summer season surface-air-temperatures.

During southwest monsoon season the PRECIS model projected rainfall is in the range between 2-18 mm/day, whereas satellite derived product, CMAP derived rainfall is in the range of 2 -19 mm/day and thus there is a difference

of 1 mm/day. The PRECIS model shows 2-10 mm/day over Telangana State, while the CMAP derived rainfall shows 2-7 mm/day. The difference between them is 3 mm/day. Thus, PRECIS model overestimates rainfall, when compared with the satellite derived CMAP data.

Telangana received 1.5 mm/day during northeast monsoon season, while the CMAP data has shown 1.0-2.0 mm/day. Thus the model overestimated the rainfall slightly. Thus baseline experiments have clearly demonstrated that the PRECIS is satisfactorily projecting temperatures and rainfall for the projected periods over Telangana State.

## 4.4. Summary and Conclusions

For understanding the future climate change in the 21$^{st}$ century, PRECIS model simulations corresponding to different IPCC SRES emission scenarios are analyzed. A comparison of observed (baseline period) and model simulated features in annual mean surface-air-temperatures and monsoon rainfall over Telangana provides an evidence of model skills. Majority of the PRECIS model outputs projected for south west monsoon anomaly shows an increase in rainfall over Adilabad district whereas there is a decrease in rainfall in other districts during the same period. North east rainfall shows a modest increase in the rainfall in North part of Telangana whereas slight decrease in the South western part of Telangana in future compare to the present day climate while the temperature changes appeared more coherent across the model outputs around 4° for different emission scenarios. Considering the climate changes that could possibly occur, suitable adaptation plans need to be designed.

# Chapter-5

# STAKEHOLDER IDENTIFICATION AND CONSULTATION WORKSHOP

## 5.0 Identification of main stakeholders

Analyzing and understanding the capacity of various stakeholders to cope with and adapt to climatic events is fundamental in characterizing current and possible future vulnerability. Understanding the role of stakeholders in the decision-making process can assist in the implementation of adaptation policies. A participatory approach has been adopted for preparation of the SAPCC comprising a range of stakeholders as well as individual consultations. Over 29 stakeholders representing a cross section of Government and quasi Government organizations, administrators, NGOs, professionals, and academia covering a wide range of sectors were engaged in the process. Stakeholder capacity building workshop was organized at Hyderabad. Stakeholder representatives also discussed and communicated their views and opinions on sectoral climate change issues.

Participatory initiatives are more likely to be sustainable because they build on local capacity and knowledge, and because the participants have "ownership" of any decisions made and are thus more likely to comply with them. Participatory initiatives are thus more likely to be compatible with long-term development plans. This can help decision-makers gain greater insight into the communities they serve, enabling them to work more effectively and produce better results. In turn, the communities can learn how the decision-making process works and how they can influence it effectively.

The process of working and achieving things together can strengthen communities and build adaptive capacity through developing awareness of the issues within the community, as well as finding ways to address them. It can reinforce local organizations, and build up confidence, skills and the capacity to cooperate. In this way it increases people's potential for reducing their vulnerability. This, in turn, empowers people and enables them to tackle other challenges, individually and collectively. The SAPCC has been designed with stakeholder participation, through priority-setting and voicing preferences, and in accordance with people's right to participate in decisions that affect their lives. Processes of engagement can improve the likelihood of equity in decision-making and provide solutions for conflict situations.

## 5.1. Stakeholders' Workshop

In line with the NAPCC, guidance on development of SAPCC, EPTRI conducted workshops for stakeholder consultation at Hyderabad on 23rd December, 2010 to identify the key climate change related issues faced by various strata of society. Participants ranging from academicians, researchers, Government officials, private sector employees, NGO professionals, social activists, students, and local citizens were invited, for proper representation of stakeholders.

Public sector/Government Department officials working at State/district levels from various government bodies like municipalities, Groundwater Department, Forestry Department, Industries Department, Animal Husbandry Department, Mines & Geology Department, Panchayat Raj, Transport Department, Sericulture Department, Health Department, Pollution Control Board, Public Health Engineering Department etc were among the participants of the stakeholder consultation. Officials invited for the stakeholder consultation ranged from higher level executives like Directors, District level Heads of Department etc involved in planning and execution of various social and infrastructural schemes, to mid level professionals like municipal engineers, site engineers and electricity department engineers etc. who are actively involved in day to day execution of various schemes run by the Government. Presence of the mix of officials from Government Departments ensured better coverage of challenges faced by government from planning and strategy development phase to execution phase.

Besides the above mentioned stakeholders, social activists and representatives of NGOs involved in various micro level social upliftment and climate change related activities like biodiversity conservation, literacy, environmental activism, human rights activism, leprosy eradication, rural development, women development etc. also participated. Feedbacks received from them were generally focused on socio economic disparity and unregulated pollution discharge from industries. Academicians participating included lecturers, professors from local State run and private colleges, research scholars and students from various technical Institutes and Universities. They emphasized promotion of research and capacity building for developing the adaptive capacity of the affected population. Retired government officials, local residents, villagers were also part of the stakeholder consultations. Their primary concerns were the provision of services like drainage and waste handling infrastructure, efficient transportation etc.

## 5.2. Proceedings of the Workshops

The workshops highlighted the 8 National Missions under NAPCC and the objectives of the SAPCC. The flow of events at the workshop is presented below:

- An indicative matrix (degree of impact vs. probability) of climate sensitive sectors was presented to the stakeholders.
- Climate risks and opportunities identified for key sectors were presented to stakeholders.
- Feedback from stakeholders was taken through questionnaire and group discussions.

## 5.3. Feedback from the Stakeholders

The feedback included:

- Increase in awareness level about climate change and impact.
- Climate change experiences of local population.
- Local risks envisaged in the future for various sectors.
- Expectations of stakeholders of local bodies, State Government and SAPCC in mitigating and adapting to climate change.

**Key concerns /Suggestions from the Stakeholders**

- Better Municipal waste management and drainage system
- Control Vector borne diseases
- Development of efficient public transport system
- Promotion of usage of public transport and subsidies to electric vehicles, removal of old vehicles
- Green tax is to be collected and utilized for raising trees
- Promoting the concept of 3Rs: Reduce, Recycle and Reuse
- Enhanced use of micro irrigation, drip Sprinkler system etc.,
- Better regulatory frame work for Industrial waste disposal and treatment.
- Development of efficient public transport system
- Reduced use of plastic
- Restrict cars/sales of vehicles and promotion of cleaner fuels for vehicles

**Common concerns/suggestion include**

- Promotion of renewable energy, alternate fuels, water management practices (ground water recharging or rain water harvesting) and sustainable agriculture practices (like organic farming).
- Awareness enhancement and capacity building programs on CC at community level.
- Forest conservation and afforestation activities
- Restrict polluted industries to particular zones and implement more stringent pollution norms.

## 5.4. Process of Preparation of SAPCC for Telangana

Towards bifurcation of the SAPCC report, EPTRI has organized workshop for all concerned line departments of the Government of Telangana, the research community, and the non governmental organizations participated in the workshop. Additionally, agencies like GIZ, NABARD were invited, who shared with the audience experiences and lessons learnt from the various climate change projects being undertaken by them.

Presentations were also made by the Professor Jayashankar Agricultural University (PJTSAU), Horticulture department, Animal Husbandry, Telangana State Science and Technology (TSCOST) and Ground water department highlighting the concerns of climate change in their respective areas.

Next a working group meeting was held to deliberate upon the sectors that need to be considered vis a vis their vulnerability to climate change. It was agreed by the members that the sectors thrust areas of State Action Plan should match as closely as National Action Plan. After thorough discussion, following sectors areas were identified for State Action Plan.

Stakeholder's workshops were organized as given Table 11:

**Table – 11: Stakeholder Consultation Schedule**

| Date | No. of Participants | Profile of participants |
|---|---|---|
| 23rd December, 2010 | 29 | Academicians, Government and public sector officials, private sector executives, NGOs |
| 3rd July, 2015 | 47 | |
| 24th July, 2015 | 29 | |
| 30th September, 2015 | 25 | |
| 27th October, 2015 | 52 | |

## 5.5. Prioritization of the Sectors

Based on the feedbacks received from various stakeholders on various sectors influenced by climate change and anthropogenic activities the major areas of prioritization and concern are summarized below:

### 5.5.1. Agriculture and livestock

- Promotion of organic farming reducing dependence on chemical fertilizers and pesticides.
- Development of temperature resistant, flood and drought resistant varieties of crops and temperature resistant breeds of livestock.
- Implementing micro irrigation schemes, constructing more check dams etc.
- Awareness and training dissemination of sustainable practices in agriculture.
- Insurance for crop failure.
- Reduction in plastic usage.
- Research and training centers for producing natural fertilizers and pesticides.
- Promoting farm mechanization.
- Financial support through micro financing.
- Protection against seasonal diseases in crops and animals.
- Review of subsidies to pesticides and fertilizers and subsidies to organic agriculture.
- Establishing village level agro meteorology centers.
- Better solid waste management practices like recycling and reuse.
- Promotion of watershed development programmes.
- Promotion of less water intensive crops and crop varieties.

### 5.5.2. Health

- Impart awareness about preventive measures.
- Better bio medical waste handling.
- Encouragement to traditional medical systems like yoga and ayurveda.
- Better health services in rural areas and urban slum areas.
- Alert system against viral infections and water pollution.
- Promotion of family planning.
- Awareness of hygiene, healthy practices, sanitation and spread of communicable diseases.
- Training programs through local bodies like panchayats.

- Prevention against seasonal disease spread by mosquitoes.
- Increasing number of hospitals and improving facilities in existing hospitals.
- Improving sanitation conditions to curb spread of water borne disease like cholera, typhoid etc.
- Allocating a dedicated fund for training and awareness programs.
- Curbing pollution due to industries and vehicular emissions.

### *5.5.3.* Energy

- Promotion of renewable energy like solar, biomass, hydro and wind
- Improving power availability in rural areas
- Generation of power using waste
- Promoting usage of energy efficient equipments
- Air pollution produced by the thermal power plants and other energy producing plants should be closely monitored and strict implementation of regulatory emission standards
- Micro level penetration of non conventional energy resources
- Subsidy on solar power systems and LED lighting systems
- Development of non conventional sources like geothermal and tidal energy
- Promotion of nuclear energy for power generation instead of coal based technologies
- Promoting biomass based energy generation in villages
- Making energy audits in industry a norm

### 5.5.4. Irrigation and water supply

- Water conservation and proper drainage facilities.
- Promoting rain water harvesting and ground water recharge.
- Promotion of organic farming, reducing water pollution problems.
- Encouraging micro irrigation systems.
- Check on industrial discharge into municipal drainage system.
- Training and awareness programs.
- Measures to prevent ground water pollution and contamination.
- Promoting better irrigation techniques like drip irrigation and sprinklers etc.
- Regular de-silting of canals and other water retaining bodies like dams, check dams etc.

### 5.5.5. Industry

- Stringent pollution control measures.
- Proper management of manufacturing waste.
- Ban on ozone depleting chemical usage in industries.
- Energy and material optimization technique implementation.
- Proper zoning / setting of industries.
- Promoting alternatives to plastic.
- Promoting the zero discharge and environmentally balanced industrial complexes (EBIC).
- Implementing energy efficient technologies.
- Promoting small and medium scale industries.
- Promotion of non conventional energy usage.
- Implementing reduce-recycle-reuse based manufacturing units.
- Introducing energy/carbon tax.

### 5.5.6. Transport

- Promoting public transport and its usage.
- Promoting electric vehicles by giving subsidies.
- Providing dedicated cycle lanes.
- Switching public transport to lower carbon fuels like CNG, LPG and electricity.
- Promotion of bio diesel blending.
- Phase out old vehicles from road.
- Discouraging inefficient vehicles by imposing carbon tax.

### 5.5.7. Forestry

- Increasing forest area.
- Promoting roadside plantation of trees.
- Promoting recycling of paper.
- Curbing wood smuggling from forests.
- Promoting afforestation in urban areas
- Enhancing public participation in afforestation activities
- Curb the loss of forests to industry, mining etc.

# Chapter-6
# SECTORAL ISSUES AND INTERVENTIONS

Ten key sectors on the basis of their relevance to climate change have been identified under SAPCC in Telangana. The importance of issues in the respective area is listed, which forms the base for framing the adaptive strategies. Though mitigation is not the primary objective of the SAPCC, certain mitigation actions inevitably find place in SAPCC.

## 6.0 Agriculture and Allied Sectors[17]

### 6.1. Background

Agricultural sector plays a predominant position in the State economy. Out of the total geographical area of the State, 44.89 percent is net sown area. The State has 55.49% of the working population dependent on some form of farm activity for livelihoods. The agriculture sector contributes about 9.3 percent of State GSDP with almost 63% of area of agriculture is under rain fed agriculture. Rice is a staple food and major food crop which is water intensive. In view of this, agriculture sector is particularly vulnerable to the vagaries of climate change.

Various soil types abound including chalkas, red sandy soils, dubbas, deep red loamy, and very deep black cotton soils that facilitating planting mangoes, oranges and flowers. Red soils are predominant, accounting for 48 percent of the total area. Other Soil types in the state are black cotton soils, alluvial, rocks and boulders accounting for 25 percent, 20 percent and 7 percent of the area respectively. The soils in Nizambad, Warangal and Nalgonda are deficient in Nitrogen (less than 44%). Phosphorus deficiency (less than 55%) is prevalent in the districts of Adilabad, Medak, Mahabubnagar and Nizambad.

