Meghalaya State Climate Change Action Plan

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Disclaimer

While every care has been taken to ensure the accuracy of information published in this report, some errors or discrepancies might have crept in advertently and un-intentionally. We request the readers to bring such errors/ omissions to our notice so that necessary corrective action can be taken up.

Abbreviations and Acronyms

ADC	Autonomous District Councils
AMD	Acid Mine Drainage
AT&C	Aggregate Technical and Commercial
BEE	Bureau of Energy Efficiency
BOD	Biological Oxygen Demand
BPL	Below the Poverty Line
CCAP	Climate Change Action Plan
C&D	Construction and Demolition
CDM	Clean Development Mechanism
CDP	City Development Plan
CFL	Compact fluorescent lamp
CO2	Carbon Di Oxide
CPP	Captive Power Plants
DMG	Department of Mining and Geology
DO	Dissolved Oxygen
DPR	Detailed Project Report
DSM	Demand Side Management
ECBC	Energy Conservation Building Code
ENVIS	Environmental Information System
ESCO	Energy Services Company
FDA	Forest Development Agency
GHG	Green House Gas
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI	Government of India
GoM	Government of Meghalaya
GSDP	Gross State Domestic Product
ha	Hectares
HVAC	Heating, Ventilating, and Air Conditioning
IGEA	Investment Grade Energy Audit
ICIMOD	International Centre for Integrated Mountain Development
IMR	Infant Mortality Rate

IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPP	Independent Power Producer
IREDA	Indian Renewable Energy Development Agency
IRRI	International Rice Research Institute
ISPRS	International Society for Photogrammetry and Remote Sensing
IWRM	Integrated Water and Resources Management
JFM	Joint Forest Management
JFMC	Joint Forest Management Committees
kWh	Kilowatt Hour
LED	Light-emitting diode
LPG	Liquefied Petroleum Gas
mm	Milimeter
m	Meter
MCM	Million Cubic Meters
MECL	Meghalaya Energy Corporation Limited
mha	Million Hectare
MNRE	Ministry of New and Renewable Energy
mn MT	Million Metric Ton
MSCC&SD	Meghalaya State Council on Climate Change and Sustainable Development
MoEF	Ministry of Environment and Forest
MoP	Ministry of Power
MREDA	Meghalaya Non-Conventional and Rural Energy Development Agency
MSDMA	Meghalaya State Disaster Management Authority
MSME	Micro, Small and Medium Enterprises
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NE	North East
NECCAP	North East Climate Change Adaptation Programme (A 7 year bilateral programme between the Government of the Federal Republic of Germany and the Government of India.
NEHU	North Eastern Hill University
NESAC	North Eastern Space Applications Centre
NH	National Highway

NO2	Nitrous Oxide
NOx	Oxides of Nitrogen
NS-EW	North-South Expressway
NTFP	Non-Timber Forest Products
PCCF	Principal Chief Conservator of Forests
PHE	Public Health Engineering
PMPC	Planting Material Production Centre
PPP	Public Private Partnership
PWD	Public Works Department
R&D	Research & Development
REDD	Reduce Emission from Deforestation and Degradation
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RWH	Rain Water Harvesting
SCADA	Supervisory Control and Data Acquisition
SG	Sacred Groves
SoE	State of Environment
SOX	Oxides of Sulphur
SPCB	State Pollution Control Board
SPM	Suspended Particulate Matter
SPV	Solar Photo Voltaic
SRI	Systematic Rice Intensification
S&T	Science and Technology
SWC	Soil and Water Conservation
SWM	Solid Waste Management
T&D	Transmission and Distribution
THI	Temperature–Humidity Index
TPD	Tonnes Per Day
ULB	Urban Local Body

Executive summary

Climate Change and Meghalaya

Climate sensitivity of the state comes from the fragile-ecosystem of the region where it is located extending to about 22,429 sq. kms. The varied physiological features of the state and the altitudinal differences gives rise to varied types of climate ranging from near tropical to temperate and alpine which is likely to be disturbed considerably under the impact of weather variability. The vulnerability of the state to water-induced disasters because of its location in the eastern Himalayan periphery, fragile geo-environmental setting and economic under-development is likely to poses considerable threat to the resilience of poorer and vulnerable community. The powerful hydrological and monsoon regime of the region, especially the Brahmaputra and the Barak (Meghna) river system which are figures out as resources to the state can also turn out to a source of vulnerability.Meghalaya's economy is closely tied to its natural-resource-base and climate-sensitive sectors such as agriculture, water, and forestry. Climate change as projected might result in increasing mean annual temperature, variability of rainfall pattern and seasonal shift in weather pattern which is likely to result into destructive effect on the agriculture, the mainstay vocation in the state. Moreover the highly dispersed and the vulnerable population segment of the state is poorly equipped to cope effectively with the adversities of climate change due to low capabilities, weak institutional mechanisms, inability to diversify to other livelihood activities and lack of access to adequate resources to enable the community to recover from climate shocks. The climate change action plan is thus formulated to strategize adaptation and mitigation initiative towards emission stabilization and enhancing the livelihood resilience and adaptive capacity of the poor and vulnerable section of the society.

Plan Process

Government of Meghalaya has taken the climate change issue very seriously. Meghalaya State Council on Climate Change and Sustainable Development (MSCC&SD) which will coordinate state action plan for assessment, adaptation and mitigation of climate change has been constituted with Honourable Chief Minister as the chair person.

	Incumbent	Position
1.	Chief Minister	Chairperson
2.	Minister, Forest and Environment	Member
3.	Minister, Agriculture and Irrigation	Member
4.	Minister, Water Resources	Member
5.	Minister, Soil and Water Conservation	Member
6.	Minister, Science and Technology	Member
7.	Minister, Power and Non-Conventional Energy Resources	Member
8.	Chairman, State Planning Board	Member
9.	Chief Secretary Meghalaya	Member
10.	Vice Chancellor NEHU, Shillong	Member
11.	Addl. Chief Secretary, Planning	Member
12.	Addl. Chief Secretary, Finance	Member
13.	Chief Executive Members, District Councils	Member

	Incumbent	Position
14.	Principal Secretary/ Commissioner and Secretary, Planning	Convener

This high level council is mandated to:

a. Evolve a coordinated response to issues relating to climate change at the State level;
b. Provide oversight for formulation of action plans in the area of assessment, adaptation and mitigation of climate change;
c. Periodically monitor key policy decisions and their implementation status
d. Any other function that may be deemed necessary by the Council from time to time

Further a steering committee has been formed to steer the whole process.

	Incumbent	Position
1.	Chief Secretary Meghalaya	Chairperson
2.	Principal Secretary Planning/ Commissioner & Secretary, Planning	Member
3.	Principal Secretary/ Commissioner Secretary Forests and Environment	Member
4.	Principal Secretary/ Commissioner & Secretary Finance	Member
5.	Principal Secretary/ Commissioner & Secretary Agriculture	Member
6.	Principal Secretary/ Commissioner & Secretary Horticulture	Member
7.	Principal Secretary/ Commissioner & Secretary, Water Resources	Member
8.	Principal Secretary/ Commissioner & Secretary Soil and Water Conservation	Member
9.	Principal Secretary/ Commissioner & Secretary C & R Development	Member
10.	Principal Secretary/ Commissioner & Secretary Science & Technology	Member
11.	Principal Secretary/ Commissioner & Secretary Power & Nonconventional Energy	Member
12.	Principal Chief Conservator of Forests (PCCF)	Member
13.	Directors of Agriculture/ Horticulture/ Soil & Water Conservation/ Community & Rural Development	Member
14.	Chief Engineer Irrigation/ Water Resources	Member
15.	Officers and/ or experts who may be co-opted from time to time by the Chairman	Member

Agriculture

The economy of Meghalaya is basically agrarian. Since, 70% of the state's population depends on Agriculture, employment and income generation also depends on agricultural developmental activities to a great extent. The agriculture sector in Meghalaya contributes 22% to the Gross State Domestic Product (GSDP). Though, 70% of the population depends on agriculture, the net cropped area is only about 9.76 % of the total geographical area of the State. Rice is the predominant crop of the state. Other dominant crops are potato, pineapple, ginger, maize, areca nut, jute, bamboo, and a wide variety of fruits, flowers and spices. The state is very much vulnerable to the impacts of a changing climate and has faced wrath of freak weather events in the recent past. The state is also prone to floods and soil erosion making the agriculture sector

much more vulnerable. Around 815,000 hectares in Meghalaya have been affected by soil erosion. High rainfall variability, weather shift and projection of water stress during the cropping season may result in decline of grain yield. Low net ground water availability, lack of irrigational facility along with large number of small and marginal land holding is likely to exacerbate the impact of climate change. Following are the key priority action proposed under agriculture mission of SAPCC.

Agriculture - Key Priorities

1. *Assessment of soil quality & soil moisture content for better productivity through generation of climatic information*
2. *Impact assessment of paddy cultivation and promotion of rain water harvesting through construction of eco friendly mini check dams.*
3. *Increasing the area under perennial fruit plantation crops and low volume high value crops to help cope with uncertain weather patterns.*
4. *Management of climate change impact on Horticulture*
5. *Improving post- harvest management such as cold chain for perishable crops and winter cultivation practices*
6. *Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops*
7. *Promotion of organic farming through usage of compost and vermin-compost*
8. *Breeding and production of varieties with stress tolerant and resistant attributes*
9. *Assessment study and demonstration of Systematic Rice Intensification (SRI) cultivation*
10. *Local mass production of such varieties for distribution to the farmers as substitutes to lesser tolerant varieties - setting up of 'Planting Material Production Centres'*
11. *Capacity building to train farmers in latest cropping techniques specially evolved to counter adverse effects of climate change*
12. *Assessment of impact of climate change in livestock and reduction of impact of vector borne diseases through vaccination of farm animals, breeding policy for climate resilient*
13. *Development of water management in minor irrigation through construction of check dams, rain water harvesting and revival of existing water bodies as adaption measures.*
14. *Impact assessment of climate change on fishery and development of watershed vulnerable to climate variations.*

Sustainable Habitat

Urbanisation in Meghalaya is much lower than the national average (28%) with an urban population of only 19.58% (Census 2001). Majority of the state's population is still continuing to live in rural areas. The urban population has however maintained a steady growth over last couple of years. The state envisages a huge gap between the demand and supply of basic urban services. Census 2001 reports that only 71% of the urban population have access to drinking water through taps. Challenges in water supply include improvement in distribution system, inequitable distribution, water resource management and treatment, rationalisation of water use. Sanitation poses major problems with the absence of adequate sewerage system in urban areas resulting in drainage of domestic effluent into nearby rivers and streams leading to contamination of water sources. Moreover about 8.41% of the population is without sanitation facility. Absence of storm water drainage poses problems of water logging and flooding, causing landslides and soil erosion. Indiscriminate developmental activities also add to the problem by obstructing drains and encroaching rainwater flow paths. Solid waste is another pressing urban issue for Meghalaya primarily because of its difficult terrain. Inadequate collection and

improper disposal currently lead to spillage and contamination of soil and surface as well as groundwater streams. Presently within Shillong Urban Agglomeration area generates about 175 TPD of Solid waste.