### 6.1.1. Crops

Rice, Maize, Jowar, Redgram and Green gram are the major traditional crops grown in Telangana. Cropping intensity is one of the indices for assessing the efficiency of the agriculture sector. The cropping intensity i.e. the ratio of gross area sown to net area sown is increased from 1.22 in 2012-13 to 1.27 in 2013-2014. The cropping intensity is high in Nizambad district (1.67) and

[17]Socio –economic outlook of Telangana, 2015 and Statistical year 2015, Directorate of economics & Statistics.

lowest in Adilabad district (1.09). The level of cropping intensity moves in consonance with the behavior of the monsoon and availability of irrigation water.

### 6.1.2. Livestock

The State has rich livestock resources especially cattle and sheep population which is accounting to 5.52% of country's population. Two thirds of the rural population is directly engaged in the agriculture sector with 29 lakh families' dependent on livestock sector for their livelihood.

Telangana stands 6$^{th}$ in the country in meat production with an annual meat production of 4.29 lakh MTs. It occupies 13$^{th}$ position in the country in milk production (2012-13 approved estimates of GOI) with an annual production of 39.51 lakh MTs of milk.

The poultry industry is one of the fastest growing industries in the State. Poultry meat and egg production is closely related to urbanization; the poultry sector is expanding far more rapidly in urban and semi-urban areas than in the hinterlands. With an annual output of 94.2 million eggs, the State stands 3$^{rd}$ in egg production in the country. Every eighth egg in the country comes from Telangana. From the regional perspective, the districts belonging to Telangana dominate in poultry meat production. Climate change affects livestock both directly and indirectly. Direct effects from air, temperature, humidity, wind speed and other climate factors influence animal performance like growth, milk production, wool production and reproduction.

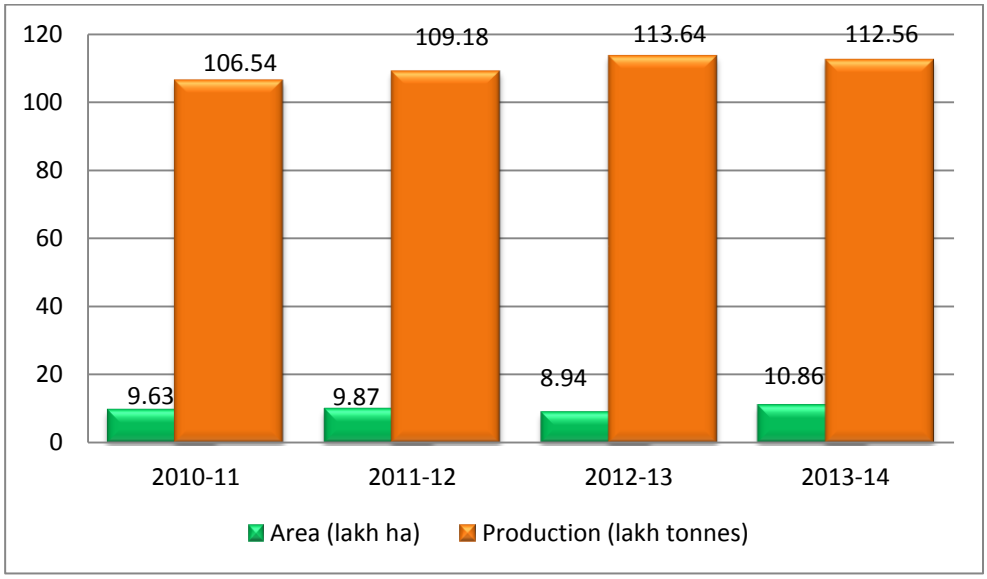
The impact of climate change on animal production is mainly due to feed grain, pasture and forage crop production and quality, health, growth and reproduction and disease and their spread.

### 6.1.3. Horticulture

Horticulture is identified as one of the growth engines in the farm sector. It has been identified as one of the "focus areas" for development of the state. Telangana State ranks 3$^{rd}$ under cultivation of fruits and ranks 1$^{st}$ in cultivation of turmeric in the country. Horticulture is a significant contributor to the Telangana State GSDP. The total area under horticulture crops covers 10.86 lakh hectares with a total production of 112.56 lakh MTs. Major fruit crops in the state are Mango, Citrus, Banana, Guava and Papaya while vegetables like Tomato, Brinjal, Okra and various varieties of Gourds are

predominant. Chillies, Turmeric and Coriander are important spices. Coconut, Cashew and Oil palm constitute major plantation crops. Exhibit- 20 depicts the increasing area and productivity of horticulture in last four years.

**Exhibit - 20: Horticulture area and production**



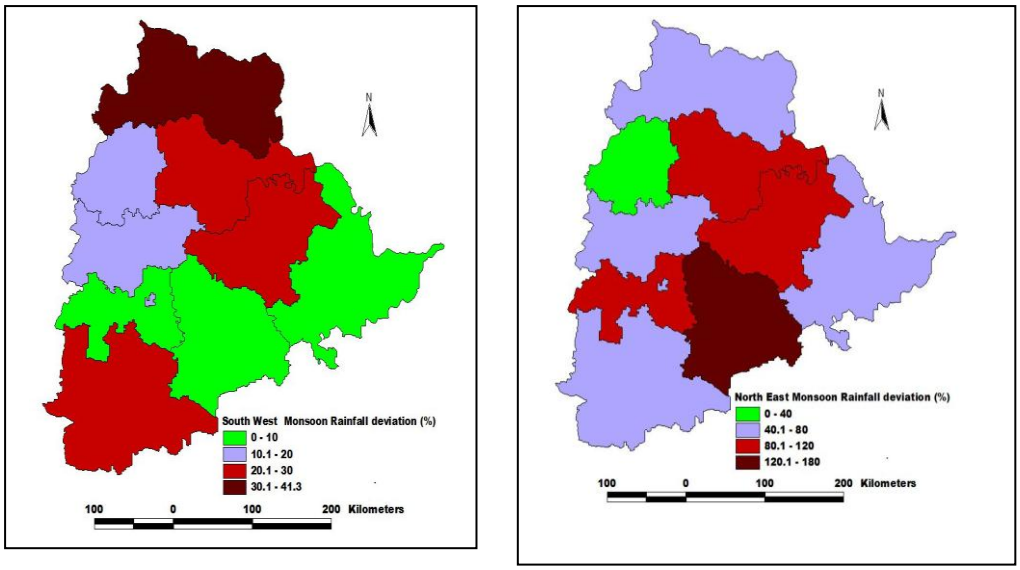

### 6.1.4. Agriculture Inputs likely to be affected by Climate Change

Agriculture in rainfed areas is likely to be affected by climate change. The major agriculture inputs that are directly affected by climate change and can affect agricultural production and productivity are:

#### 6.1.4.1. Rainfall

The rainfall in the State is erratic, uncertain and distribution of the rain fall is uneven in various mandals, thus making agriculture a proverbial gamble in monsoon. Of the rainfall received during the period from 2004-05 to 2013-14, the annual actual rainfall was lowest in 2004-05 with 614 mm, where as it was the highest in 2013-14 with 1212 mm against normal rainfall of 906 mm in the state. Further, agriculture will be adversely affected not only by an increase or decrease in the overall amount of rainfall, but also by shifts in the timing of the rainfall. There are fluctuations in area and production of food grains in the past decade due to adverse seasonal conditions like drought, floods and heavy rains. It can be observed that in years of low rainfall i.e. during 2008-10, there is substantial decrease of 23.61% of food grain production. Exhibit 21 shows that in the recent year 2013-2014 there was a significant deviation in the SW and NE monsoon.

**Exhibit - 21: Percentage Deviation of SW and NE monsoon in Telangana State (2013-2014)**

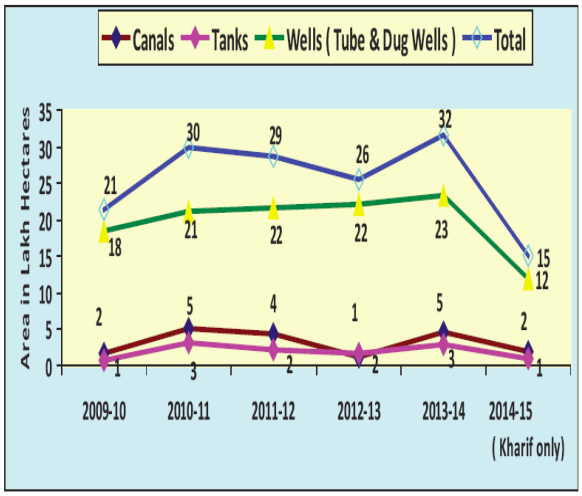



### 6.1.4.2. Temperature

The climate of Telangana is generally hot and dry. Summer starts in March, and peak in May with average high temperatures in the $42^0$C ($108^0$F) range. The monsoons enter in the state in June and lasts until September with about 715 mm of precipitation. A dry, mild winter starts in late November and lasts until early February with little humidity and average temperatures in the 22–23 °C (72–73 °F) range. This area is also prone to hailstorms in the month of April and May which are affecting horticulture crops especially mango crops. Temperature plays a significant role in the growth and productivity of agriculture. Higher maximum daytime temperature accelerates crop maturity, resulting in reduced grain filling, while higher minimum night time temperature increases respiration losses. Temperature fluctuations and high night temperature can severely affect the Rabi crops. Heat waves result in permanent and irrecoverable dehydration of plants. Damaging effect appears to be caused by rapid dissipation of reserve carbohydrates that slow down new leaf production and poor recovery from defoliation.

### 6.1.4.3. Irrigation

**Exhibit - 22: Irrigation Sources in Telangana**




Irrigation is one of the major inputs in agriculture. The major source of irrigation in the State is tube wells followed by canals. 84% of irrigated area in Telangana is by bore wells and dug wells. During 2013-14, rice was cultivated in about 20.0 lakh ha. It is planned to restrict rice to 16.50 lakh ha. by 2018-19. Water thus saved for 3.5 lakh ha will irrigate about 10.00 lakh ha of Irrigated Dry crops such as Maize, Jowar, Bajra, Pulses and Soybean[18].

The gross area irrigated in the State during the year 2013-14 is 31.64 lakh hectares which has increased by 23.74% from the previous years. The irrigation intensity i.e. the ratio of Gross Irrigated Area to Net Irrigated Area is 1.36 for year 2013-14. The role of irrigation becomes much more important due to the drought vulnerability of the State.[19]

### *6.1.4.4. Power availability for agricultural purposes*

Farm power intensity in the State is yet to achieve the envisaged level due to relatively slow adoption of tractors and other mechanical devices. The per capita consumption of electricity for Agriculture is 245 KWHs. In the FY 2013-14, the consumption of the agricultural category consumers increased from its previous year's levels of 6229.27MU to 6694.29MU which is 7.46% growth over the FY 2012-13 due to release of new agricultural service connections and increase in specific consumption per service. Dependency and vulnerability of the sector on natural climatic events has caused crop failures and distress among the farmers. Farm mechanization can reduce the cost of cultivation and drudgery.

[18] Department of Agriculture, Telangana, Fourteenth meeting on NFSM held on 18.11.2014.
[19] Socio –Economic outlook, 2015 Telangana

### *6.1.5 Key sectoral issues and concerns*

- Temperature fluctuations affect Rabi crops severely.
- Heat waves result in dehydration of plants.
- There is decrease in area under crops on account of insufficient rainfall, particularly in the South- West Monsoon period.
- Rain fed agriculture has become risky due to unpredictable rains.
- Due to loss in vegetation, heavy run-off takes place resulting in wastage of water and soil erosion.
- Dryland areas (parts of Mahabubnagar and Nalgonda) exist in the State where annual rainfall is less than 500 mm in Mahabubnagar whereas in Nalgonda annual rainfall is 560 mm and rain fed farming is not viable.
- Loss in fertility of soil in many areas due to excessive use of fertilizers and pesticides.
- Hail storms are affecting horticulture crops.

### *6.1.6* **Interventions and Strategies**

Being a State with 55.49% population still dependent on agriculture, various initiatives at village, regional and State level are required to adapt to the impacts of climate change on agriculture. Some important interventions and strategies to address climate change are given in the box below.

- Development and dissemination of new crop varieties resilient to heat, photo and water stress
- Replacement of inorganic fertilizers by bio-fertilizers
- Reducing the use of synthetic pesticides and weedicides and promoting the use of bio-pesticides
- Assured credit facility, including for tenant farmers
- Insurance against crop failures (not just for the bank loan component)
- Increase the efficiency of water use
- Extension work for change of cropping timings and patterns, efficiency of water use, weather advisories to farmers, information on market prices etc.
- Intensive research work on stable agriculture in the context of climate change, in all its aspects
- Establishment of field centers, data banks and germplasm banks
- Use of energy efficient pump sets and other agricultural equipments
- Retrofitting existing pump sets for higher energy efficiency
- Improved animal feeds and digesters
- Reuse of domestic wastewater for horticulture crops and crops with minimum risk of contamination
- Soil health improvement and Integrated Nutrient Management (INM)
- Increase the efficiency of water use by micro-water shed development, catchment area systems and water management practices
- Strict regulation of ground water abstraction
- Minor irrigation works and other engineering solutions to recharge groundwater aquifers

## 6.2 Forestry and Biodiversity

### 6.2.1 Background

Forest sector is important in the context of climate change mainly due to three reasons-(i) deforestation, forest degradation and land-use change which contributes to about 20% of global $CO_2$ emissions, ii) forest sector provides a large and low-cost opportunity to mitigate climate change, and iii) forest ecosystems are projected to be adversely impacted by climate change, affecting biodiversity, biomass production and forest regeneration. Climate is one of the most important determinants of forest vegetation patterns and

likely changes in climate would alter the configuration of forest ecosystems in India[20].

As per the Forest records, Telangana State stood 12th rank in India having forest cover area of 29,242 Sq.kms. The forest products in the state include Nallamaddi, Yegisa, Bijasal, Sheesham, Tuniki, Rose Wood, Narayepa, Bamboo and teak. Forestry and logging contribution to the State GSDP at current prices is 0.9% and 5.02% respectively in Agriculture sector GSDP for the year 2014-15. The total revenue realized during 2013-14 is INR 148.28 crores on sale of forest produce in the State[21].

### 6.2.2 Key sectoral issues and concerns

- Wind erosion: Soil is eroded due to strong winds, especially in deforested areas. The areas susceptible to soil erosion are situated near the forested hills and water flows through these areas through innumerable gullies, nalas etc. to finally join a river. Flooding could further contribute to soil erosion.
- The area of degraded forest has shown an increasing trend from 8497.84 sq. km. in 2011 to 8538.69 sq. km. in 2012[22]. The forest cover of the State has increased from 28853.79 sq. km. to 29242.08 sq. km. from year 2008 to 2015[23] mainly because of the effect of improved protection and development of forests by more Vana Samrakshana Samities (VSSs) or JFPCs in the State. 23.8 % of forest area is under Community Forest Management (CFM) with involvement of approximately 1539 thousand members.
- Due to changes in climate, there is a disturbance in the timing of flowering and appearance of pollinators. Moreover, excessive use of pesticides/insecticides, loss of forests (natural habitats for pollinators), air pollution etc. have also decreased the appearance of pollinators.
- As per 2011 census, 9.34 % of States population is tribal. Tribal population in forest areas heavily depends upon sericulture. Promoting sustainable sericulture through climate change adaptation initiatives.
- The exact impact on local species due to change in temperature and rainfall patterns have not been studied in detail. Documentary evidence to take structured and conscious decisions are absent. As a result of which the forest adaptation to climate change in taking place based on know-how. Thus, it is important that a thorough knowledge base is

[20] Climate Change & 12th Five year Plan, Government of India, Planning Commission
[21] Statistical Year, 2015, Telangana
[22] Facts and Figures of Forest, Telangana, 2013
[23] Facts, Forest, 2014

developed on impacts of climate change to develop meaningful adaptation techniques.

### 6.2.3 Interventions and Strategies

- Protection and Conservation of forests, including fire protection
- Soil and Water Conservation in forest lands
- Afforestation and eco-development through community based programmes (like Joint Forest Management). Also increase forestry through focus on realizing compensatory forestry and encouraging increased compensatory forestry efforts.
- Creation of forests in degraded/public lands, including such lands in and around cities and towns through programs like Nagar Van/Urban Forest and Harita Haram
- Documentation of biodiversity, including genetic fingerprinting
- Public awareness programmes on conservation of forests and biodiversity
- Preservation of rare/threatened germplasm (e.g. under cryogenic or other controlled conditions)
- Plantation for sustainable commercial utilization to reduce pressure on natural forests.
- Research, knowledge and capacity development on exact climatic impacts on the forests in Telangana and develop adaptation measures to combat in short term and long term.

## 6.3 Energy

### 6.3.1 Background

Quality power supply to various competing sectors is a sine-qua-non to meet the ambitious development objectives of Telangana. Driven by considerable growth in demand for energy in agriculture, domestic, industrial sectors and metro city of Hyderabad, the per-capita consumption of the state stands at 985 units, as against the national average of 917 units. Energy deficit in Telangana for last three years was in the range of 5%-12%. There are 261.46 lakh service connections available with a connected load of 54725 MW in the state and 72518 MUs were consumed during the year 2013-14 which includes both low tension and high tension connections.

Going forward, energy requirement is expected to increase around 11% for the period 2014-15 to 2018-19. However, due to the strong policy push by the Government of Telangana, non-conventional energy, predominantly solar and wind is expected to contribute around 7,529 MU by 2019-20 which would be around 8% of the energy availability of the State. The installed capacity of energy in the State is presented in Table 8.

**Table - 12: Installed Capacity (in MW) of power in Telangana. (as on 30th April 2015)**

| Owner-ship Sector | Mode wise breakup | | | | Nuclear | Hydro (Renew-able) | RES** (MNRE) | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Thermal | | | Total Thermal | | | | |
| | Coal | Gas | Diesel | | | | | |
| State | 3606.59 | 0.00 | 0.00 | 3606.59 | 0.00 | 2012.54 | 0.00 | 5619.13 |
| Private | 270.00 | 1697.75 | 19.83 | 1987.58 | 0.00 | 0.00 | 61.25 | 2048.83 |
| Central | 1653.28 | 0.00 | 0.00 | 1653.28 | 148.62 | 0.00 | 0.00 | 1801.90 |
| **Sub-total** | **5529.87** | **1697.75** | **19.83** | **7247.45** | **148.62** | **2012.54** | **61.25** | **9469.86** |

Central Electricity Authority, Ministry of Power, Government of India.

### *6.3.2 Key sectoral issues and concerns*

20% of power in the state is sourced through hydro power projects which depend on rainfall. Thus, it is important that dependence of hydro sources is limited to a certain extent and compensated by other renewable and non-coal based sources.

- Use of fossil fuel is the principal contributor to climate change
- Lack of Incentive for cleaner energy technologies
- Promotion of renewable energy
- Demand side management to reduce consumption is not adequate.
- Availability and investment in renewable energy sources
- Subsidization of clean technologies

### 6.3.3 Interventions and Strategies

- Improve the efficiency of thermal power generation
- Improve the efficiency of transmission, including elimination of pilferage
- Improve the efficiency of electrical equipment, including water pumping equipment used in agriculture
- Promotion of affordable alternative energy sources i.e. solar home systems, solar street lights, solar thermal systems
- Rationalization of power tariff for sectors that are currently subsidized
- Decentralized rural electrification using woody or agricultural residue

## 6.4 Industries (including mining)[24]

### *6.4.1 Background*

The growth of industrial sector in Telangana has been impressive. During the year 2014-15(Advanced Estimate), the growth of industries surged to 4.1 percent from 0.13 percent of 2013-14 at constant (2004-05) prices due to the incentives being offered under the Government's Industrial Policy Framework, 2014. During the decade 2004-05 to 2014-15 the State registered an average growth rate 7.8 % at constant prices (2004-05). However, the growth path of the State exhibited greater fluctuations than that of all India. Manufacturing sector growth across districts indicates that seven districts other than Medak, Rangareddy and Hyderabad require specific strategies and policy interventions. The growth in sub-sectors indicates a fall in the unregistered manufacturing sector represented by the micro and small enterprises, electricity, gas & water supply, and construction.

Up to January 2015, 2,091 large scale industries have gone into production with an investment of INR 45,3933.3 millions providing employment to 6,67,499 persons. During the period from 2001 to 2015 (January, 2015), about 48,894 Micro, Small and Medium Enterprises (MSMEs) are established providing employment to 5,65,496 persons involving an investment of INR 225,206.3 millions. The number of MSMEs and the number of persons

[21] Socio economic outlook, 2015 Telangana

employed in the State has witnessed an impressive growth between 2001-05 and 2013-14. There are 6 SEZs in the field of IT/ITES. Aerospace, Biotech, Formulations also have been developed in the State of Telangana.

The Telangana State Industrial Infrastructure Corporation (TSIIC) has identified 150 industrial Parks in 10 districts with an area of about 74133.8 acres of land. At present, 13165 units (enterprises) exist in these parks and out of 74133.18 acres of land, 917.30 acres of land is available for allotment to Industries. TSIIC had surveyed 2.50 lakh acres of waste/ barren land and has identified an extent of 234064.35 acres, fit for industrial use and are making ready for industrialization.

The State produces 33 million tonnes of industrial minerals and 54 million cubic meters of dimensional stones and building materials. There are 18 prospecting license, 521 Mining Leases and 1186 Quarry Leases for Major Minerals (industrial minerals) and 1429 Minor Minerals (construction minerals) with an extent of 53,5805 hectares, 5633 hectares, 2764 hectares and 3611 hectares respectively.

The State is endowed with a number of minerals. They include Coal, Limestone falling under large scale mechanized sector, Granite, Dolomite, Quartz, Feldspar, Clays and Barytes etc., falling under semi mechanized medium sector and the other minerals falling under semi mechanized small sector. Nearly 90% of the mines fall under small sector and remaining under medium and large sectors. Most of the mining activity in the State is concentrated in Khammam, Warangal, Adilabad and Karimnagar districts.

### 6.4.2 Key sectoral issues and concerns

- Increasing fossil fuel consumption and GHG emissions from the industries
- Increasing number of industries in State and their improper waste management practices
- Agro business and food processing industries are vulnerable to extreme weather events like floods, hail storms, unseasonal heavy rains on account of both location and raw material supply
- Depletion and degradation of surface water, aquifers and leaching from dumps
- Land degradation and large scale deforestation, noise and vibration, destruction of habitat, loss of bio-diversity etc.

- The activities in open cast mining like blasting, drilling, excavation, truck loading and transportation are responsible for the increase of suspended particulate matter in the air
- Dislocation of human communities and health impacts on the community living in close proximity to the mine areas.
- The industries are at risk due to climate change primarily on creation of heat islands specially in chemical units, supply chain disruption, loss of productive time due to increased heat wave (especially in general engineering units)
- Water quality and quantity both are under stress and will further get stressed impacting the operation of industries
- Consistent power supply, is a must of industries which could be impacted if energy sector issues are left unattended
- Low awareness level on the possible impacts of climate change and appropriate adaptation measures
- Flooding for industrial units and parks as incidents of sudden heavy rain increase.

### 6.4.3 *Interventions and Strategies*

- Enforce 'Cleaner production processes' and waste minimization across industries in partnership with the Central and State Pollution Control Boards
- Assess the vulnerability of major industrial hubs to climate related risk maps.
- Protection and disaster mitigation and adaptation works to minimize risks to industrial hubs (e.g. alternate rail and road access, improving drainage, alternate water supply sources etc.)
- Minimize environmental damage including GHG emissions, caused by industrial and mining activities
- Promote diversified and dispersed industries, including small/medium scale agro processing to stabilize agricultural livelihoods
- Intensive research for the biological methods of metal extraction from mine spoils to prevent acid mine drainage
- Pollution prevention measures to reduce and prevent air pollution during open cast mining activities
- Implementation of resettlement and rehabilitation plans for affected population
- Compensatory afforestration activities on a large scale to prevent biodiversity losses in the forest area

## *6.5* Transportation[25]

### *6.5.1 Background*

The Transport Department plays a key role in licensing of drivers, registration of motor vehicles, issue of transport permits, levy and collection of motor vehicle tax and enforcement. It acts as the nodal agency for road safety and motor vehicles pollution control. As on 01.02.2015, the State has a registry of 7.7 million vehicles. About 74.12% of the vehicles on road are two wheelers followed by cars, three wheelers, buses and trucks. The registered motor vehicles on road are shown in Table 13.The Transport Department collects revenues from the issue of driving licenses, registrations, permits and taxes. The growth of revenue is shown in Table 14.

**Table - 13: Registered motor vehicles on roads[26]**

| S. No | Class of Vehicle | As on January- 2015 |
|---|---|---|
| **1.** | Auto-Rickshaws | 291354 |
| **2.** | Contract Carriage Vehicles | 6466 |
| **3.** | Educational Institute Vehicles | 20243 |
| **4.** | Goods Carriage Vehicles | 328087 |
| **5.** | Maxi Cabs | 18978 |
| **6.** | Mopeds and Motor Cycles | 5722894 |
| **7.** | Motor Cars | 924778 |
| **8.** | Motor Cabs | 62590 |
| **9.** | Private Service Vehicles | 2482 |
| **10.** | Stage Carriage Vehicles | 15572 |
| **11.** | Tractor and Trailers | 285581 |
| **12.** | Others | 42090 |
| **Total** | | **7721115** |

**Table - 14: Growth of Revenue of Transport Department**

| Year | Total Revenue (Rs. Crore) |
|---|---|
| **2010-11** | 1294.73 |
| **2011-12** | 1517.40 |
| **2012-13** | 1768.00 |
| **2013-14** | 1753.72 |
| **2014-15 (Upto January 2015)** | 1579.76 |

[25]Telangana State, Socio –Economic outlook, 2015
[26]Reinventing Telangana, Socio Economic Outlook, 2015, page no 107

### *6.5.2 Key sectoral issues and concerns*

- The growth of cities and large-scale migration of rural population to urban areas has increased the population and population density. The urban population is disproportionate to the available infrastructural facilities[27]. Higher population and rising income levels have increased the vehicular population multi-fold (almost 200% in the last 10 years).
- The transport sector has a large share in anthropogenic climate change impacts. After energy, the transport sector (mainly road transport) is the main source of increasing $CO_2$ levels in the atmosphere.
- The share of public transport is low; share of public transport in Hyderabad is 44% which is far below the global best practices.
- Because of the high vehicle population in urban areas, road congestion has become a major problem, resulting in poor fuel economy.
- Although incentive program is in place (like tax exemption for battery / compressed natural gas / solar power driven vehicles) penetration of low carbon fuel vehicles usage is negligible.
- Telangana holds tremendous potential in Natural Gas availability. However in comparison to the potential, mobilization of CNG in transportation sector is not adequate (in Hyderabad 1623 vehicles are CNG driven; a mere 0.08% of the total vehicle population of Hyderabad[28]).
- Lack of organized efforts to promote fuel efficiency improvement and eco-driving habits for 'vehicles in use' among drivers or owners of the vehicles (private or governmental).