The urban transport sector has been largely neglected, characterised by heavy traffic congestion due to narrow roads, rapid growth in number of vehicles along with highly topographic and concentric development. Public transport is limited due to inadequate road network, poor infrastructure and scattered demand.

Within the state about 22% of the urban population is estimated to be BPL population (according to town surveys as per old guidelines). 45 slums have been identified and notified, 5 more have been identified and yet to notified within the 6 towns in Meghalaya. Slum population constitutes around 42% of the population of these towns. Housing in urban Meghalaya is primarily characterised by medium density development with 4.5% of the urban population living in dilapidated condition. As per the 2001 Census, the condition of house used for residence and other purposes in the urban areas shows that 60.8% are in good condition, 34.7% in liveable condition and 4.5% in a dilapidated condition. Following are the key priority action proposed under sustainable habitat mission of SAPCC.

Key Priorities -Sustainable Habitat

1. *Capacity Building on Climate Change Impacts and Preparedness*
2. *Incorporate Climate Concerns in Urban Water Supply and Sewage Design. E.g. Liquid waste Management*
3. *Working Towards Greater Water Use Efficiency and conservation in Urban Areas*
4. *Developing a climate friendly waste management system*
5. *Development of satellite townships*
6. *Environmental Profiling and GHG Emissions Inventorisation for all urban bodies including upcoming satellite townships*
7. *Energy efficient Street Lighting*
8. *Wprove enforcement to control vehicular pollution*
9. *Urban poor mapping to identify vulnerable urban population*
10. *Undertaking carrying capacity study of the areas*

Sustainable Forestry

With more than two third of its land area still forested, Meghalaya is one of the eight states of North-eastern India with high potential for the development and conservation of forest cover. There are, however, various constraints to the development of forest cover as degraded by the development of industries and mining activities along with rapid urbanization in the state and the dearth of real time information regarding the status of existing forest cover. Climate change impacts can be minimized by increasing forest cover and conservation of biodiversity. The state does not possess proper land records to chronicle deforestation and overall degradation.

Also there is huge potential for development of forest based enterprises for which enabling forest policy is required. Some of the emerging problems for loss of forest and biodiversity are land tenure systems in the state, lower enforcement of District Council Acts wherever applicable, overexploitation of ornamental and medicinal plants and animal products, conversion of mixed forests into monoculture forests and habitat destruction, conversion of forests areas into agricultural lands, urbanization and industrialization. Shifting agriculture, logging, mining and other human activities have also been responsible for fragmentation, destruction and degradation of the forests in the state. High rainfall and hilly terrain have further accentuated the impact of human activities on the forest. Almost the entire state is

influenced by age-old practice of slash and burn agriculture, except some pockets of valley bottomlands. This practice destroys the protective and productive vegetation in preference to a very brief period of immediate crop production. In order to earn their livelihood people practice shifting cultivation and over-exploit forest resources, causing serious damage to the forest and biodiversity. Following are the key priority action proposed under Green India mission of SAPCC .

Key Priorities - Sustainable Forestry

1. *Assessment of biodiversity and preparation of micro-plans for conservation*
2. *Assessment of Afforestation-Reforestation for emission reduction and sustainable livelihood*
3. *Institutional capacity building, implementation and evaluation for forest development and management for climate change*
4. *Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change*
5. *Undertaking study on valuation of forest resources (Non traded) and Monitoring of carbon stock and biodiversity at regular intervals*
6. *Study on Climate change impact on forest cover (Temperature and Rainfall regime) and indicative adaptation measures*
7. *Site identification and survey demarcation and PRA for community Forest land*
8. *Adaptive species identification for effective plantation through establishment of Permanent Nursery*
9. *Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions*
10. *Increase plantation and ecological restoration on non-forest/ degraded forest land through different plantation and soil conservation programme*
11. *Assess additional threats to biodiversity and wildlife and mitigation of man- animal conflicts due to Jhum, cash crop cultivation in elephant corridors*
12. *Encourage continuance of existing community forests by way of giving inputs towards sustainable livelihood options.*

Sustainable Water Management

Climate data from recent years as well as modelling results for the future predict decreases in winter (dry), and increases in summer (wet) precipitation. In addition to this, climate change is set to increase uncertainty in weather patterns as well as increases in frequency of extreme weather events. These can have adverse consequences for agriculture, water security and the safety of the people. Therefore it is essential for state government to synthesize an adaptation strategy that can protect vulnerable section of the society from these climate shocks. The water resource in the state are currently threatened with contamination, siltation and pollution primarily contributed from coal mining. The water in these areas is highly acidic with silt and suspended solids were deposited at the bottom of these water bodies. The agricultural field in the state has turned into unusable infertile land.

The irrigation potential of the state is approximately 2.18 Lakhs Hectares. Out of the total 23351.72 Hectares is under surface water and 1913.45 Hectares under the ground water irrigation. There are huge potential in minor irrigation in both the surface and ground water within the state. However, very small percentage of the total potential has been utilised. In Meghalaya only 18.52 % of gross sown area is having irrigation facilities. Within the state about 25 watersheds are present which are further divided into 179 sub watersheds. The water management mission of the state would provide 350 kms of waterways, irrigation for 35 lakh acres, generate 1500 MW of power and provide drinking water for 60% people in the state. Following are the key priority action proposed under national water mission of SAPCC .

Key Priorities -Sustainable Water Management

1. *Formulation of water use policy*
2. *Expansion of hydrometry network*
3. *River health monitoring and environmental flow study*
4. *Restoration and creation of water bodies*
5. *Preparation and implementation of water management plan*
6. *Agricultural zoning and capacity building of farmers*
7. *Micro-hydel projects*
8. *Development of flood/ drought forecasting models*
9. *Establishment of River Basin Authority*

Mining Sector

Meghalaya is extremely rich in mineral resources. The level of exploitation of the mineral resource is poor and the captive utilisation is also too low. Most of the coal reserves are on private lands and the method employed in Meghalaya is the age old rat-hole method. The rate of recovery of coal is very low in this method. Unscientific coal mining in the state has caused major damage to the environment primarily land degradation. One of the most perceptible damages caused by the rat-hole mining is the degradation of land. These rat-hole pits get filled up with water during rain and percolate into ground water or floods into rivers, streams and pollutes the water resources. In addition, the soil extracted from these mines washes away to nearby rivers, streams, lakes causing siltation and increasing the risk of flood. The Sulphur present in the coal makes the water acidic and has converted many agricultural lands infertile. Pollution from increased vehicular traffic due to mining activities, suspended particulate matter and gaseous emissions makes matter worse.

Mining also adds dust to the air through fugitive emission leading to health hazards of the local inhabitants. Increasing vehicular movement for transportation of the mineral ore also contributes to the air pollution through SPM, SOX and NOX emission. Being energy intensive, this sector is a major contributor to state's greenhouse gas emissions.

Since much of the land is privately owned, mining in the state is largely unregulated and unscientific. All of this emphasizes on the need for an effective policy on mitigating emissions and minimizing impacts. At the same time it is necessary to set up institutions and undertake capacity building exercises, as part of an adaptation strategy, in order to ensure sustainable mining and economic development. There are various initiative planned to mitigate as well as adapt climate change. All these initiatives pertain to three goals- emission reduction, capacity building and adaption measures. Following are the key priority action proposed under mining sector of SAPCC .

Key Priorities -Mining Sector

1. *Incorporate climate concerns in state mineral policy and state industrial policy e.g. 'polluter pays principle'.*
2. *Analyzing appropriate policies to promote energy efficiency*
3. *Exploring potential of Low Grade Mineral Beneficiation*
4. *Strengthening environmental monitoring and introducing environmental safeguards*
5. *Identification and maintenance of green zones in mining clusters*
6. *Capacity building and generating awareness among local community, mining personnel and government departments.*
7. *Analyzing appropriate policies to promote energy efficiency*

Energy Sector

Outlook towards linking climate change and energy sector are usually centred on mitigation effort because the current fossil fuel based energy generation method is a major contributor to climate change. Developing options of low carbon growth and reducing carbon footprint are important activities towards limiting the degree of future climate change.

Energy and water sector are closely and dynamically linked. All human devised energy system have water footprint to one degree or others including non-consumptive transfer of river flow in case of hydro power or consumptive use of water in thermal plant and bio fuel plantation. The projected impact of the variation of precipitation level due to climate change will severely impact the hydropower generation which in turn will change the energy supply scenario at the state level where hydro-generation has a lion's share. Also the lower availability of water and enhanced temperature level resulting from heat waves will severely impact the cooling process of thermal power project. Power station other than hydro that bank on availability of water for its operation (for cooling and also as heat transfer fluid) may have to shut down if water level or availability gets too low. Higher ambient temperatures may affect the efficiency and capacity ratings of fossil-fuel-powered combustion turbines. Even increased threat of flooding in flood prone area which is projected as possible impact of climate change will lead the power plant and electricity distribution network vulnerable.

On demand side regions that will face warmer temperature and lower precipitation level will call for an increase of electricity demand because of higher use of electric gadget and farm irrigation resulting to knock on effect on energy consumption and will thereby enhance the pressure on electricity distribution network through increased seasonal demand.