### *6.5.3 Interventions and Strategies*

- Enhance the share of public transport in the total transportation mix
- Enhance the share of low emission/fuel-efficient vehicles and vehicles that run on alternate fuels
- Encourage non-motorized transport like walking and cycling
- Design or redesign road networks so as to facilitate smooth traffic movement
- Interlinking of private and public transport modes so as to minimize the use of private transport

[27] Report published on Hyderabad city by Centre of Science and Environment
[28] Source: http://www.eai.in/ref/fe/nag/nag.html

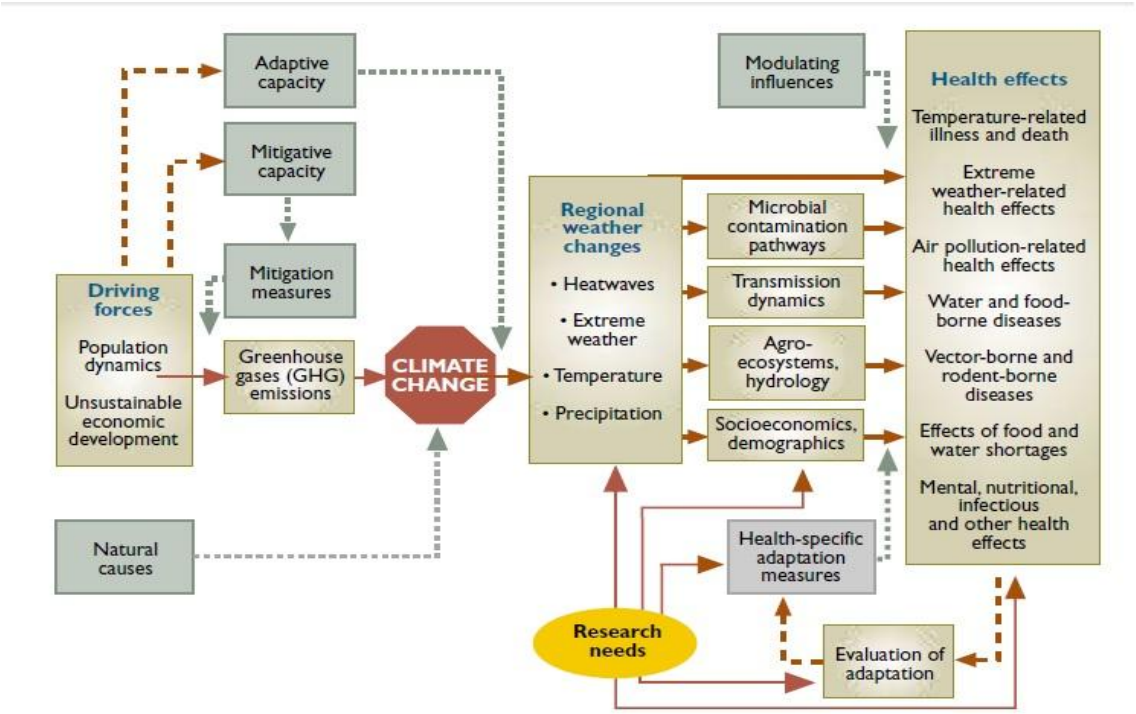
## 6.6 Health

### *6.6.1 Background*

Global climate change is a phenomenon that is now considered strongly associated with human activities. Atmospheric carbon dioxide levels, which have remained steady at 180-220 ppm for the past 420,000 years, are now close to 390.55 ppm and rising[29].

Climate change is already having a discernible influence on the global burden of disease and particularly on the health of the most impoverished in the society. Pathways by which aspects of climate change ranging from heat waves to precipitation lead to adverse health impacts are illustrated by the WHO diagram which is reproduced below. However, research on health impacts of climate change in India is limited. The likely health impacts in Telangana have been extrapolated from global research evidence. Exhibit 23 illustrates the driving forces triggering off a series of events that cause climatic changes and adversely affect health in turn.

**Exhibit - 23: Health and Climate Change[30]**




[29] IPCC 5th Assessment
[30] WHO, 2003

The State of Telangana is strategically located in the semi arid region and susceptible to frequent droughts, the climate is predominately hot and dry.

### *6.6.2 Environmental Health in Telangana*

Telangana has a high neonatal mortality rate. With 27 deaths per 1000 live births, neonatal mortality constitutes 65 percent of all infant deaths. Only 27 per cent of the rural households in Telangana district have access to a toilet facility (Census 2011). Over 90 percent of Hygienic aspects are associated with traditional environmental risks such as lack of access to safe water and sanitation and indoor air pollution resulting from the use of biomass fuels.

Although urban households have a higher level of access to water and sanitation and cleaner cooking fuels than their rural counterparts, they are more at risk from the environmental pollution resulting from vehicular transport and industrialization which may increase exposure to biological, chemical and toxic wastes. Climate change is adding to the health impacts associated with these traditional environmental risks[31].The disease prevalence as per the mode of communication will be further discussed.

#### *6.6.2.1 Water borne diseases*

Water borne diseases from faecal contamination of drinking water remain a major public health challenge in India. Malnutrition increases the vulnerability to water borne diseases. Acute gastroenteritis, Hepatitis A and cholera are known to be endemic to Telangana. The malnutrition levels in Telangana are at higher end at 43 percent among children below 6 years and over 80 percent among adults. The World Bank study confirmed that the districts of Karimnagar, Ranga Reddy have the highest proportion of population exposed to water contamination[32]. In Telangana from 2011 – 15 are affected with Acute diarrheal diseases (ADD) whereas in 2013 five death cases are found in Ranga Reddy and Medak districts as per the records of Public Health Department, Telangana.

#### *6.6.2.2 Vector borne diseases*

The major vector-borne diseases prevalent in Telangana are malaria, dengue, filariasis and chikungunya. Semi-arid regions of Khammam, Rangareddy and Nalgonda districts have a greater incidence of vector borne diseases compared with other parts of the State.

[31] http://unicef.in/StateInfo/Telangana/Challenges
[32] World bank, 2001

The endemicity of malaria in Telangana is attributed to the pollution of water bodies and water logging. It is a climate sensitive disease and its transmission continues almost throughout the year owing to the relatively humid climate. It is also estimated that an increase in the temperature by 2-3$^{o}$C may increase the incidence of malaria by about 3-5%.[33] Although the disease is more prevalent in rural Telangana, the Health and Family Welfare Department data confirm that approximately 10.6 percent of malaria cases in 2001 were recorded in urban Telangana.[34] In 2015, an about 6686 cases of Malaria, 1067 Dengue cases, 101 chikungunya and 160 Filaria cases are found in Telangana State as per the records of Public Health Department.

#### *6.6.2.3 Air borne diseases*

There are many sources of outdoor air pollution including factories, refineries, power plants and vehicular exhaust. Toxic air pollutants include benzene, toluene, methylene, chlorides and dioxins released in degradation of plastics and asbestos and metals such as cadmium, mercury and lead. Indoor air pollution is contributed by cigarette smoke, nitrogen dioxide, fuels such as oil, gas, kerosene and coal; cooling systems, such as air conditioners and humidification devices and cleaning agents.

Climate change is an important determinant of air quality. Some weather patterns may increase the levels of chemical pollutants in air. The formation of ground level ozone which is a constituent of urban smog depends on bright sunshine with high temperatures. Its concentration may therefore increase with higher ambient temperatures. Climate change may also increase concentrations of other air pollutants such as fine particulate matter. Adverse health effects of air pollution include mainly heart disease, cancer and respiratory disease including asthma and chronic obstructive pulmonary disease (COPD). The Khammam district had the highest incidence of asthma between the years 2007 and 2008 (EPTRI, 2009). In keeping with global projections, the health impacts of air pollution and their exacerbation due to climate change are likely to increase.

### *6.6.3 Impact of extreme weather events on Health*

Extremes of both hot and cold waves have been shown to result in excess morbidity and mortality. Heat waves are projected to become more common, resulting in increased risk of heat stress, stroke and death, particularly in

[33]INCCA, 2010
[34]Directorate of Health, 2001

vulnerable populations, such as the very old and very young. The lack of drinking water (and safe drinking water) is likely to cause heat strokes and increase mortality. In Telangana State, the periods from April to June are summer months. During this period, the temperature rises considerably and sometimes touching 47º C in May in Khammam, Nizamabad, Nalgonda, Karimnagar and Warangal in districts. As per records of Disaster Management Department, Telangana State 541 deaths were reported in the State during 2014-15 (May 30th, 2015) owing to sunstrokes.

### *6.6.4 Existing Policy and Legislation for health problems caused by environmental changes*

The Rajiv Aarogyasri Health Insurance scheme which aims to improve equity of access to healthcare for the poor, may experience increasing demands for healthcare services resulting from climate related ill health. Monitoring of these trends will enable the Government of Telangana to develop preventive measures such as heat wave warnings which would enable the vulnerable population such as outdoor workers to take appropriate precautions against heat stress.

The Urban Malaria Scheme (UMS) under NVBDCP was sanctioned in 1971 by GoI with main objectives of preventing deaths due to malaria and reduction in transmission and morbidity. This scheme is currently being implemented in 131 towns in 19 States and Union Territories protecting about 130 million population. Under this scheme, the larvicides are supported by GoI through cash assistance; however, the entire staff for implementation and operational cost is to be borne by the state/corporation/municipality.

The Government of Telangana has established a number of programmes to improve safe water provision and living conditions, and reduce poverty and malnutrition. The 'Jawahar Bala Aarogyya Raksha' aims at improving the health and nutrition status of school children will be scaled up in future. The challenge will be to maintain a strong public health programme to continue to improve health despite the adverse impacts of climate change.

### *6.6.5 Key sectoral issues and concern*

- Increased Impacts of Vector Borne Diseases
- Increased Impacts of Water- Borne Diseases
- Increased Impacts of Air pollution related health effects
- Increased Impacts of extreme weather related health effects

### *6.6.6* Interventions and Strategies

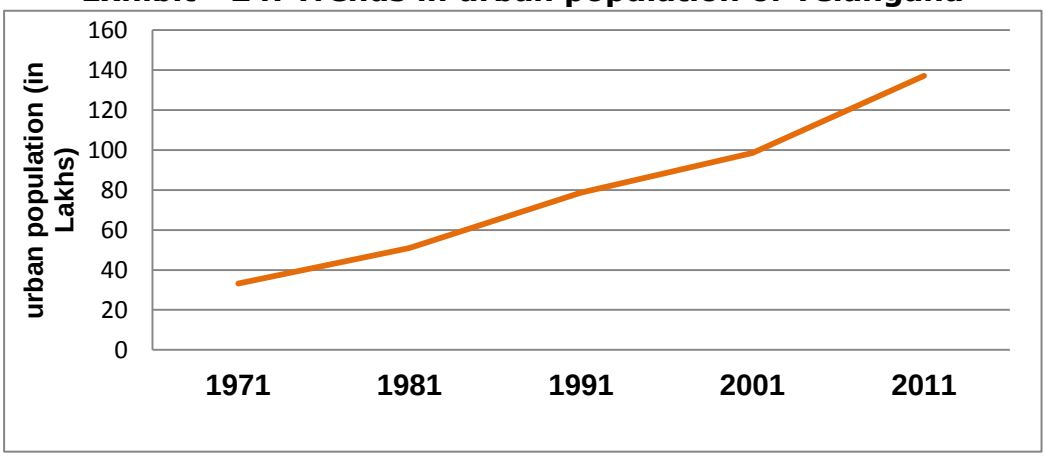
- Undertake longer-term studies to investigate links between climate change and disease patterns, as also between pollution loads and disease patterns
- Strengthen detection and early warning systems for outbreaks of diseases
- Health Surveillance
- Public education on prevention of diseases related to climate change and resulting from environmental pollution
- Research on development of low cost vaccines, particularly those related to vector borne diseases
- Development of rapid response capabilities to handle climate related disasters such as exposure to sun and prolonged droughts

## Urban Development

### *6.7.1 Background*

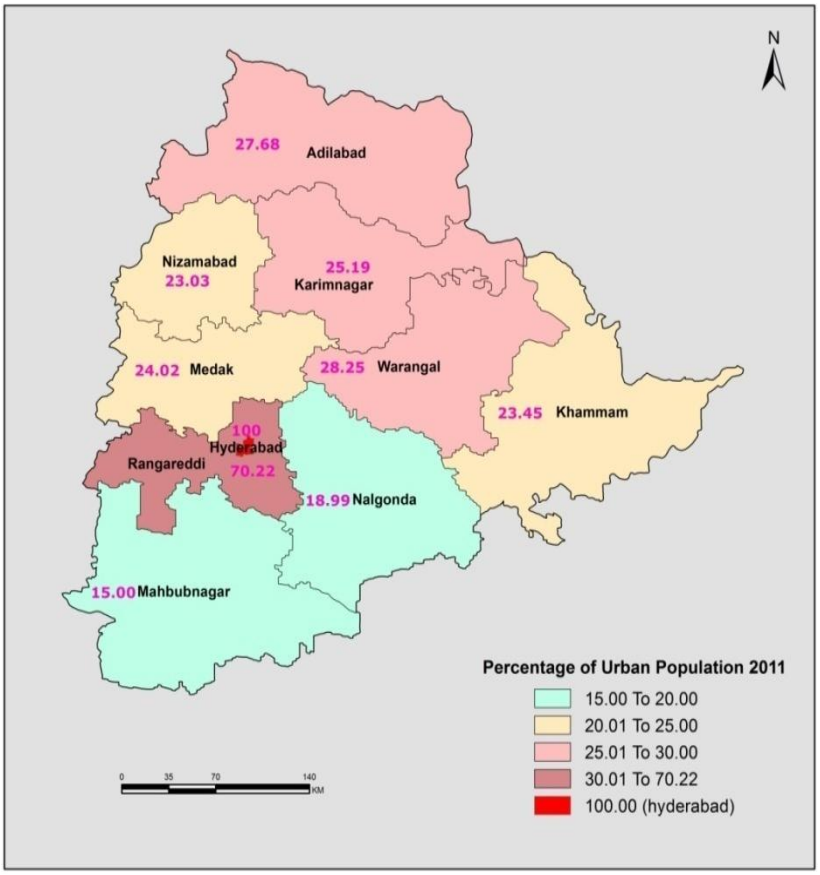
Indian cities are predicted to be at high risk due to climate change. This situation may be accentuated due to the 500 million people who are predicted to be added in 7000 urban settlements by 2060.Telangana has also shown a large population shift to the urban areas over the last 100 years. Urban population in the State grew by 38.12% in the decade 2001 to 2011 as compared with 25.13 % in the preceding decade. The capital city of Hyderabad, which is entirely urban, accounts for over 29% of the State's total urban population (2011)[35].

**Exhibit - 24: Trends in urban population of Telangana**




[35] Socio economic outlook,2015 Telangana

**Exhibit – 25: Distribution of Urban Population in Telangana**




A major part of the urbanization in Telangana resulted from the development triggered by the formation of Hyderabad Urban Development Authority (HUDA) in September, 1975. The above graph indicates that the percentage of urban population has constantly increased from around 20% in 1971 to 31.15% in 2011. Exhibit 35 shows the distribution percentage of urban population in different districts of Telangana (Census 2011). It indicates that the districts namely Rangareddy are the ones with high urban population.

Vulnerabilities of the urban poor can be a direct result of climate change, such as Heat waves or drought, or an indirect result such as higher incidence of disease or an increase in food prices. The impact of climate change on the urban poor is thus often disguised and entangled with other socio-economic and urban issues.

### *6.7.2 Key sectoral issues and concerns*

- Increasing energy use in the urban areas due to the changing pattern of urban livelihood

- Drainage of the cities not adequate to accommodate the precipitations during the heavy rains
- Demand on water resources due to the growth in the urban population and therefore increased pressure on the water supply infrastructure
- Consequent generation of large quantity of sewage
- Generation of huge quantum of solid waste
- Increased threat to urban health due to vector borne diseases
- Increased private transportation leading to huge pressure on the road infrastructure and the increased emissions.
- Building infrastructure development is not designed to accommodate the climate change impacts

### 6.7.3 Interventions and Strategies

- Safe water supply as per norms to the entire urban population (projected population of 2022)
- 100% coverage of sewerage and sanitation for the urban population (projected as of 2022)
- Study and remodel existing water supply, sanitation and sewerage systems to reduce climate change vulnerability
- Protection and restoration of existing water bodies in urban areas
- Creation of new water bodies in urban areas
- Scientific management of municipal solid waste in all municipalities and corporations (population and number of municipalities projected as of 2022)
- Restoring efficiency of drainage network of all municipalities to enable quick evacuation of water and to avoid flooding
- Enforce spatial planning in cities and towns to reduce vehicular movement
- Mandatory rainwater harvesting in Government buildings, commercial establishments, offices, schools/colleges, academic/research establishments and industrial units
- Policy and incentives for rooftop solar power generation and provision of grid connectivity
- Rail based MRTS in emerging cities and expansion of existing MRTS
- Provision of safe footpaths, cycle tracks etc to promote non-motorised transport.

- Mandatory implementation of sustainable urban planning systems like green building codes in all new constructions.
- Retrofitting of current urban planning to accommodate sustainable or climate friendly planning
- Develop capacity of government departments involved in urban planning and maintenance of urban infrastructure on climate change

## 6.8 Tourism

### *6.8.1 Background*

Telangana attracts the largest number of domestic tourists among all the States of India. Recognition of the importance of tourism for sustainability of local communities and heritage has led to theme-based and specialized forms of tourism. Prominent eco-tourism sites include Charminar, QuliQutub Shah tombs in Hyderabad, 1000 pillars temple in Warangal, and Bhadrachalam in Khammam District. Because of its close connections to the environment and climate, tourism is considered to be a climate-sensitive[36] economic sector like agriculture and transportation. Tourism is affected by a very wide range of environmental and socio-economic factors, and has been continuously adapting to challenges and crisis situations, such as natural disasters, epidemics, economic downturns, political events etc showing great resilience. Therefore, the capacity of the tourism sector to adapt to climate change is thought to be relatively high due to its dynamic nature.

### *6.8.2 Key sectoral issues and concerns*

- Habitat loss and degradation, caused by logging for firewood and timber materials, are major threats to restricted-range species[37]
- Poaching , hunting and unsustainable exploitation threaten both flora and fauna
- Tourism transportation and usage of high carbon intensive fuels in resort/tourist spots cause high levels of $CO_2$ emissions which increase the pollution levels in tourist places like Warangal and Hyderabad etc. [38]

[36] Climate Change and Tourism-UNEP

[38]Balaji Colony, Gandhi Road and railway station with SPM recorded at around 350 µg/$m^3$units in Tirupati. Increased pollution levels in Hyderabad have increased the incidence of respiratory disorders among the traffic police personnel from 0.36% in 2003 to around 3.5% in 2009 (TSPCB, Hyderabad).

### *6.8.3 Interventions and Strategies*

- Promote low emission/fuel-efficient mass transportation, to and within tourist areas (e.g. battery operated vans operating around the TajMahal)
- Promote energy efficiency lighting, climate control equipment etc. in hotels and other areas where tourists congregate
- Promote eco-tourism to enhance environmental consciousness
- Enforce cleanliness in tourist areas
- Protect both built and natural heritage against climate related damage (e.g. damage from high temperature, water accumulation, pests etc.)

## 6.9 Rural Development

### *6.9.1 Background*

The rural population as per 2011 census in the State is 215.85 lakhs constituting 61.33% of total population. Rural Development Programmes viz., Watershed Development Programme, Self Help Groups and related programmes and Employment Guarantee Schemes are being implemented. There are 47, 41,891women who have formed Self Help Group members in 4, 16,811 SHGs organized into 17,811Village Organizations (VOs) and 438MandalMahilaSamakhyas (MMSs). In addition to the above, there are 436MandalVikalangulaSangams, and 9 ZillaVikalangula (ZVS).

### *6.9.2 Key sectoral issues and concerns*

- Deterioration of natural water resources and other ecological resources impacting the life and livelihood of rural population
- Due to lack of opportunities in the rural areas, there is large migration of rural population to urban areas, is in turn putting pressure on the urban infrastructure

### 6.9.3 *Interventions and Strategies*

- Safe water supply as per norms to the entire rural population (projected population of 2022)
- 100% coverage of sewerage and sanitation for the rural population (projected as of 2022)
- Study the climate change vulnerability of existing water supply and sewerage/sanitation systems
- Remodel or strengthen existing water supply and sanitation/sewerage systems to reduce vulnerability to climate change
- All-weather road connectivity to all habitations (projected as of 2022) for access to goods and services, and for evacuation in emergency
- Creation of new water bodies (lakes, tanks, kuntas etc.) and restoration of existing dilapidated water bodies
- Water shed development, catchment area system and water management systems
- Micro credit facility for promoting livelihood

## 6.10 Research in Climate Change

### *6.10.1 Background*

Various aspects of climate change directly or indirectly affect the sensitivity and stability of the environment. Research would deal with the changes in the greenhouse gases, aerosols, solar irradiance, rainfall and monsoon, incidence of natural calamities, land use changes, knowledge and awareness of the people, and the vulnerability of various sectors to climate change and its consequences. The research would focus on the long and short term studies on areas and populations prone to climate change. Due to observed changes in the rainfall patterns and incidence of natural calamities in the State, climate related research studies on river basins, industrial hubs, Urban Local Bodies (ULBs) etc has become an imperative.

The two major river basins of the State are Godavari and Krishna. The State is dependent on these rivers for agriculture, domestic and commercial usage of water. Hydrological modeling studies on vulnerability of river systems in State are required to prepare the baseline scenario and predict the future changes in the water availability in the State. Such research projects can help to

develop adaptation methods/tools and strategies that will help in addressing the climate change impacts on hydrological regimes.

The State is transforming into a dynamic industrial economy. With the friendly investment atmosphere, the State has become an attractive choice for investment and has witnessed high industrial growth. The industrially developed areas generally have inadequate vegetation, and are unplanned as well as haphazardly and unscientifically developed, making them prone to erosion and flood hazards. The risks and vulnerability further increase due to the concentration of industries in a narrow strip. The industrial hubs are also facing water scarcity problems and impact of climate changes on industrial water supply needs to be investigated.

The State has recorded a high rate of urbanization. The decadal urban population growth of the State has been recorded to be 38.12% whereas the rural decadal population growth has been observed to be just 2.16%.[39] The State has presently 8687 Gram Panchayats, 438 Mandal Praja Parishads, 25 Nagar Panchayats, 37 Municipalities and 6 Municipal Corporations. Lack of knowledge and awareness among people about the climate change issues and consequences is major issues that need to strengthen by knowledge management through training and capacity building programmes. The dissemination of quality research on climate change through projects at ULBs and major gram panchayats and research and analysis on combating climate change with the help of local organizations, NGOs, SHGs, RWAs etc. are required.

Studies need to be carried out both in urban and rural areas to adapt to and mitigate the impacts of climate change. In rural areas pilot projects on energy efficiency by embarking on locally suitable renewable energy technologies, integrated farming, water resource management, rural development and waste management can be started with the help of Panchayat Raj Department. The Urban Local Bodies need to focus on projects to achieve the overall reduction in conventional energy consumption by promoting renewable energy technologies in street lighting, lighting in public places, water heating, zero waste management, integrated water resource management, green cover and city climate protection campaign. Pilot studies in these areas can focus on baseline survey, identification of technologies, preparation of project implementation plan, stakeholder specific capacity building programmes and monitoring and evaluation.

[39]Statistical year, 2015 Telangana

The Environment Protection Training and Research Institute (EPTRI) is being a renowned organization of the State and notified Nodal Agency for Clean Development Mechanism (CDM) and center for Climate Change in Telangana. It has a large complement of scientists and engineers. It is proposed to establish a Climate Change Knowledge Centre at EPTRI. The institute is presently working in a number of environmental research consultancy and training projects, and is uniquely placed to host the Climate Change Knowledge Center not only in Telangana., but for the Southern zone or even nationally.

### *6.10.2 Key sectoral issues and concerns*

- The river basins are prone to climate change impacts due to changing precipitation and temperature patterns.
- The major industrial hubs are prone to climate change impacts.
- The majority of rural and urban population is not aware about the climate change issues, impacts and consequences to their lives.
- Need for a Climate Change Knowledge Centre.

### *6.10.3 Interventions and Strategies*

- Setting up of Climate Change Knowledge Center at EPTRI
- Agro-climatic vulnerability studies in major river basins of the State
- Climatic and socio-economic vulnerability studies in major industrial hubs
- Climatic baseline studies in ULBs and municipal corporations
- Demonstration projects at ULBs and major Gram Panchayats
- Development of sector based research matter on climate adaptation measures for each of the zones
- Carry out extensive capacity building for proper dissemination of CCA measures

# Chapter-7

# BUDGET FOR INTERVENTIONS

The majority of the interventions that would increase the 'adaptive capacity' to climate change, are neither new nor novel. These interventions have formed significant parts of the programmes of State Departments of Agriculture, Rural Development, Urban Development, Forests, Disaster Management etc. for years if not for decades. However, these interventions have always been viewed more from the social and economic impact on communities and classes of people, rather than the adaptation to climate change.

These interventions now need to be seen as contributors to the adaptation to climate change, in addition to their social and economic impacts. It is possible that the change of view would cause some modifications to the designs of the various programmes and more importantly, require faster or more intense implementation, to be of use for adaptation.

The Departments concerned to Government of Telangana State had been requested to assess the budgetary requirements for the identified interventions, including those interventions that are in the nature of mitigation.

**Table: 15 Budgetary requirements conveyed by departments**

| Departments | Key Climate Change Sector addressed | Status of budgetary estimates | Table no. |
|---|---|---|---|
| Agriculture Department | Agriculture and allied | Provided / conveyed | Table No. 16 |
| Irrigation and CAD | Ground water & I & CAD | Provided / conveyed | Table No. 17 |
| Forest Department | Forest and Biodiversity | Provided/conveyed | Table No. 18 |
| Energy Department | TRANSCO, TGENCO, TNEDCAP | Provided/conveyed | Table No. 19 |
| Industries and Commerce | TSIIC | Provided/Conveyed | Table No. 20 |

| Departments | Key Climate Change Sector addressed | Status of budgetary estimates | Table no. |
|---|---|---|---|
| Transport Department | TSRTC | Provided/conveyed | Table No. 21 |
| Health and family welfare | Health | Provided/conveyed | Table No. 22 |
| Municipal Administration and Urban Development | Urban Development | Provided/conveyed | Table No. 23 |
| Tourism | Tourism | Provided/conveyed | Table No. 24 |
| Panchayat Raj and Rural development | Rural Development | Provided/conveyed | Table No. 25 |
| TSPCB | Pollution | Provided/conveyed | Table No. 26 |

It is foreseen that a substantial amount of research and documentation would be needed. A total requirement of INR 12.38 crore and 92.40 crore is made (plan period 2012-2017) in Table-27 and Table-28 for setting up of Climate Change Knowledge Center and research related to climate change respectively for climate change impacts, adaptation strategies and mitigation measures.