Impact of extreme events due to climate change on energy sector can damage economic and social infrastructure because of the fact that centralised power plants tend to serve large catchment of population and are also sensitive to climate change.

Biomass still dominates to meet household energy requirement in the state e.g. fuel wood, agricultural waste, dung, etc.. The natural resource sector is more vulnerable to adverse effects of water cycle changes and extreme climate events and might affect the poorest segment of the society. Following are the key priority action proposed under National Solar mission and mission of enhanced energy efficiency SAPCC.

Key Priorities -Energy Sector

1. *Undertaking hydrology study of existing Hydro power source in light of observed and projected impact of climate change and framing adaptation measures*
2. *Functional Reorganisation and Institutional development of State Energy Department*
3. *Establishment of Evacuation Corridor and strengthening of transmission and distribution network*
4. *Demarcation of Hydro power potential in the state with site specific capacity mapping*
5. *Life Cycle Analysis of Existing hydro power plant and implementation of R&M measures*
6. *Reduction of AT&C losses*
7. *Facilitating overall village electrification*
8. *Implementation of Pilot Energy Efficiency Project and IGEA*
9. *Promoting Energy Efficiency Practices in the State*
10. *Creating State Energy Conservation fund*
11. *Maximising harnessing of Renewable Energy for the purpose of Power Generation*
12. *Maximum and judicious utilisation of renewable energy resources for household*

Cross Cutting Issues

Although not new, collaboration across the sectors—private, public and civil society—has traditionally been defined by a single issue or geography. 'Convergence' is a more complex form of collaboration involving multi-stakeholder coalitions, seeking to affect systemic change on wide-ranging issues, focused on outcomes rather than inputs to deliver scalable and sustainable change.

Cross-sectoral challenge	Sectors-Involved	Actions	Typology of action	Anticipated conflict
Damage to the housing and storage infrastructure in flood prone areas	Agriculture, Water, Housing	Change in crop storage structure and raised plinth	Adaptation	Medium
Food Insecurity during extreme weather conditions	Agriculture, Horticulture, Rural Development	Food preservation, seed bank, homestead garden	Adaptation	Low
Management of water scarcity	Agriculture, Rural Development, Water, PHED, Health	Raising the plinth of tube-wells	Adaptation	Medium
Alternate livelihood during flooding conditions	Agriculture, Animal Husbandry, Fishery	Duck rearing, seed storage, Banana cultivation	Adaptation	Low
Basin/Flood Plain Management	Water, Agriculture, Industry, Energy	Integrated water resource management at basin level should determine the apportionment of water different sectors	Adaptation	High
Promoting sustainable agricultural practices	Agriculture, Rural Development, Forestry	Prevention of slash and burn type shifting cultivation and moving to better agro-silvicultural pattern	Adaptation	High
Preserving the bio-diversity	Forest, Fishery, District autonomous councils	Requires a holistic action to preserve the flora as well as the fauna including the aquatic ones of a specific area	Adaptation	Medium
Institutionalising Energy use efficiency	Energy, Industry, Works, Agriculture	A multi-layered approach to change the mindsets, methods and appliances to improve end-use efficiency and process efficiency	Mitigation	Medium

Promoting green infrastructure	Energy, Works, Urban, Transport	Green topped road, promotion of renewable and energy saving measures in the housing sector	Mitigation	Medium

Moreover there are some cross cutting needs that has emerged across the sector and has proposed several institutional mechanisms to move forward. This includes the apex council, building capacity of the district councils, an institution of Governance, looking at program monitoring and impact assessment, an entrepreneurship development institute to promote skill building in general with a special emphasis on the green skills.

Geography Strategies	Local	State level	Linkages to national programmes/ missions
Awareness	Creating local level awareness is a first step, e.g. barefoot workers, framer field schools may promote descaled climate change concerns	Building awareness of legislators, policy makers on socio-economic and socio-political cost of climate change	Participation in national networks, interface with the national knowledge network and research systems
Capacity	Monitoring, observation Awareness/ assessmen t at state/ district/ community levels	Scientific assessment, measurement, models, with state level technical institutions like SPCB, Watershed Mission, Regional Centres of National Institution, Universities	Special regional modelling and assessments, best practices study and resource leveraging from various missions and mission resource centres and technical secretariats
Generation of Knowledge/ Information	Locale specific databases, scenarios and assessment, local monitoring networks, rapid assessment for input to state inventory	Research networks, Compilation of state level GHG inventory and input to National databases(e.g. NATCOM), scientific and policy models, state-wide and area specific scenarios, technology inventory	Interface with IPCC assessments, interfacing with regional/ global databases, scenarios and assessments, technology inventory database
Institutions/ Partnerships	Community initiatives, Early warning networks, Disaster management teams	Stakeholders networks, public/ private programs	Standardised Climate impacts assessment both academic as well more applied ones for result based management and programming
Policy/ Instruments	Local specific adaptation plans, community based adaptation programs	Science-policy linkage, mainstreaming climate change agenda in sectoral policies of the state (agriculture, mining, industry, energy, water, forestry, etc.) economic	Adaptation funds, Interface with private sector participants for fund under market mechanisms like CDM, REDD& REDD+

		instruments (e.g. insurance, R&D funds), integration with national development/ planning process	
Technology	Locale specific technology adaptation	Targeted R&D, Technology transfer protocols, demonstration/ pilot projects	Scientific exchange, technology transfer

Way Forward

The state has undertaken massive exercise of identifying key priorities in each sector. About 150 actions have been identified across six sectors. Out of which 66 actions have been prioritised.

Climate change has been mentioned as a cross-cutting sector in the annual plan of the state. Institutional Arrangement has been worked out and notified. The cross-sectoral working groups have shown commitment in producing these drafts by working together and moderating the different positions.

The total planned outlay proposed for taking up prioritised action identified under the climate change action plan works out to be approximately Rs 6298 crore. The institutional arrangement has been enshrined in the notification and has been approved by the cabinet. Meghalaya State Council on Climate Change and Sustainable Development is designated as the apex body for coordinating and approving climate change related work. There will be a project management agency to support Basin Development Authority in developing implementation guidelines in each sector and work with departments and agencies to develop baseline, emission inventory, have consultation across departments and networks towards implementation of the state action plan on Climate change. This will also include creating awareness and building the capacity of line department staff and the vulnerability community towards implementation of the adaptation actions proposed under CCAP.

Chapter 1: Background

1.1. Introduction

Meghalaya has a fragile eco-system covering an area of about 22,429 Sq. Kms. It has one of the wettest places in the world. The average rainfall at Cherrapunji during the last 35 years has been 11,952mm (470 inches) and there were several years when it was substantially more than this. The last few years since 2005-06, have shown a declining trend in the rainfall. Experts attribute this to the phenomenon of Global Warming and deforestation. However, short duration heavy rainfall has brought into destructive effect on the agriculture, mainstay vocation in the state. Meghalaya's rich natural resources, high potential horticulture that can have temperate, tropical and sub-tropical fruits and vegetables and its fodder plains including tea bushes are highly sensitive to climate change. Government of Meghalaya has understood the importance of climate change issue and its impact on growth, development and poverty reduction and has therefore facilitated development of CCAP.

1.2. Objective

The main objective of Climate Change Action Plan (CCAP) is to strategize adaptation and mitigation initiative towards emission stabilization and enhances the resilience of the ecosystem, climate proofing of the livelihood sector and diversification of the dependency on the natural resources.

This exercise helps serving as a platform to take the climate change agenda of the state forward which in future could be a combination of advocacy, knowledge deepening, policy analysis and operational work. However, there is also the need for putting forward actions where public investment would be needed to make the state and community more climate resilient.

1.3. Methodology

Government of Meghalaya has taken the climate change issue very seriously. Meghalaya State Council on Climate Change and Sustainable Development (MSCC & SD) is formed to coordinate state action plan for assessment, adaptation and mitigation of climate change.The composition of the Meghalaya State Council on Climate Change and Sustainable Development is as follows.

	Incumbent	Position
1.	Chief Minister	Chairperson
2.	Minister, Forest and Environment	Member
3.	Minister, Agriculture and Irrigation	Member
4.	Minister, Water Resources	Member
5.	Minister, Soil and Water Conservation	Member
6.	Minister, Science and Technology	Member
7.	Minister, Power and Non-Conventional Energy Resources	Member
8.	Chairman, State Planning Board	Member

	Incumbent	Position
9.	Chief Secretary Meghalaya	Member
10.	Vice Chancellor NEHU, Shillong	Member
11.	Addl. Chief Secretary, Planning	Member
12.	Addl. Chief Secretary, Finance	Member
13.	Chief Executive Members, District Councils	Member
14.	Principal Secretary/ Commissioner and Secretary, Planning	Convenor

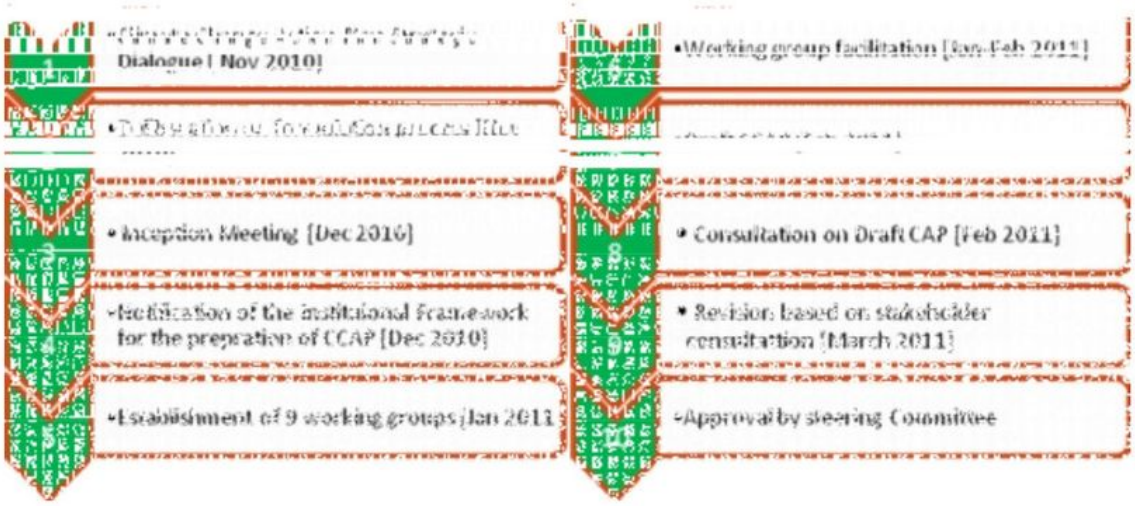
This high level council is mandated to:

- Evolve a coordinated response to issues relating to climate change at the State level;
- Provide oversight for formulation of action plans in the area of assessment, adaptation and mitigation of climate change;
- Periodically monitor key policy decisions and their implementation status
- Any other function that may be deemed necessary by the Council from time to time

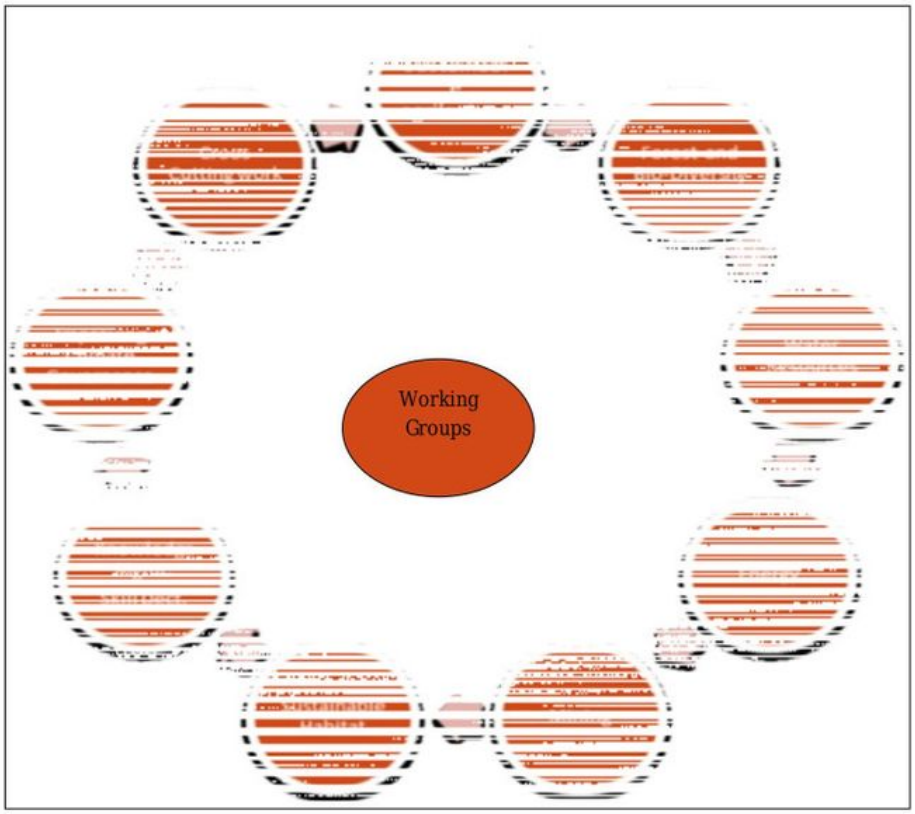
Further a steering committee has been formed to steer the whole process.

	Incumbent	Position
1.	Chief Secretary Meghalaya	Chairperson
2.	Principal Secretary Planning/ Commissioner & Secretary, Planning	Member
3.	Principal Secretary/ Commissioner Secretary Forests and Environment	Member
4.	Principal Secretary/ Commissioner & Secretary Finance	Member
5.	Principal Secretary/ Commissioner & Secretary Agriculture	Member
6.	Principal Secretary/ Commissioner & Secretary Horticulture	Member
7.	Principal Secretary/ Commissioner & Secretary, Water Resources	Member
8.	Principal Secretary/ Commissioner & Secretary Soil and Water Conservation	Member
9.	Principal Secretary/ Commissioner & Secretary C & R Development	Member
10.	Principal Secretary/ Commissioner & Secretary Science & Technology	Member
11.	Principal Secretary/ Commissioner & Secretary Power & Nonconventional Energy	Member
12.	Principal Chief Conservator of Forests (PCCF)	Member
13.	Directors of Agriculture/ Horticulture/ Soil & Water Conservation/ Community & Rural Development	Member
14.	Chief Engineer Irrigation/ Water Resources	Member
15.	Officers and/ or experts who may be co-opted from time to time by the Chairman	Member

The following processes were followed which is detailed below.



The following working groups have been formed based on the core climate change issues confronting Meghalaya.



Each working group has been provided with templates for the following: (a) identification of issues and brainstorming on adaptive and mitigation actions (b) prioritisation (c) project/ investment planning for the high priority actions.

1.4. Structure of the Report

This report is divided into three parts (actually three reports combined into one)

- Chapter 1 Deals with the Climate Change Context for Meghalaya
- Chapter 2 Deals with National Climate Change Action Plan and mapped to the state of Meghalaya.
- Chapter 3: Deals with the vulnerability issues
- Chapter 4: Summarises the sectoral and cross-sectoral issues and action points with recommendations for the Government and Policy makers
- Chapter 5: Outlines Cross Cutting issues to tackle climate change in State.

The purpose of this report is to make the climate change agenda inclusive, transparent and with the validated ownership of the different kinds of stakeholders. Initially, through the process which started with administrative and technical groups within the government, there was a conscious decision to take it to public and validated the proposed actions from the point of view of the wider interest groups.The GIZ has provided support for this action planning facilitation and engaged CTRAN to coordinate and manage the process on behalf of the Government. The report tries to best capture the views of the stakeholders and put it together in a completely unbiased and professional manner. The team with the knowledge partner have tried to use the various frameworks emerging out of the National Climate Change Action Plan in the sub-national context around vulnerability, resilience and climate governance to framing policies at the state level and operations to support climate change adaptation and to manage the potential social risks associated with climate change mitigation. No attempt has been made to reinvent the wheel.

Chapter 2: National Action Plan on Climate Change and Meghalaya

2.1. Introduction

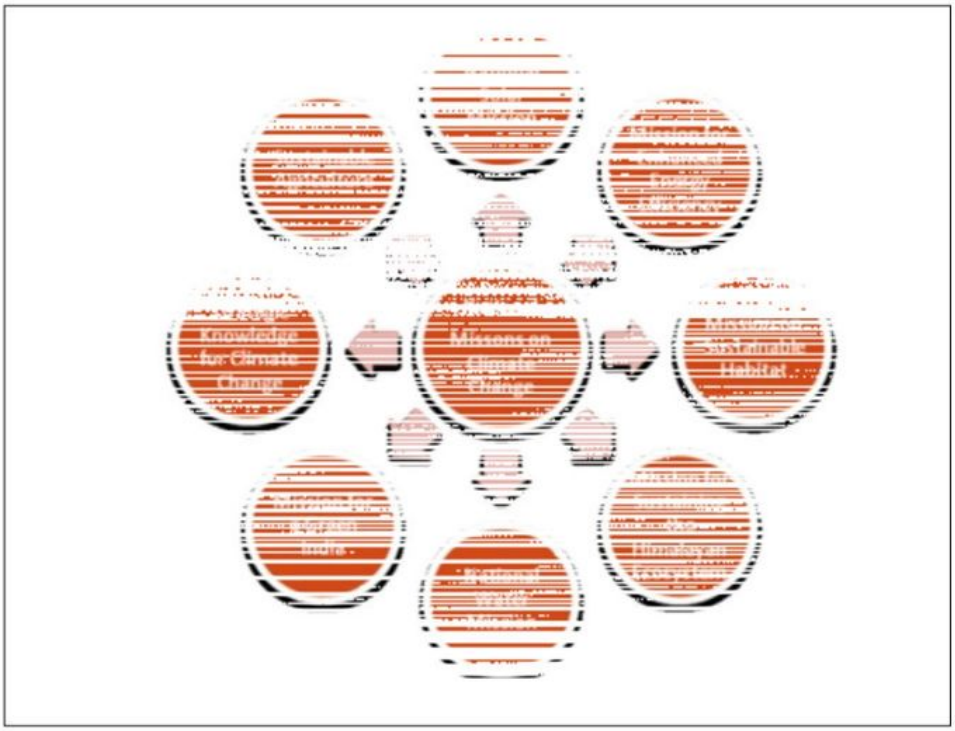
National Action Plan on Climate Change emphasizes the overriding priority of maintaining high economic growth rates to raise living standards of the people and aligns the measures that promote the development objectives while also yielding co-benefits for addressing climate change effectively.

2.2. Domestic Actions

India has taken a lead in devising several domestic actions that go a long way in addressing the issue of climate change.

2.3. National Missions

On June 30, 2008, Prime Minister Dr. Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight cores "National Missions" running through 2017. The various missions are presented in the following diagram.The idea of a sub-national action plan emerged as it is grounded locally and has high ownership, better awareness linking experiences of climate linked issues to corrective actions, better preparedness and also to set strategic priorities at the Sub-National level. These priorities would enable the leaders in the states to make plan for the resources and also to see the savings in terms of long run cost associated with climate change more closely.



2.4. Other Initiatives

Apart from eight fold nation mission there have been several initiatives that have positive influence on mitigating the adverse impact of climate change. These include (a) establishment of market based instruments in sectors that have maximum influence on climate change (Perform Achieve and Trade) for energy efficiency and white certificates in renewable in energy

sector, air pollutant trading in industry and mining sector, offset instruments in forestry sector such as compensatory afforestation (b) encouraging Kyoto market instruments like Clean Development Mechanism (CDM). (c) Other initiatives like Bio-Diversity Conservation, Wetland Management, Coastal Zone Management, etc.

2.5. National Missions and Objectives

2.5.1. National Solar Mission

The NAPCC aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar competitive with fossil-based energy options. The plan includes:

- Specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishments;
- A goal of increasing production of photo-voltaic to 1000 MW/ year; and
- A goal of deploying at least 1000 MW of solar thermal power generation.