**Table - 16: Budget estimates for Agriculture Department**

| Sl. No | Name of Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Development and dissemination of new crop varieties resilient to heat, photo and water stress | 35.00 | 120.00 |
| 2 | Replacement of inorganic fertilizers by bio-fertilizers | 2.00 | 5.00 |
| 3 | Reducing the use of synthetic pesticides and weedicides, and promoting the use of bio-pesticides | 2.64 | 5.78 |
| 4 | Assured credit facility, including for tenant farmers | 140073.00 | 168088.00 |
| 5 | Insurance against crop failures (not just for the bank loan component) | 300.00 | 500.00 |

| | | | |
|---|---|---|---|
| 6 | Intensive research work on stable agriculture in the context of climate change, in all its aspects | 30.00 | 60.00 |
| 7 | Extension work for change of cropping timings and patterns, efficiency of water use, weather advisories to farmers, information on market prices etc. | 45.00 | 310.00 |
| 8. | Establishment of field centres, data banks and germplasm banks | 15.00 | 15.00 |
| 8 | Improved animal feed and digesters | 6.16 | 10.38 |
| 9 | Increase the efficiency of water use by micro-water shed development, catchment area systems and water management practices | 25.00 | 80.00 |
| 10 | Soil health improvement and Integrated Nutrient Management (INM) | 22.00 | 90.00 |
| 11 | Integrated Pest Management in major crops of Telangana | 20.00 | 80.00 |
| 12 | To disseminate the price forecast information to help the farmers in taking decisions on disposal of the procedures (Market Intelligence) | -- | 30.00 |
| 13 | To improve the farmer-scientist interactions using ICT tools. (ICT Agriculture) | -- | 90.00 |
| 14 | Capacity building of farmers and students | -- | 70.00 |
| | **Grand Total** | **140575.8** | **169554.2** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 17 : Budget estimates for Irrigation and CAD Department**

| Sl. No | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Full utilization of the sustainable surface water irrigation potential, to stabilize agricultural production | 43358.92 | 102897.00 |
| 2 | Utilization of the sustainable groundwater potential, to stabilize agricultural production | 117.00 | 260.43 |

| | | | |
|---|---|---|---|
| 3 | Minor irrigation works and other engineering solutions to recharge groundwater aquifers | 6581.00 | 9018.00 |
| 4 | Monitoring and early warning of river flows, to minimize flood damage | 280.55 | 1180.00 |
| 5 | Strict regulation of ground water abstraction | Policy / Enforcement | |
| | **Grand Total** | **50337.47** | **113355.4** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 18 : Budget estimates for Forest Department**

| Sl. No | Interventions | *Estimate for 2012 - 2017 (INR Crore) | Estimate for 2017 - 2022 (INR Crore) |
|---|---|---|---|
| 1 | Protection and Conservation of forests, including fire protection | 2.1431 | 140.00 |
| 2 | Soil and Water Conservation in forest lands | - | 168.00 |
| 3 | Afforestation / Eco-Development through JFM | 10.15 | 629.00 |
| 4 | Creation of forests in degraded/public lands, including such lands in and around cities and towns, Plantation for commercial utilization to reduce pressure on natural forests. | 529.17 | 110.00 |
| 5 | Documentation of biodiversity, including genetic fingerprinting | 11.1032 | 18.00 |
| 6 | Public awareness programmes on conservation of forests and biodiversity & livelihood enhancement | - | 110.00 |
| | **Grand Total** | **552.57** | **1175.00** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

## Table - 19: Budget estimates for Energy Department

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Improve the efficiency of thermal power generation | 276.00 | 194.46 (upto 2021 only) |
| 2 | Improve the efficiency of transmission, including elimination of pilferage | 12460.00 | 11588.00 |
| 3 | Improve the efficiency of electrical equipment, including water pumping equipment used in agriculture | 9116.00 | 5209.00(upto 2019 only ) |
| 4 | Promotion of affordable alternative energy sources i.e. solar home systems, solar street lights, solar thermal systems | 208.255 | 312.387 |
| 5 | Rationalization of power tariff for sectors that are currently subsidized | 95% of the agricultural consumers are availing free Power supply. Nearly one lakh agricultural services are being released every year. Government of Telangana State is committed to provide necessary assistance as needed by the Power Sector and providing subsidy to the utilities in accordance with the provisions of section 65 of Electricity Act, 2003 to ensure quality power supply to all consumers with special emphasis on BPL families and farm sector. | |
| 7 | Electricity generation using Non-conventional sources like agricultural residues, municipal solid waste, flows in irrigational canals, Tide, wind and solar | 531.00 | 3425.00 |
| | **Grand Total** | **22591.26** | **20728.85** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 20 : Budget estimates for Industries Department**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crore) | Estimate for 2017 - 2022 (INR Crore) |
|---|---|---|---|
| 1 | Enforce 'cleaner production processes' and waste minimization across industries, in partnership with the Central and State Pollution Control Boards. | 0.1 | -- |
| 2 | Assess the vulnerability of major industrial hubs to climate related risks and Climate Change adaptation Measures | 21.50 | -- |
| 3 | Minimize environmental damage including GHG emissions, caused by industrial and mining activities. | Policy / Enforcement | |
| 4 | Promote diversified and dispersed industries, including small/medium scale agro processing, to stabilize agricultural livelihoods. | 2.00 | -- |
| | **Grand Total** | **23.6** | **---** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 21 : Budget estimates for Transportation Department**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Enhance the share of public transport in the total transportation mix | 57.82 | 97.44 |
| 2 | Enhance the share of low emission/fuel-efficient vehicles and vehicles that run on alternate fuels | Policy / Enforcement | |
| 3 | Design or redesign road networks so as to facilitate smooth traffic movement | 1003.66 | 1691.226 |
| 4 | Interlinking of private and public transport modes so as to minimize the use of private transport | 21.51 | 36.25 |
| | **Grand Total** | **1082.99** | **1824.916** |

* Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 22: Budget estimates for Health, Medical & Family Welfare Department**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Undertake longer-term studies to investigate links between climate change and disease patterns, as also between pollution loads and disease patterns | 4.50 | 4.50 |
| 2 | Research on development of low cost vaccines, particularly those related to vector borne diseases | 100.0 | 100.0 |
| 3 | Public education and capacity building on prevention of diseases related to climate change and resulting from environmental pollution | 3.70 | 3.70 |
| 4 | Strengthen detection and early warning systems for outbreaks of diseases | 2.50 | 2.50 |
| 5 | Strengthening of Labs | 1.50 | 1.50 |
| 6 | Development of rapid response capabilities to handle the impacts of climate related heat waves and prolonged droughts on health | 2.50 | 2.50 |
| | **Grand Total** | **114.70** | **114.70** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 23: Budget estimates for Municipal Administration &Urban Development**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Safe water supply as per norms to the entire Urban population. | 385.87 | 669.24 |
| 2 | 100% coverage of sewerage and sanitation for the urban population | 25.46 | 44.15 |
| 3 | Study and remodel existing water supply, sanitation and sewerage | 0.93 | 1.57 |

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| | systems to reduce climate change vulnerability | | |
| 4 | Protection & restoration of existing water bodies in urban areas. | 2.45 | 4.13 |
| 5 | Scientific management of municipal solid waste in all municipalities and corporations | 325.00 | 227.5 |
| 6 | Restoring efficiency the drainage network of all municipalities to enable quick evacuation of water and to avoid flooding | 0.17 | 0.29 |
| 7 | Mandatory rainwater harvesting in Government buildings, commercial establishments, offices, schools /colleges, academic/research establishments and industrial units | Policy / Enforcement | |
| 8 | Policy and incentives for rooftop solar power generation and provision of grid connectivity | Policy / Enforcement | |
| 9 | Shift from Conventional lighting to Solar power and LED street lighting, parks and EWS housing Scheme | 550.00 | -- |
| 9 | Rail based MRTS in emerging cities and expansion of existing MRTS | 17.79 | 29.97 |
| 10 | Provision for safe footpaths, cycle tracks etc to promote non-motorized transport and increase in Green Cover and creation of carbon sinks | 116.7 | 566.00 |
| 11 | Enforce the laws on management of municipal solid waste and plastic waste | Policy / Enforcement | |
| | **Grand Total** | **1424.37** | **1542.85** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 24: Budget estimates for Tourism Department**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crore) | Estimate for 2017 - 2022 (INR Crore) |
|---|---|---|---|
| 1 | Promote low emission/fuel-efficient mass transportation, to and within tourist areas (e.g. battery operated vans operating around the TajMahal) | Policy / Enforcement | |
| 2 | Promote energy efficiency lighting, climate control equipment etc. in hotels and other areas where tourists congregate | Policy / Enforcement | |
| 3 | Promote eco-tourism to enhance environmental consciousness | 25.00 | 26.00 |
| 4 | Enforce cleanliness in tourist areas | Policy / Enforcement | |
| 5 | Protect both built and natural heritage against climate related damage (e.g. damage from high temperature, water accumulation, pests etc.) | 38.26 | 66.35 |
| | **Grand Total** | **63.26** | **92.35** |

*Since Telangana was formed in June,2014,all the budgetary allocation here refer to financial year 2014 -17

**Table - 25 : Budget estimates for Panchayat Raj Department**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Safe water supply as per norms to the entire rural population | 16339.81 | 28728.00 |
| 2 | Sewerage and sanitation | 2551.23 | 2721.52 |
| 3 | Study on the climate change vulnerability of existing water supply and sewerage/sanitation systems | -- | -- |
| 4 | Remodel or strengthen existing water supply and sanitation/sewerage systems to reduce vulnerability to climate change | -- | -- |

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 5 | Creation of new water bodies (lakes, tanks, kuntas etc.) and restoration of existing dilapidated water bodies | -- | -- |
| 6 | Water shed development , catchment area system and water management systems | 304.29 | 2997.40 |
| 7 | Micro credit facility for promoting livelihood | 17100.00 | 35750.00 |
| 8 | Increasing energy efficiency in street lighting and water pumping by Panchayats | 716.89 | 402.00 |
| 9 | Public education on climate change and its effect on various sectors | -- | -- |
| | **Grand Total** | **37012.22** | **70598.92** |

*Since Telangana was formed in June,2014,all the budgetary allocation here refer to financial year 2014 -17

**Table - 26: Budget estimates for Telangana Pollution Control Board**

| Sl. No. | Interventions | *Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Monitor emissions, including GHGs | 15.00 | 10.00 |
| 2 | Enforce cleaner production techniques and penalize 'dirty production' | 05.00 | 05.00 |
| 3 | Enforce energy audit in industries generally ( or selected industries or classes of industries | Policy / Enforcement | |
| 4. | Enforcement of Municipal Solid waste/Plastic Waste Management | 3.00 | 2.00 |
| | **Grand Total** | **23.00** | **17.00** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

**Table - 27: Setting up of Climate Change Knowledge Centre at EPTRI**

| Sl. No. | Interventions | Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Setting up of Climate Change Knowledge Center at EPTRI | 12.38 | 13.87 |
| | **Grand Total** | **12.38** | **13.87** |

**Table - 28: Research Studies in Climate Change**

| Sl. No. | Interventions | Estimate for 2012 - 2017 (INR Crores) | Estimate for 2017 - 2022 (INR Crores) |
|---|---|---|---|
| 1 | Agro-climatic vulnerability studies in two major river basins of the State | 19.00 | 21.28 |
| 2 | Climatic and socio-economic vulnerability studies in major industrial hubs | 25.00 | 28.00 |
| 3 | Climatic baseline studies in ULBs including municipal corporations | 18.40 | 20.61 |
| 4 | Demonstration projects at ULBs and major Gram Panchayat levels and extensive capacity building programmes | 30.00 | 33.60 |
| | **Grand Total** | **92.40** | **103.49** |

## Table - 29: Summary of the Budget Interventions

| Sl. No. | Sectors | *Estimate for 2012-17 (INR Crores) | Estimate for 2017-22 (INR Crores) |
|---|---|---|---|
| 1 | Agriculture and allied | 140575.8 | 169554.2 |
| 2 | Irrigation and CAD | 50337.47 | 113355.4 |
| 3 | Forest and Biodiversity | 552.57 | 1175.00 |
| 4 | Energy | 22591.26 | 20728.85 |
| 5 | Industries (including mining) | 23.6 | --- |
| 6 | Transportation | 1082.99 | 1824.916 |
| 7 | Health and Family welfare | 114.70 | 114.70 |
| 8 | Urban Development | 1424.37 | 1542.85 |
| 9 | Tourism | 63.26 | 92.35 |
| 10 | Panchayat Raj and Rural development | 37012.22 | 70598.92 |
| 11 | TSPCB | 23.00 | 17.00 |
| 12 | Setting up of Climate Change Knowledge Centre at EPTRI | 12.38 | 13.87 |
| 13 | Research Studies in Climate Change | 92.40 | 103.49 |
| | **Grand total** | **253906.02** | **379121.5** |

*Since Telangana was formed in June,2014, all the budgetary allocation here refer to financial year 2014 -17

# Chapter-8

# MONITORING AND EVALUATION

## 8.0 Background

Monitoring and Evaluation (M&E) is the key for measuring the effectiveness of implementation of the State Action Plan on Climate Change. Apart from measuring the degree of success of the key interventions, M&E would enable appropriate short-term and mid-term changes to the identified adaptation and mitigation strategies, correcting past mistakes and improving practices. Corrective actions might be required, for example, in the event of:

i) Impacts being more or less severe than anticipated.
ii) Key targets not being attained in time.
iii) Planned interventions not having the desired effect.

In the context of Telangana State, the aspects that would require monitoring and evaluation would be in terms of:

- State developmental goals vis-à-vis their integration of climate concerns in planning for achieving these goals.
- Sectoral level climate policies, programmes and actions.
- Interventions undertaken to achieve the objectives of the SAPCC.

## 8.1 Development objectives

It is important to monitor and evaluate the policies governing the State developmental goals, as many of them are likely to be affected by climate change. For example, the goal of reducing poverty may be affected by variability of rain fall, increase in ambient temperature, increase in extreme events etc. that reduce agriculture production, increase spread of diseases, deplete forest products etc., leading to loss of livelihoods. Therefore, devising climate sensitive policies for each of the developmental sectors is a necessity. It is equally important that monitoring and evaluation of the implementation of the policies is put in place to record the achievements, as well as to take corrective action.

## 8.2 Sectoral / Departmental level

The Telangana SAPCC has identified a set of 'Interventions' aimed primarily at enhancing the 'Adaptive Capacity' of vulnerable areas and populations. Some of the interventions are also in the nature of mitigation efforts at the level of production units, cities/towns and villages. The proposed interventions, which have been concurred to (at this stage of development) by the Government Departments concerned, follow the National Missions that form part of the National Action Plan on Climate Change (NAPCC).

The sectoral interventions have been organized according to the implementing Departments, to be consistent with the division of responsibilities within the State Government. While each of these interventions would need to be monitored by an array of monitoring tools, both financial and physical, only one or two key 'Monitoring Indicators,' in the nature of output or outcome, have been selected and listed for each of the interventions, in the SAPCC. A monitoring frequency appropriate to each of the monitoring indicators, insofar as the SAPCC is concerned, has also been suggested. The indicators and monitoring frequencies are shown as a 'Monitoring Matrix' against the interventions and related 'key issues'. To the extent possible, the 'Monitoring Indicators' are selected from those that are routinely monitored by the Department concerned, to integrate better with Departmental systems, and at lower cost.

There is at present no State level agency charged with the responsibility of measuring GHG emissions, preparing an inventory of GHGs emitted, and enforcing mitigation measures. Among existing agencies, the State Pollution Control Board would be the obvious choice, and a few suggested interventions in the hands of the TSPCB are also presented in the 'Monitoring Matrix' that follows.