Other objectives include the establishment of a solar research centre, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

2.5.2. National Mission for Enhanced Energy Efficiency

Current initiatives are expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:

- Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
- Energy incentives, including reduced taxes on energy-efficient appliances; and
- Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.

2.5.3. National Mission on Sustainable Habitat:

To promote energy efficiency as a core component of urban planning, the plan calls for:

- Extending the existing Energy Conservation Building Code (ECBC);
- A greater emphasis on urban waste management and recycling, including power production from waste;
- Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of fuel efficient vehicles; and
- Incentives for the use of public transportation.

2.5.4. National Water Mission

With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.

2.5.5. National Mission for Sustaining the Himalayan Ecosystem

The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.

2.5.6. National Mission for a "Green India"

Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

2.5.7. National Mission for Sustainable Agriculture

The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.

2.5.8. National Mission on Strategic Knowledge for Climate Change

To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

2.6. Mapping the National Mission in the State

The state has decided to map the various missions according to the National Action Plan. Therefore it would have the following kind of linkages as detailed out in the table below:

National Mission	Key Departments	Key issues
Sustainable Agriculture	Agriculture, Horticulture, Fishery	Flood resistant varieties, methane management
Green India	Forest, Tourism	Forestry, Bio-diversity, ecotourism
Energy Efficiency	Energy, Industry	Energy efficiency in MSME sector, food processing, mineral based industries
Solar mission	Energy	Reduction of carbon foot print
Sustainable habitat	Urban development, PWD, housing	Storm water management, energy efficient green building
Strategic Knowledge for Climate Change	Planning, Forest, Finance	Addressing cross cutting issues
Himalayan Ecosystem	NEHU	Academic research, glacial flow, delta management, local variability
Water	Water, Agriculture	Water management

Apart from that there is state specific configuration of cross-sectoral working groups to improve the climate related governance so that the state can address the problem in a holistic manner. The state has decided to focus on a comprehensive strategy on adaptation to climate change in different sectors and for mitigation the state would follow the national policy and no sectoral targets have been set. Any market mechanism like CDM , REDD+will be a co-benefit.

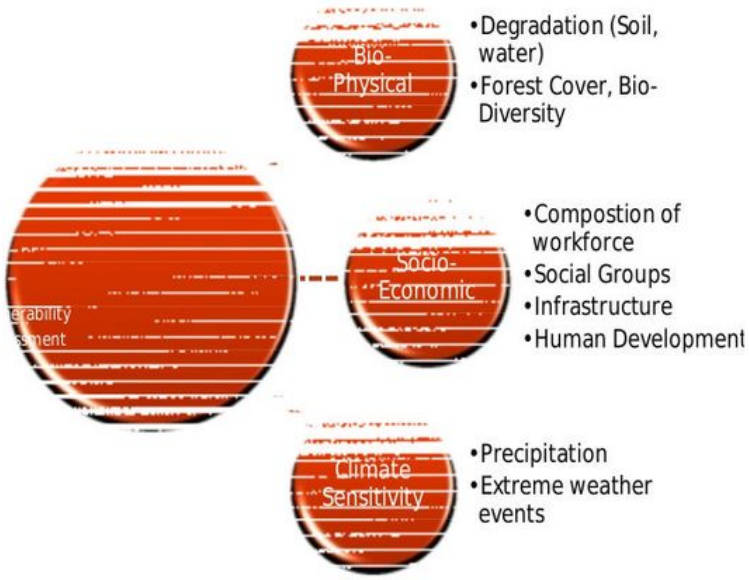
2.7. Institutional Mechanism

The state will have a nodal entity to address the climate change issue in a holistic manner. The proposed institutional mechanism is the Meghalaya State Council on Climate Change and Sustainable Development and Basin Development Authority. These bodies will coordinate across departments on cross cutting issues. It will also interpret the various national missions, objectives and the strategy in the context of the state. It will try to have a time horizon (medium term) of 5-10 years and integrate into the development planning cycle of the state. The body will forge partnership with private sector, academic institutions and civil society to facilitate the implementation of various proposed actions in the state.

Chapter 3: Climate related Vulnerability in Meghalaya

3.1. Overview

Meghalaya is at the unique confluence of the Indo-Malayan, an Indo-Chinese and Indian bio-geographical region coupled with its physiographic has generated a profusion of habitats, which harbours diverse biota with high level of endemism. Meghalaya's economy is closely tied to its natural-resource-base and climate-sensitive sectors such as agriculture, water, and forestry. That is the reason; the state faces a major threat from the projected changes in climate. Crucial sectors in state like agriculture, water resources, health, sanitation, and rural development are likely to be affected by climate change. State's population primarily depends on climate-sensitive sectors like agriculture and forestry for livelihood. The highly dispersed and the vulnerable population segment of the state is poorly equipped to cope effectively with the adversities of climate change due to low capabilities, weak institutional mechanisms, and lack of access to adequate resources.



Climate Change is a multi-objective problem therefore the vulnerability and adaptive capacities are diverse and varies from state to state and based on several sectoral and cross sectoral parameters. Sectoral parameters include key sectors of the state's economy and cross sectoral factors include (a) Poverty (b) inequality and social discrimination over property rights and (c) access to resources (d) social attrition/ migration, (d) unequal and unsustainable competition for scarce natural resources.

3.2. Climate sensitivity/ variability

Climate variability refers to variations in the mean state (of temperature, monthly rainfall, etc.) and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or variations in natural (e.g. solar and volcanic) and external forcing (external variability).

In this section, the focus is on the current mean climate and climate variability in Meghalaya at the district level and investigates how changes will alter Meghalaya's vulnerability to climate change. Precipitation and temperature are used as the key climate variables in this analysis.

Climate sensitivity of the state comes from fragile-ecosystem of the region. The varied physiological features of the state and the altitudinal differences gives rise to varied types of climate ranging from near tropical to temperate and alpine. The state is vulnerable to water-

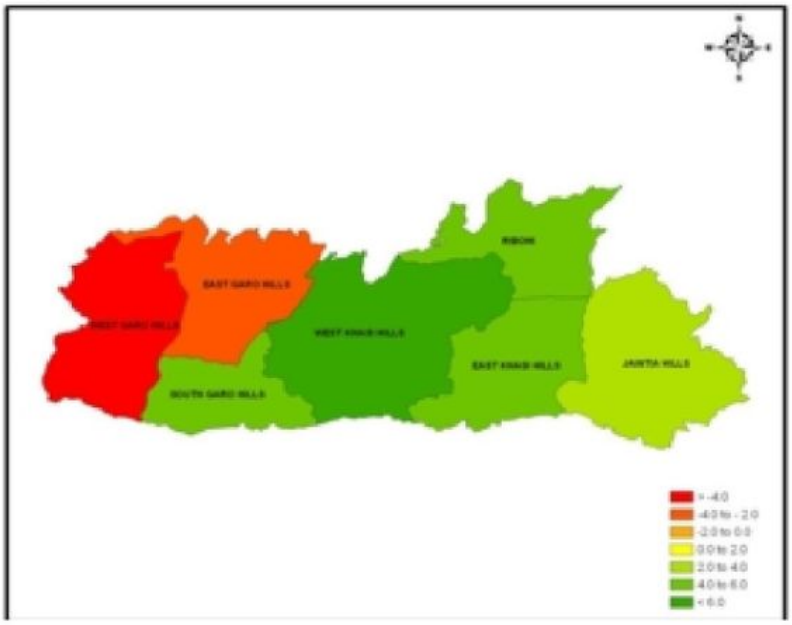
induced disasters because of its location in the eastern Himalayan periphery, fragile geo-environmental setting and economic under-development. The powerful hydrological and monsoon regime of the region, especially the Brahmaputra and the Barak (Meghna) river systems are both a resource and a source of vulnerability.

3.2.1. Data and methodology

The high resolution (0.5° x 0.5° lat. and long.) daily gridded rainfall dataset for a period of 35 years (1971–2005) provided by Indian Meteorological Department (IMD) for precipitation and the Climatic Research Unit Time Series (CRU TS) version 2.10 on a 0.5° lat x 0.5° l long resolution monthly dataset spanning 102 years (1901-2002) for temperature were used. District-wise data was obtained by re-gridding the dataset to 0.1° lat. x 0.1° long, and re-aggregating by the districts to study the climate variability at district level.

3.2.2. Rainfall variability

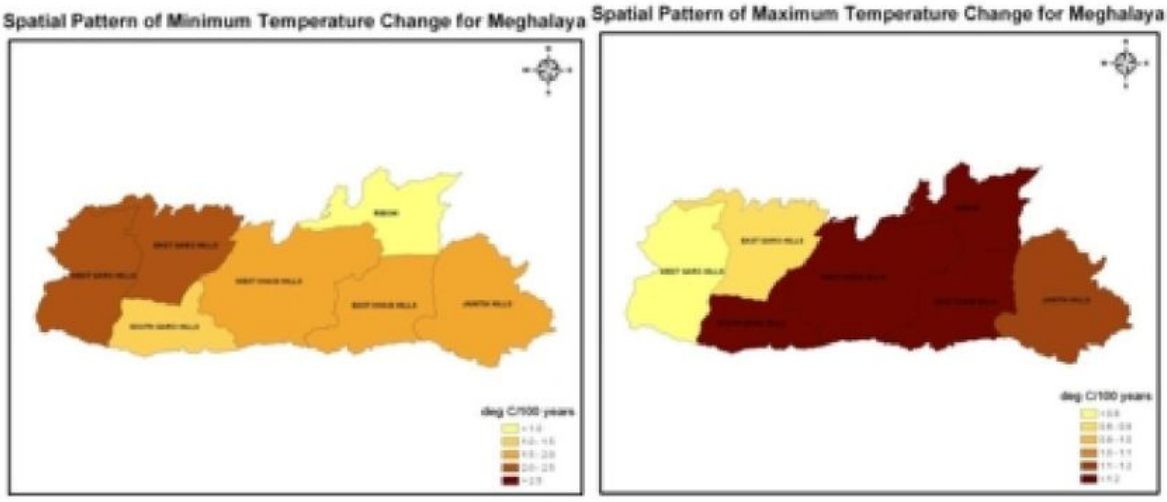
- Majority of the districts of Meghalaya have experienced an increase in precipitation in the past 100 years (Figure below).
- However the two western districts, West Garo Hills and East Garo Hills showed a decrease in precipitation of 3.72 mm/ day and 6.85 mm/ day respectively. This is a very high decrease and is of concern.
- The West Khasi Hills, located in the central region of the state has the highest increase in precipitation, about 6.01 mm/ day. This is also a very high increase and may lead to flooding if the trend continues.
- The precipitation trend shows high variability with West Khasi Hills showing an increase in precipitation of 6.01 mm/ day and West Garo Hills showing a decrease of 6.85 mm/ day.



District-wise precipitation trend (mm/ day per 100 yr) of southwest monsoon season (June-September) for the period 1971-2005.

3.2.3. Temperature variability

The analysis of the meteorological measurements of temperature for Meghalaya shows a steady warming trend in both the minimum and maximum temperatures (Figure below).



Spatial pattern of temperature trends for JJAS (°C per 100 yr) over Meghalaya for the period 1901-2002

- The spatial pattern of minimum and maximum temperature trend over the past 100 years (Figure above -left panel and right panel) shows an overall increase in the region.
- The western part of the state exhibited an increase in minimum temperature (West Garo Hills, East Garo Hills) when compared to the eastern part of the state.
- The central parts of the state, West Khasi Hills, South Garo Hills, East Khasi Hills exhibited a high increase in the maximum temperature (about 1.2°C), when compared to Western and Eastern districts.
- Overall, the trend of last 100 years shows that an increase in minimum temperature is slightly higher in absolute terms than the increase in maximum temperature.

3.3. Future climate projections for Meghalaya

3.3.1. Model and methods

For climate change projections, simulation data from the global climate model, HadCM3 from the Hadley Centre, UK (Collins et al., 2001) has been used. HadCM3 has been used recently for generating climate change projections for various parts of the Indian subcontinent (Kumar et al., 2006).

GCM and SRES scenario used: In this report, data from the HadCM3 global climate model downscaled by PRECIS model, a regional climate model for downscaling climate projections (Kumar et al., 2006), is used. The combination of HadCM3 and PRECIS models is known as the HadRM3 model. The pathways for atmospheric greenhouse gases (e.g. CO_2, CH_4, N_2O, CFCs) were prescribed from the SRES A1B mid-term (2021-2050) projections. Climate change projections were made:

- For daily values of temperature (average)
- For daily values of precipitation
- At grid-spacing of 0.44250 latitude by 0.44250 longitude
- For periods of 2021-2050

Derivation of district-wise data: Data derived from the PRECIS model outputs (which had a grid spacing of 0.4425° latitude by 0.4425° longitude) was regridded to 0.2° in latitude and 0.2° in longitude. This ensures that enough grids fall inside each district. Then, the data was re-aggregated (as averages) at the district-level.

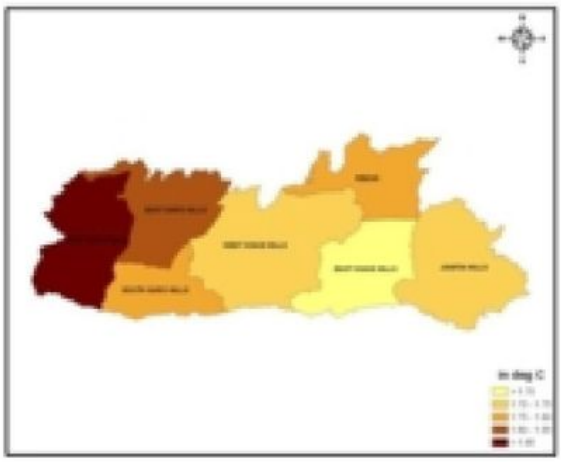
3.3.2. Projected change in average temperature

Climate modelling studies for India show that the sub continent is likely to experience a warming over 3-5 ^{0}C. The projection of temperature increase by Ravindranath et al (2010) is as follows

- The western parts of the state are projected to experience a higher increase in temperature, when compared to the eastern parts of the state.
- However, the variability in the increase in temperature is not high, with the highest increase being 1.8 ^{0}C and average increase in range of 1.6 ^{0}C.

Projected changes in temperature in Meghalaya district 2021-50

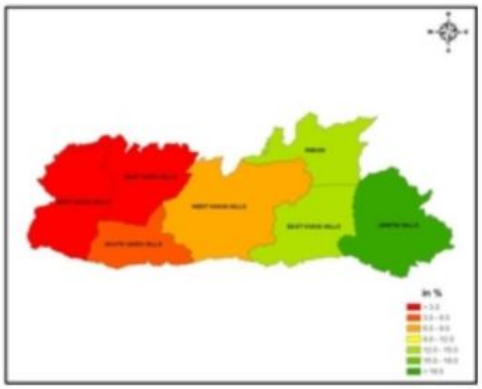
Sl. No	District	Increase in Temp(^{0}C)
1	West Garo hills, East Garo hills, South Garo hills	1.8-1.9
2	Ri-Bhoi, Jantia hills, West Khasi hills	1.7-1.8
3	East Khasi hills	1.6-1.7



District-wise projected increase in annual average temperature (°C) for the period 2021-2050 (A1B SRES scenario) compared to baseline (1975), projected by the HadRM3 model. The solid black lines indicate district boundaries.

3.3.2. Projected changes in rainfall

Figure below shows the projected change in total annual rainfall and for the south west monsoon season (June, July, August and September months abbreviated as or JJAS) in the short-term future A1B scenario.



District-wise projected increase in annual rainfall and JJAS rainfall for the period 2021-2050 (A1B SRES scenario) compared to baseline (1975), projected by the HadRM3 model. The solid black lines show the district boundaries

It can be seen that:

- Meghalaya is projected to receive an increase in precipitation in all the districts.
- The western districts of Meghalaya are predicted to obtain a smaller increase in rainfall, compared to the eastern districts which are predicted to obtain a higher increase in rainfall.
- There is high variability of projected rainfall, where eastern districts such as East and West Garo Hills are projected to obtain an increase in rainfall of only about 3%, while Jaintia hills in the west are projected to obtain an increase in rainfall of about 18%.

The district wise projected change in rainfall

Sl. No	District	Increase in rainfall (%)
1	Jantia hills	15-20%
2	East Khasi hills, Ri-Bhoi,	10-15%
3	West Khasi hills ,	5-10%
4	West Garo hills, East Garo hills, South Garo hills	0-5%

3.4. District-wise projection of extreme events in precipitation

The extreme events in precipitation for Meghalaya for the last 100 years were analyzed. The main results are:

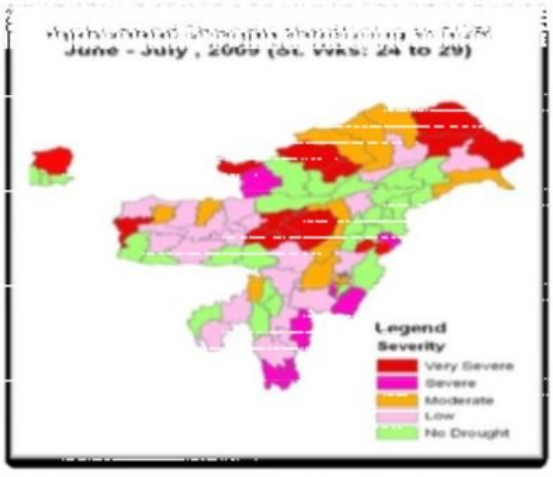
- There is an increase in extreme events (>100mm of rainfall/ day) in almost all the districts of the state.
- The exception is West Garo Hills, which seems to have experienced a decrease in the number of extreme event days, which is consistent with the observation of decrease in amount of rainfall in this district in the past 100 years.
- There is a gradual increase in the number of extreme events eastward, with Jaintia Hills, East Khasi Hills and Ribhoi exhibiting an increase in 2 or more days of extreme events in the past 100 years.

District-wise change in the number of days (in a year, on an average) when the rainfall exceeds 100 mm per day for Meghalaya

S. No.	District	Annual increase in extreme event days
1	Jaintia Hills, East Khasi Hills, Ribhoi	2.0 and more
2	West Khasi Hills	1.0 – 2.0
3	South Garo Hills, East Garo Hills	0.0 – 1.0
4	West Garo Hills	Less than 0.0 (reduction in extreme rainfall events)

** *A heavy rainfall day is defined as a day when the rainfall exceeds 100 mm*

3.5. Rainfall, flood and forest dependence



Climate models predict 2^0 -3.5^0 C increase in temperature and 250-500 mm increase in precipitation in the North Eastern region *(Ravindranath et al., 2006; IPCC technical paper V)*. The predicted increase in the precipitation in the forest areas in the Indian subcontinent is higher than that of the non-forest area *(Ravindranath et al., 2006)*. Increase in rainfall may not have significant impact on the forest areas of North East which are already experiencing high rainfall but change in temperature regime may cause severe impact and significant changes *(Ravindranath and Sukumar, 1996)*.

The most damage in the past few years have been caused due to high variability in rainfall, sometimes causing flash floods and extensive damage to crop, livestock and human life.
Analysis of the monsoon rainfall (June-September) distribution trend for the period of 27 years (1983-2009) shows a drastic rise in monsoon rainfall from the year 2001. *(ISPRS Archives XXXVIII-8/W3 Workshop Proceedings: Impact of Climate Change on Agriculture).During 1983-2000, the mean monsoon rainfall was far below of 1000mm except the year 1991(1154.7mm).* The monsoon rainfall significantly increased during the year 2001-09 up to 1102.6 to 1937.7mm. It indicates that the monsoon rainfall has shifted to post monsoon season. It plays havoc with the crop planning and water management.
Under influence of global climate change even high rainfall areas are facing drought like situations in the current years and the reverse i.e. flood is frequenting mostly in low rainfall areas. In 2009 (up-to end July) most of the NE states were affected by drought like situation. Manipur, Nagaland, Meghalaya witnessed severe meteorological drought. Other states have recorded moderate drought. Till July, 20, 2009 Manipur recorded 67 % rainfall deficiency followed by Nagaland (-63), Meghalaya (-56), Assam (-34).
Rainfall occurring earlier or later has adversely affected sowing and harvesting of crops, harvestable grains have been damaged. Moreover, there are reports that natural wetlands are shrinking in many parts of the region. Some ecologists have informed about appearance of more number of invasive species and changes in their distribution pattern in the region. Some have reported more number of diseases and pests in citrus species. One significant impact which many plant scientists agree to is the change taking place in the phonological phases in plants *(ICIMOD, 2008)*.