**Exhibit -26: A Flow Diagram of Monitoring and Evaluation of SAPCC**

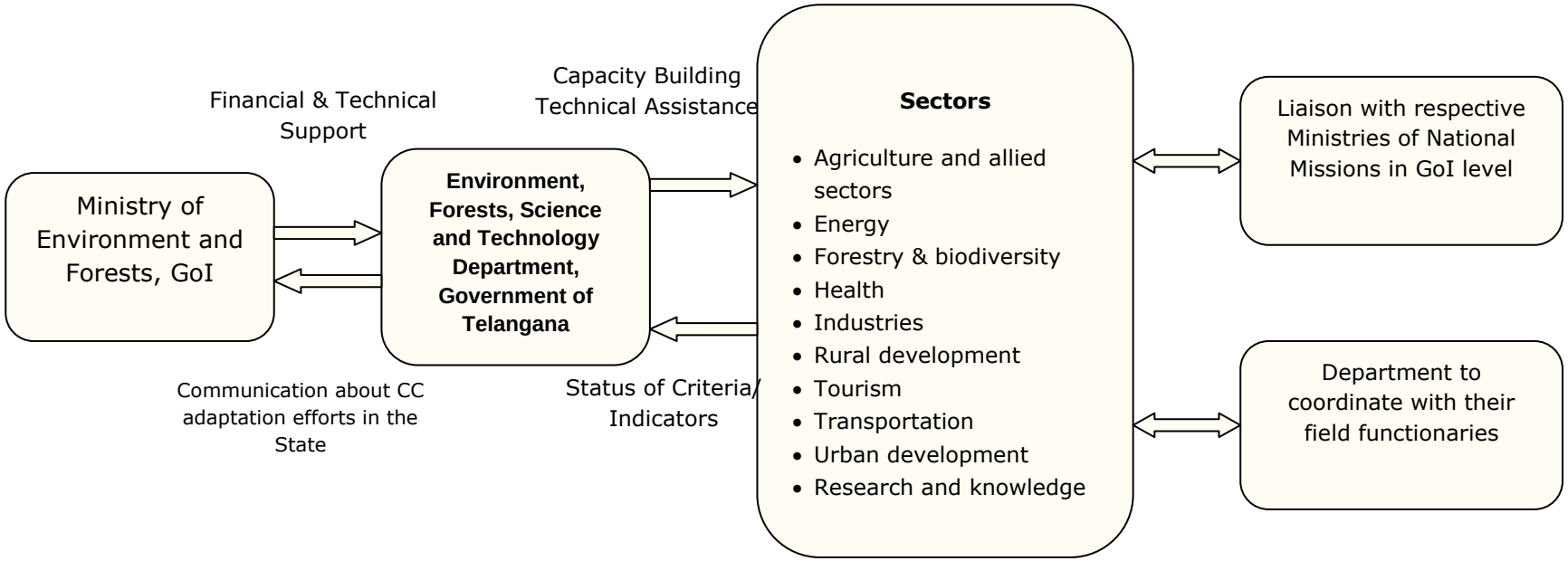


**Table - 30: Monitoring of Interventions related to the Telangana State Action Plan on Climate Change**

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | ***Rural Development (Panchayat Raj Engineering Department)*** | | | |
| 1 | Safe Water Supply as per norms to the entire rural population (projected population of 2022) | Enhancement of adaptive capacity (adequacy of water supply and quality of water, public health) | Per capita water supply (litres per day) available to the current population | As of every financial year end (12) |
| | | | Percentage of water supply conforming to standards (percentage of conforming samples, number of samples required to be defined based on population) | Over each financial year (12) |
| 2 | 100% coverage of sewerage and sanitation for the rural population (projected as of 2022) | Enhancement of adaptive capacity (safe sanitation, scientific disposal of liquid waste, public health) | Percentage of current population having access to sewerage and sanitation | As of every financial year end (12) |
| | | | Percentage of estimated liquid waste captured and treated | Over each financial year (12) |
| 3 | Study the climate change vulnerability of existing water supply and | Documenting the impact of climate change on basic municipal services | Disruptions or shortfalls in services as compared to the potential | Review every financial year end (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | sewerage/sanitation systems | | | Research and studies (occasional) |
| 4 | Remodel or strengthen existing water supply and sanitation/sewerage systems to reduce vulnerability to climate change | Enhancement of adaptive capacity (securing basic municipal services) | Work done during the year in comparison to identified need for remodeling or strengthening of systems | Review at end of every financial year (12) |
| 5 | All-weather road connectivity to all habitations (projected as of 2022) for access to goods and services, and for evacuation in emergency | Enhancement of adaptive capacity (road density) | Percentage of current population having access to all-weather road connectivity | As of every financial year end (12) |
| | Creation of new water bodies (lakes, tanks, kuntas etc.) and restoration of existing water bodies | Enhancement of adaptive capacity (stabilization of agriculture by enhancing potential for surface water storage and ground water recharge) | Thousand acre-feet or thousand hectare-metre storage capacity added in the financial year | As of every financial year end (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 6 | Increasing energy efficiency in street lighting and water pumping by Panchayats | Mitigation effort | Energy annually consumed by the Panchayat on public services per thousand population | Over each financial year (12) |
| | ***Panchayat Raj Department*** | | | |
| 1 | Increasing energy efficiency in street lighting and water pumping by Panchayats | -do- | -do- | -do- |
| 2. | Introduce spatial planning in rural areas to reduce and streamline vehicular movements | Mitigation effort | Percentage of current area of each Panchayat covered by master plan | End of each Plan period (60) |
| 3. | Public education on climate change and its effect on various sectors | Enhancement of adaptive capacity (dissemination of knowledge and behavioral change) | Number of person – hours of instruction | Over each financial year (12) |
| | ***Municipal Administration & Urban Development Department*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Safe water supply as per norms to the entire urban population (projected population of 2022) | Enhancement of adaptive capacity (adequacy of water supply and quality of water, public health) | Per capita water supply (litres per day) available to the current population | As of every financial year end (12) |
| | | | Percentage of water supply conforming to standards (percentage of conforming samples, number of samples required to be defined based on population) | Over each financial year (12) |
| 2. | 100% coverage of sewerage and sanitation for the urban population (projected as of 2022) | Enhancement of adaptive capacity (safe sanitation, scientific disposal of liquid waste, public health) | Percentage of current population having access to sewerage and sanitation | As of every financial year end (12) |
| | | | Percentage of estimated liquid waste captured and treated | Over each financial year (12) |
| 3. | Study and remodel existing water supply, sanitation and sewerage systems to reduce climate change vulnerability | Documenting and adapting to the impact of climate change on basic municipal services | Reduction of disruptions or shortfalls in services as compared to the potential | Review every financial year end (12) |
| | | | | Research and |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | | | | studies (occasional) |
| 4. | Protection and restoration of existing water bodies in urban areas | Enhancement of adaptive capacity (enhanced potential for surface water storage and ground water recharge) | Volumetric storage capacity restored (from disuse or dilapidation) or recovered (from encroachments) etc. | As of every financial year end (12) |
| 5. | Creation of new water bodies in urban areas | | Volumetric storage capacity newly created during the year | As of every financial year end (12) |
| 6. | Scientific management of municipal solid waste (MSW) and plastic waste in all municipalities and corporations (population and number of municipalities projected as of 2022) | Enhancement of adaptive capacity (safe disposal of MSW/PW, public health) | Tonnage of MSW / PW collected and treated compared to tonnage generated in the ULB | Over each financial year (12) |
| | | Mitigation effort through capture of $CH_4$ | Population covered by the system and its percentage to the total of the ULB | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 7. | Restore efficiency of the drainage network of municipalities and corporations to enable quick evacuation of water and to avoid flooding | Enhancement of adaptive capacity (reduced potential for flood damage in the cities and towns) | Volumetric improvement in the carrying capacity of the drains of the city or town | End of each Plan period (60) |
| | | | Critical review of episodes of flooding over the review period | Research and studies (occasional) |
| 8. | Mandatory rainwater harvesting in Government buildings, larger homes and apartment blocks, commercial establishments, offices, schools/colleges, academic/research establishments, industrial units and homes or clusters of homes | Enhancement of adaptive capacity (increased ground water recharge and reduced runoff) | Capacity created (this information can be captured and compiled from an appropriate query in the application for the 'Occupancy Certificate' for the building | End of each Plan period (60) |
| 9. | Policy and incentives for rooftop solar power generation and provision of grid connectivity | Mitigation effort (low carbon generation of electricity) | Generation capacity (MW) created and linked to the grid | End of each Plan period (60) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 10. | Rail based MRTS in emerging cities and expansion of existing MRTS | Mitigation effort (low carbon transportation) | Transportation system created (km or population served) | End of each Plan period (60) |
| | | | Utilization in terms of passenger-km or revenue earned | |
| 11. | Provision of safe footpaths, cycle tracks etc. to promote non-motorized transport | Mitigation effort (promoting low carbon modes of transportation) | Kilometer of dedicated non-motorized vehicle tracks created or restored | End of each Plan period (60) |
| 12. | Recovery of phosphates, nitrates etc. from wastewater (by either chemical or biological process) | Adaptation action (reduced downstream need for freshwater, recovery of useful chemicals) | Quantities of phosphates, nitrates, nitrites etc. recovered | End of each Plan period (60) |
| | | Mitigation effort through reduced $NO_x$ emissions | | |
| | ***Forest Department*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Protection and Conservation of forests, including fire protection | Adaptation (source of food, fuel and fodder, preservation of local climate and biodiversity, protection against extreme climatic events)<br>Mitigation (carbon sink) | Extent and density of forests | Biennial as per existing practice (24) |
| 2. | Soil and Water Conservation in forest lands | Adaptation (increased ground water recharge and reduced runoff for stabilization of green cover) | Increase in ground and surface water levels and changes in extent and density of vegetative cover | Biennial as per existing practice (24) |
| 3. | Afforestation and eco-development through community based programmes (like Joint Forest Management) in forest lands | Adaptation (source of food, fuel and fodder, preservation of local climate and biodiversity, protection against extreme climatic events like drought, storms, heavy rainfall) | Extent and density of forest and tree cover | Biennial (24) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 4. | Creation of forests in degraded/public lands, including such lands in and around cities and towns | | | Biennial as per existing practice (24) |
| 5. | Plantations for sustainable commercial utilization to reduce pressure on natural forests | Mitigation (carbon sinks) | Production | Over each financial year (12) |
| 6. | Public awareness programmes on conservation of forests and biodiversity | Increase in adaptive capacity (dissemination of knowledge) | Number of participants/programs/frequency | Biennial (24) |
| 7. | Documentation of biodiversity, including genetic fingerprinting | Documentation and adaptation to the impact of climate change | Diversity indices | End of each Plan period (60) |
| 8. | Preservation of rare/threatened germplasm (e.g. under cryogenic or other controlled conditions) | | Number of samples/species | End of each Plan period (60) |
| | ***Revenue (Disaster Management) Department*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Establishment of a Disaster Rapid Response Force, with rapid deployment capability, equipment, communication systems etc. | Enhancement of adaptive capacity (disaster prevention, preparedness and management of impact) | Number of units deployed and equipped vis-à-vis the assessed need | As of every financial year end (12) |
| 2. | Early flood warning system, including communication | | Extent to which system deployed and functional, vis-à-vis the plan | As of every financial year end (12) |
| | | | Test runs (disclosed or surprise) | Periodically as decided by the management |
| 3. | Protection works on rivers such as flood banks, groynes, dykes etc. | | Works done in the financial year, vis-à-vis the annual plan | Over each financial year (12) |
| 4. | Strengthen disaster mitigation policies/manuals/drills for State and districts | | Completion of initial drafting and issue, periodical reviews thereafter | Initial issue |
| | | | | Revision/review as decided (3-5 years) |
| | ***Agriculture & Cooperation Department*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Development and dissemination of new crop varieties resilient to heat, photo and water stress | Enhancement of adaptive capacity (research and dissemination for agricultural security) | Varieties developed, results of field trials, acreage planted, consumer acceptance | End of each Plan period (60) |
| | | | | Evaluation studies (occasional) |
| 2. | Replacement of inorganic fertilizers by bio-fertilizers (including urban compost and recovered $PO_4$, $NO_3$ etc.) | Enhancement of adaptive capacity (research and dissemination for agricultural security) | Bio-fertilizers and bio-weedicides/pesticides developed, results of trials, sales, consumer acceptance, | End of each Plan period (60) |
| 3. | Reducing the use of synthetic pesticides and weedicides, and promoting the use of bio-pesticides | Mitigation effort by reducing $NO_X$ emissions | | Evaluation studies (occasional) |
| 4. | Assured credit facility, including for tenant farmers | Enhancement of adaptive capacity (stabilization of agriculture for agricultural security) | Indicators exist for measuring the disbursement and utilization of agricultural credit | Over each financial year (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 5. | Insurance against crop failures (not just for the bank loan component) | Enhancement of adaptive capacity (stabilization of agriculture for agricultural security) | Indicators exist for measuring the coverage, efficacy, efficiency and client-friendliness of insurance | Over each financial year (12) |
| 6. | Increase the efficiency of water use | Enhancement of adaptive capacity (research and dissemination for agricultural security) | Water used per unit crop produced (for various crops) | Over each agricultural year (12) |
| 7. | Extension work for change of cropping timings and patterns, efficiency of water use, weather advisories to farmers, information on market prices etc. | | Indicators exist for measuring the performance of agricultural extension staff and results achieved. | Over each financial year (12) |
| 8. | Intensive research work on stable agriculture in the context of climate change, in all its aspects | Enhancement of adaptive capacity (research and dissemination for agricultural security) | This is a new area of work in the State. Suitable indicators have to be 00000developed. | To be decided |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 9. | Establishment of field centers, data banks and germplasm banks | Enhancement of adaptive capacity (protection of biodiversity related to agriculture) | *This is a new area of work in the State. Suitable indicators have to be developed.* | *To be decided* |
| 10. | Use of fuel or energy efficient irrigation pump sets and other agricultural equipment | Mitigation effort (reduced $CO_2$ emissions) | Number of efficient pump sets or efficient agro-equipment sold (can also be compared to an annual target) | Over each financial year (12) |
| 11. | Retrofitting existing pump sets for higher energy efficiency | | Number of pumps retrofitted (can be compared to an annual target) | |
| | ***Transport Department*** | | | |
| 1. | Enhance the share of public transport in the total transportation mix | Mitigation effort (reduced $CO_2$ emissions) | Share of public transport in total passenger-kilometer travelled | End of each Plan period (60) |
| 2. | Enhance the share of low emission/fuel-efficient vehicles and vehicles that run on alternate fuels | Requires major policy decisions, investments and public-private partnerships | Number of low-emission vehicles in the total (from vehicle registration data) | As of every financial year end (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 3. | Encourage non-motorized transport like walking and cycling | | Share of non-motorized transport in total passenger-kilometer travelled | End of each Plan period (60) |
| 4. | Design or redesign road networks so as to facilitate smooth traffic movement and non-motorized transport | Also requires changes to spatial planning of cities | *Suitable indicators have to be developed* | End of each Plan period (60) |
| 5. | Interlink private and public transport modes so as to minimize the use of private transport | | Share of public transport in total passenger-kilometer travelled | End of each Plan period (60) |
| | ***Health, Medical and Family Welfare Department*** | | | |
| 1. | Undertake longer-term studies to investigate links between climate change and disease patterns, as also between pollution loads and disease patterns | Enhancement of adaptive capacity (understanding and documenting the links between climate change and health) | Research papers published, policy inputs provided | End of each Plan period (60) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 2. | Research on development of low cost vaccines, particularly those related to vector borne diseases | Enhancement of adaptive capacity (preventive public health measures) | Vaccines developed, tested and released for use in the public health system | End of each Plan period (60) |
| 3. | Public education on prevention of diseases related to climate change and resulting from environmental pollution | Enhancement of adaptive capacity (preventive public health measures) | Indicators exist for measuring the efficacy of public health education | Over each financial year (12) |
| 4. | Strengthen detection and early warning systems for outbreaks of diseases | Enhancement of adaptive capacity (detection of threats to public health, warning and response) | Extent to which system deployed and functional, vis-à-vis the plan | As of every financial year end (12) |
| 5. | Health Surveillance | | Test runs (disclosed or surprise) | Periodically as decided by the management |
| 6. | Development of rapid response capabilities to handle the impacts of climate related events such as exposure to sun, floods, cyclones and prolonged droughts | | Extent to which system deployed and functional, vis-à-vis the plan | As of every financial year end (12) |
| | | | Test runs (disclosed or surprise) | Periodically as decided by the management |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | ***Energy Department*** | | | |
| 1. | Improve the efficiency of thermal power generation | Mitigation effort (reduced GHG emissions) | Indicators exist for measuring the efficiency of thermal power generation | As decided by the utility management or electricity regulatory authority |
| 2. | Improve the efficiency of transmission, including elimination of pilferage | Mitigation effort (reduced GHG emissions) | Indicators exist for measuring the efficiency of transmission | As decided by the utility management or electricity regulatory authority |
| 3. | Improve the efficiency of electrical equipment, including water pumping equipment used in agriculture | Mitigation effort (reduced GHG emissions) by enforcing efficiency | Indicators exist for measuring the efficiency of electrical equipment, ratings also exist | As decided by the Government, or by the Bureau of Energy Efficiency |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 4. | Promotion of affordable alternative energy sources i.e. solar home systems, solar street lights, solar thermal systems | Mitigation effort (reducing GHG emissions) | Indicators exist under the renewable energy programme of the Government | As decided by the Government |
| 5. | Rationalization of power tariff for user segments that are currently subsidized | Mitigation effort (reducing GHG emissions) through efficiency | Policy decisions | Monitoring frequency cannot be set in advance |
| 6. | Electricity generation using non-conventional sources like agricultural residues, municipal solid waste, flows in irrigation canals, tide, wind and solar | Mitigation effort (reducing GHG emissions by promoting renewable energy sources) | Indicators exist under the renewable energy programme of the Government | As decided by the Government |
| | ***Tourism Department*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Promote low emission/fuel-efficient mass transportation, to and within tourist areas (e.g. battery operated vans operating around the Taj Mahal) | Mitigation effort (reducing GHG emissions) | Vehicle trips replaced by energy-efficient transportation | End of each Plan period (60) |
| 2. | Promote energy efficient lighting, efficient climate control equipment etc. in hotels and other areas where tourists congregate | Mitigation effort (reducing GHG emissions) | Indicators exist for measuring the efficiency of electrical equipment, ratings also exist | As decided by the Government, or by the Bureau of Energy Efficiency |
| 3. | Promote eco-tourism to enhance environmental consciousness | Enhancement of adaptive capacity (dissemination of knowledge and behavioral change) | This would be a new area of work in the State. Suitable indicators have to be developed | End of each Plan period (60) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 4. | Enforce cleanliness in tourist areas | Mitigation effort + Adaptation (reduce GHG emissions, public health measure, reduce pollution) | Observations, customer feedback, site specific evaluation studies | Periodicity of evaluation to be decided by authorities concerned |
| 5. | Protect both built and natural heritage against climate related damage (e.g. damage from high temperature, water accumulation, pests etc.) | Adaptation (reduce climate induced damage and restore damage already occurred) | Damage prevented, ascertained by site specific evaluation | Periodicity of evaluation to be decided by authorities concerned |
| | ***Industries Department*** (both Mines and Industries) | | | |
| 1. | Enforce 'cleaner production processes' and waste minimization, including reduction of water consumption, across | Adaptation (reduction of waste and pollution) + Mitigation effort (to reduce GHG emissions) | Carbon intensity of State Domestic Product (in line with national policy) | End of each Plan period (60) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | industries, in partnership with the Central and State Pollution Control Boards | | | |
| 2. | Minimize environmental damage including GHG emissions, caused by industrial and mining activities | | Number of industrial units adopted cleaner production / waste minimization or value of production using such processes | End of each Plan period (60) |
| 3. | Assess the vulnerability of major industrial hubs to climate related risks | Enhancement of adaptive capacity (reduce the threat from extreme climate events to industries, production capacity and infrastructure) | Monitoring against the targets and schedules set in the adaptation plan for industries | End of each Plan period (60) |
| 4. | Protection and disaster mitigation works to minimize risks to industrial hubs (e.g. seawalls, alternate rail and road access, improving drainage, alternate water supply sources etc.) | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 5. | Promote diversified and dispersed industries, including small/medium scale agro processing, to stabilize rural livelihoods | Enhancement of adaptive capacity (dispersal of industry to reduce risk, stable livelihoods, value addition to agriculture) | Increments in (i) per capita GDP (ii) employment in organised sector (iii) other economic indicators in districts having low adaptive capacity | End of each Plan period (60) |
| | ***Irrigation & Command Area Development Department*** | | | |
| 1. | Full utilization of the sustainable surface water irrigation potential, to stabilize agricultural production | Enhancement of adaptive capacity (stabilization of agriculture and agricultural livelihoods) | Indicators and mechanisms exist for monitoring the gross and net surface irrigation | As of every financial year end (12) |
| 2. | Utilization of the sustainable groundwater potential, to stabilize agricultural production | | Indicators and mechanisms exist for monitoring the utilization of groundwater and its sustainability | As of every financial year end (12) |
| 3. | Strict regulation of ground water abstraction | Enhancement of adaptive capacity by ensuring the sustainability of | Law, enforcement mechanism, indicators and monitoring mechanisms exist | As of every financial year end (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | | groundwater use | | |
| 4. | Minor irrigation works and other engineering solutions to recharge groundwater aquifers | Enhancement of adaptive capacity (recharging groundwater aquifers and stabilizing agriculture) | Indicators and mechanisms exist for monitoring the progress of works and impact on groundwater storage | As of every financial year end (12) |
| 5. | Monitoring and early warning of river flows, to minimize flood damage | Adaptation action of preventive nature to reduce the risk to life and property | This is an ongoing work, and would be monitored against targets / objectives set in the plan | As of every financial year end (12) |
| 6. | Inter-State coordination of river management agencies to manage flood flows | | | As of every financial year end (12) |
| 7. | Assured water supply to urban centers and industrial hubs | Enhancing adaptive capacity by assuring the supply of raw water | Indicators exist for monitoring the availability of raw water vis-à-vis demand | Over each financial year (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | | | | |
| 8. | Treatment and recovery of wastewater (agricultural, municipal and industrial) for reuse | Adaptation action by reducing the demand for fresh water | Quantum of wastewater reused | Over each financial year (12) |
| 9. | Recovery of minerals and phosphates, nitrates etc. from wastewater | Adaptation action (reduced downstream need for freshwater, recovery of useful chemicals) | Quantities of phosphates, nitrates, nitrites etc. recovered | End of each Plan period (60) |
| | | | | |
| | | Mitigation effort through reduced $NO_x$ emissions | | |
| | ***Telangana State Pollution Control Board*** | | | |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| 1. | Monitor emissions, including GHGs | Detection, measurement and documentation of emissions and effluents; inventorisation of GHGs | Monitoring of emissions and effluents is an ongoing activity and well established indicators exist. Inventorisation of GHG emissions, if required by the Government, would be a new activity. | As per legal requirements or CPCB norms |
| 2. | Monitor effluents | | | |
| 3. | Enforce cleaner production techniques and penalize 'dirty production' | Adaptation (reduction of waste and pollution) + Mitigation effort (to reduce GHG emissions) | Carbon intensity of State Domestic Product (in line with national policy) | End of each Plan period (60) |
| | | | Number of industrial units adopted cleaner production / waste minimization or value of production using such processes | |
| 4. | Enforce the laws on management of municipal solid waste and plastic waste (the PCB is a statutory | Enhancement of adaptive capacity (safe disposal of MSW/PW, public health) | Tonnage of MSW / PW collected and treated compared to tonnage generated in the ULB | Over each financial year end (12) |

| Sl. No. | Intervention | Related Key Issue(s) | Monitoring Indicator(s) | Monitoring Frequency (months) |
|---|---|---|---|---|
| | authority in this matter) | Mitigation effort through capture of $CH_4$ | Population covered by the system and its percentage to the total of the ULB | |
| 5 | Enforce energy audit in industries generally (or selected industries or classes of industries) | Mitigation effort | Percentage of industries conducting the audit among those required to | As per legal requirements or statutory norms |
| | | | Energy saved as a result of action following from the audit | |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