3.6. Extreme weather events

The key extreme events observed in the state are as follows:

- Floods, Heavy rain and Landslides
- Heat wave, Cold wave and Fog
- Drought

With glacial contribution deceasing over the years, in future lean season flow will decrease and water stress will increase in the Brahmaputra basin where large populations depend on agriculture for livelihoods. Glacial retreat in the Himalayas may lead to serious alterations in the hydrological regime of the Brahmaputra river system as the mainstream of the Brahmaputra (known as the Yarlung Jhangbo in Tibet, China) and some of its tributaries like the Subansiri and the Jia-Bharali are partly fed by snow-melt run-off. Projected increase in rainfall and accelerated summer flows may give rise to more intense flooding and flood hazards, but consequent retreat of glaciers may reduce flows in the long run. It has been observed in the National assessment that the frequency of hot days are on decline in the state, especially in the plateau areas so also there is a decline in the number of cold days. This indicates a pattern that shows high climatic variability and affects the climate sensitive plantation crops of the region.
Extreme precipitation events (heavy rain storm, cloud burst) may have their own impacts on the fragile geomorphology of the Himalayan part of the Brahmaputra basin causing more widespread landslides and soil erosion. The response of hydrologic systems, erosion processes, and sedimentation in the Himalayan river basins could alter significantly due to climate change. Two extremely intense cloud bursts of unprecedented intensity- one in the western Meghalaya hills and Western Arunachal Pradesh in 2004 produced two devastating flash floods in the

Goalpara and Sonitpur districts of Assam bordering Meghalaya and Arunachal respectively causing hundreds of deaths.

Ravindranath et al (2010) indicates that for most parts of Meghalaya the probability of drought is relatively high. Higher incidence of drought leads to higher exposure to vulnerability to climate change especially for poor people who have less adaptive capacity. A combination of drought and higher temperature will lead to increased evapo-transpiration. This cause extreme moisture stress condition during the critical crop growing stage and reduces yield.

3.7. Socio-Economic Vulnerability based on source of livelihood

3.7.1. Structure of Employment

Meghalaya has rich natural resource base. Despite that it has acute poverty, a recent survey by the state Government has a figure that about 49% of the population in rural areas are below poverty line. Its per capita income is also below the national average. The structure of the economy shows that little less than 2/3rd of its workforce depend on agriculture and allied activities. The sector however contributes only 18.7 per cent to state domestic product. The share of agriculture sector is also on decline and the sector is also vulnerable to climate change. The services sector which is rising in the state is also very much sensitive to climate, especially the eco-tourism, transport and trade.

3.7.2. Presence of large number of vulnerable groups

The state is also home to number of tribal groups with higher dependency on natural resource and is thus more vulnerable to climate change. The tribal largely depend on the forests which is on the path of declining. One of the major factors affecting forest cover is the growth of human populations throughout the Northeast India and the forests are the best place to accommodate the growing pressure of additional people. According to Census statistics, the population density in many states grew by approximately 30% between 1991 and 2001. Other significant drivers of the change include clearance of forests for agriculture, Tea cultivation, slash and burn mode of cultivation with ever reducing 'jhum' cycle, alteration of prime natural habitat for developmental and industrial activities (Coal mining), forest fire and other biotic interferences have led to the rapid loss of forest cover.

Increasing population and decreasing land productivity, relatively higher dependence on natural resources (e.g. forests) also are constraints for the region's environmental sustainability. A high degree of vulnerability to the water and climate induced disasters will increasingly make the region environmentally insecure in the future unless pragmatic interventions are made immediately. A set of holistic policy and programmes that integrate development goals with disaster risk management for the region as a whole is the need of the hour.

3.7.3. Infrastructure Deficit

The vision document 2020 of North Eastern Region identifies five basic deficits for the region (a) basic needs deficit (b) infrastructure deficit (c) resource deficit (d) governance deficit (e) two-way deficit of understanding with the rest of the country.

Lack of connectivity has made the population very much vulnerable and reduced their preparedness against disaster. The traditional land routes and inland waterways are lying defunct due to lack of public investment. High transportation cost has discouraged private investment in the state making it more resource starved and under developed.

3.7.4. Human Development

In terms of rank, Meghalaya ranks 24th out of 32 states and union territories and it slipped down three ranks below in 1991 as compared to 1981. The ranks were 26th in 2005. The slippage in ranks is attributed to the slower rate of development in the state for constraints mentioned above. The disaggregated data at the state level shows that, the developments wherever visible are largely urban centric. Urban Infant Mortality Rate (IMR) was 44 in 2003 and it further deteriorated in 2007 to 46. Low immunisation, high death rate and obesity do not give a rosy picture for the state. It is also prone to vector borne diseases due to repeated water logging. Garo hills are categorized high-risk for drug-resistant malaria and the parasite is highly sensitive to variability in temperature and precipitation. Meghalaya (25° - 26° N latitude & 90° - 93° E longitude) contribute >20% of cases of those reported from the north-east states annually. Combined, Gross Enrolment ratio for the classes I to XII dropped to 87.8 per cent in 2004-05 from a high of 92.19% in 1990.

Sector	Deficit	2d Plan targets
Roads / Highways	65,569 Km of NH comprise only 2% of network carry 40% of traffic; 12% 4-laned; 50% 2-laned; and 38% single-laned	6-lane 6,500 km in GQ; 4-lane 6,736 km NS-EW; 4-lane 12,109 km; 2-lane 20,000 km; 1,000 km Expressway
Ports	Inadequate berths and rail / road connectivity	New capacity: 485 mn. MT in Major Ports; 345 mn. MT in Minor Ports
Airports	Inadequate runways, aircraft handling capacity, parking space and terminal buildings	Modernize 4 metro and 35 non-metro airports; 3 greenfield in NE; 7 other greenfield airports
Railways	Old technology; saturated routes; slow speeds (freight: 22 kmph; passengers: 50 kmph); low payload to Tare ratio (2.5)	10,300 km new rail; 10,000 km gauge conversion; modernize 21 stations; Dedicated Freight Corridors
Power	11% peaking deficit; 7% energy shortage; 40% transmission and distribution losses; absence of competition	Add 78,000 MW; access to all rural households
Irrigation	1123 BCM unusable water resources; yet near crisis in per capita availability and storage; only 43% of net sown area irrigated	Develop 16 mha major and minor works; 10.25 mha CAD; 2.18 mha flood control
Telecom / IT	Only 18% of market accessed; obsolete hardware; acute human resources' shortages	Reach 600 mn subscribers – 200 mn in rural areas; 20 mn broadband; 40 mn internet

The poverty profile shows the state has a declining work participation rate, there is high natural resource intensive livelihood pattern with very little diversification and added climatic stress make them more vulnerable.

3.8. Bio-Physical factors

The key bio-physical factors that are affected by climate change are soil water and forest.

3.8.1. Forest, climate impact and vulnerability

Forest is an important resource in Meghalaya accounting for 77.02% of its geographical area and a large section of tribal population dependent on it. Traditional shifting (jhum) cultivation is practiced by the people which impacts forest conservation. Besides timber, a number of non-timber forest produce (NTFPs), including cane, bamboos, orchids, honey and wax are extracted from the forests every year in large quantities.

The state is known for its ecologically distinctive and rich biodiversity, having many endemic flora and fauna and a number of sacred groves. The state is rich in plant diversity with 3,128 species of flowering plants including 1,237 endemic species and several valuable medicinal plant species. Beside a large number of amphibian, reptile, fish and bird species, more than 110 mammal species are found in the forests of Meghalaya. Therefore, climate change could have adverse impacts on the forest sector of Meghalaya and there is a need for effective adaptation and mitigation strategies that promote the conservation and sustainable use of the endangered forests. Under the State Action Plan firstly, the impact of climate change on forests of Meghalaya is assessed using dynamic modeling along with assessing the vulnerability of the forest sector

and secondly, adaptation and mitigation options are proposed for the forest sector in the context of Greening India Mission (GIM).

The total forest and tree cover of the state is 17,853 km^2, which is 79.60% of the geographical area (FSI, 2011). The protected areas constitute 1.01% of the geographical area of the state. Forests in the state can be categorized as Tropical Wet Evergreen, Tropical Semi Evergreen, Tropical Moist Deciduous, Subtropical Broadleaved Hill and Subtropical Pine Forests. The distribution of forests along with crown densities in Meghalaya is given in Figure below. Moderate dense forests account for about 42.36% of the forest area followed by very dense forests accounting for about 1.83%. Forests are classified as Reserved Forests (11.71%), Protected Forests (0.13%) and Unclassed Forests (88.16%). The Unclassed Forests are managed by Autonomous District Councils, village durbars, traditional institutions and private owners. Over the last few years due to an increase in population, pressure on forest land for cultivation has increased with more and more forest area being brought under shifting cultivation and at the same time, the jhum cycle being reduced from 10-12 years to 2-3 years. Mining activities particularly in the Garo Hills districts and Jaintia Hills have altered the landscape to a great extent leading to loss of forest cover, biodiversity and increase in acidity of soil and water. Besides unregulated shifting cultivation, other causes of forest fragmentation and degradation include seismic activities, frequent landslides and soil erosion, logging or illegal timber extractions, etc. Deforestation and the resultant loss of soil have also led to increased siltation of rivers and streams.

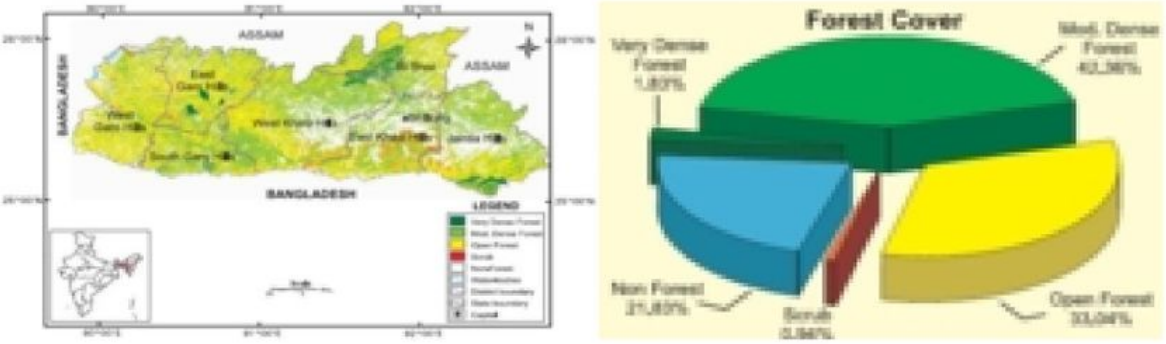


Figure: Meghalaya forests cover Map (left panel) and forest types of Meghalaya (right panel) (FSI, 2009)

Trends in area under forests are given in Table below. According to the Forest Survey of India, total area under forests seems to have marginally increased in Meghalaya. This could be due to the increasing number of afforestation activities undertaken in the state. It should be noted that there has been an increase in the area under scrub forest over the 2003-2011 assessments.

Trends in area under different types of forest in Meghalaya (sq km)

Forest type	2001 Assessment	2003 Assessment	2005 Assessment	2009 Assessment	2011 Assessment
Dense forest	5,681	6491	7146	VDF[1] – 410 , MDF - 9501	VDF– 433 , MDF - 9775
Open forest	9,903	10,348	9,842	7410	7067
Scrub forest	259	169	181	211	485
Total	**15,843**	**17008**	**17,169**	**17,532**	**17,760**

[1] VDF- Very Dense forest , MDF – Medium Dense Forest

The micro-studies show that due to climate change the flora and fauna have been impacted. There is a decline in the numbers of the earthworm considerably affecting the soil quality. The soil organic carbon has also reduced due to declining rate of humus formation. Many wild vegetables are like *Colocassia*, NTFPs like amla (*Phyllanthusemblica*) are facing extinction reducing the choice of the forest dwellers. Overall, experts claim there is diminishing bio-diversity with increased anthropogenic activities, especially mining activities and diversion of forest land for agriculture and industry has accelerated the degradation of the soil and water in the region. This is a vicious cycle, as the forest in the state is degraded the soil condition deteriorates so also the water quality. Coal mining has damaged the environment to a large extent in the state through forest clearing, and increase in acidity of soil and water. The rural areas are badly affected by unscientific mining activities being carried out in different parts of the state. It has increased the vulnerability of people having their habitat in such clusters.

3.8.2. Impact of climate change on forests of Meghalaya

Methods and models: An assessment of the impact of projected climate change on forest ecosystems in Meghalaya is made using the following:

- ***Climate model***; Regional Climate Model of the Hadley Centre (HadRM3)
- ***Climate change scenario***; A1B scenario
- ***Climate impact model;*** global dynamic vegetation model IBIS
- ***Period of assessment***; short-term (2021-2050) and long-term (2071-2100) periods.
- ***Input data***; monthly mean cloudiness (%), monthly mean precipitation rate (mm/ day), monthly mean relative humidity (%), monthly minimum, maximum and mean temperature (C) and wind speed (m/ s), soil parameter (percentage of sand, silt and clay) and topography.

Impacts of climate change: The dynamic global vegetation model has been validated by Indian Institute of Science for its suitability for Indian conditions. The impacts are assessed at regional climate grid scales (about 50km x 50km). Figure below shows the vegetation change projected by 2035 A1B scenario in Meghalaya. It can be observed from Table below that during the short term period of 2030s, **out of the 839 forested grids in Meghalaya, 67(8.68%) will be impacted by climate change**. The distributions of the forested grids which are projected to be impacted by climate change is presented in Figure for 2030s. A change in forest types is projected in the northern part of West Khasi Hills. Thus **Meghalaya is projected to be adversely impacted by climate change by 2030s.**

No of forested grids projected to be impacted by climate change during 2030s and 2080s in Meghalaya

Period	*Number of grids affected*
Total number of grids	839
Number of grids projected to be affected in 2035	67
Number of grids not affected in 2035	772

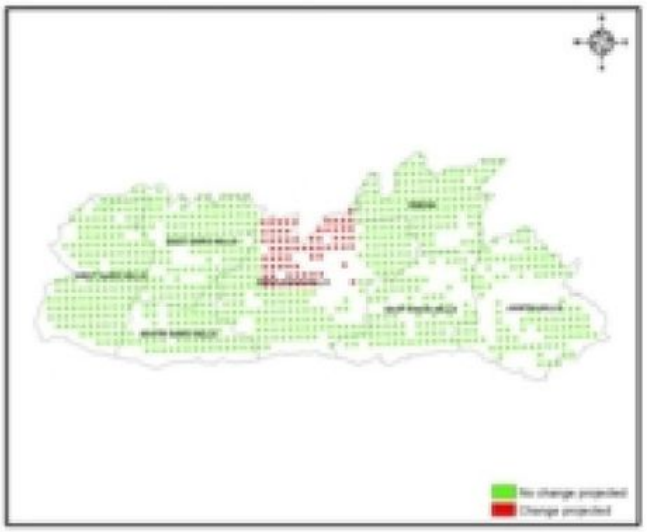


Figure: Forest vegetation change projected by 2035 under A1B scenario in Meghalaya

3.8.3. Forest vulnerability profile of Meghalaya

For estimating climate change impacts, IBIS model was used. For every forest grid (of resolution 0.5° lat x 0.5° long) the vegetation type predicted by IBIS for the current climate were obtained. Similarly, the vegetation type for the future climate (2021-2100, factoring in climate change as per the SRES A1B scenario) was also obtained. If these two were different, it was concluded that the future climate may not be optimal for the current vegetation, for that grid. Hence, that forest grid was marked as being vulnerable to climate change. Then, the percent of such vulnerable grids in each district was calculated. Later, a vulnerability index for each district (in the scale of 1 to 5) was assigned by linearly scaling this percentage (which varies from 0 to 100) to this scale. Forest vulnerability index was developed considering the following indicators with equal weight:

- **Disturbance index:** An **indication of the human disturbance for a particular forest patch.** More the disturbance index, higher the forest vulnerability.
- **Fragmentation status:** An **indication of how fragmented the forest patch** is. More the fragmentation status, higher the forest vulnerability.
- **Biological richness: Indicates the species diversity of the forest patch**, a measure of the number of species of flora and fauna, per unit area. *Higher* the biological richness, *lower* the forest vulnerability.

Impact of climate change obtained from IBIS model

The value of each of the indicators was reduced to a scale of 1.0 to 5.0. All values of vulnerability in this study hence range from 1.0 (very low vulnerability) to 5.0 (very high vulnerability). A Composite Forest Vulnerability Index was calculated for each district, for two scenarios: Current CFVI and Future CFVI. Based on the CFVI, it was found that the forests of the following districts of Meghalaya have high CFVI (have high overall vulnerability): ***West Garo Hills, Ribhoi, Jaintia Hills, East Garo Hills* and *East Khasi Hills.***

Cumulative forest vulnerability index (CFVI) for forest in Meghalaya

District	CFVI	Reasons for high CFVI (greater than 3.0)
West Garo Hills	3.50	High disturbance index, high fragmentation status
Ri-Bhoi	3.32	High disturbance index , high fragmentation status
Jantia Hills	3.22	High disturbance index, high fragmentation status
East Garo hills	3.13	High disturbance index, high fragmentation status

The state has also seen reduction in wetlands and high degree of change in aquatic fauna. If shifting cultivation and mining in their present form and magnitude are allowed to continue, land degradation, water pollution and the impoverished living condition of the poor in rural Meghalaya will further deteriorate. To address the adverse impacts of deforestation, shifting cultivation, mining, water pollution, over-exploitation of plant and animal species – suitable policy, strategies and action plans need to evolve to stem the vicious cycle.

3.9. Impact of Climate Change in Agriculture in Meghalaya and vulnerability

Agriculture is the mainstay of the people in Meghalaya with about 80% of its total population has been depending entirely on agriculture for their livelihood. Due to the hilly terrain, settled cultivation is practiced only in a small portion of the total cultivated land, mostly confined to the valleys. The total cropped area has increased over the last twenty-five years with an introduction of different crops of high yielding varieties such as Masuri, Pankaj IR 8, IR 36, etc. Paddy and maize are the major crops grown along with wheat, potato, ginger, turmeric, black pepper, areca nut, betel vine, cotton, jute, mustard and rapeseed. There is tremendous potential for developing the horticultural sector in Maghalaya. Major horticultural crops grown are lemon, pineapple, guava, litchi, banana, jack fruits, plum, pear, peach, etc. The types of cultivation usually found in the state are (1) forest land for jhum cultivation (2) wet paddy land (3) high grass land and (4) homestead land which is situated close to homes. Efforts have been made of late to replace 'jhum' or the shifting system of cultivation by more scientific cultivation methods, bringing land under permanent cultivation.

3.9.1. Impact of climate change on crop yield

Indian Institute of Science has used INFOCROP, a crop growth simulation model, to simulate impacts of climate change on rice production in Meghalaya. INFOCROP is a generic dynamic crop model developed to simulate the effects of weather, soils, agronomic management practices (including planting, nitrogen, residues and irrigation) and major pests on crop growth, yield, soil carbon, water and nitrogen, and the associated environmental impacts. It can be used for a variety of applications at field, farm and regional levels. The various inputs required by the model include rice variety sown, location, soil type, type of sowing, irrigation, fertilizer application, pest type and diseases. Two model runs were performed - first simulation called "baseline" using climate data averaged over the period 1975-2005 and fixed CO_2 concentration at 370 ppm and second simulation incorporating changes in precipitation and temperature for 2035 and CO_2 concentration of 466 ppm.

Projected changes in rice yield can be attributed to the increase in temperature and CO_2 concentration coupled with the change in rainfall pattern for the region. Climate change could have positive as well as negative impacts on the rice yield. Figure below shows the district-wise impacts of climate change on the rice yield in Meghalaya.

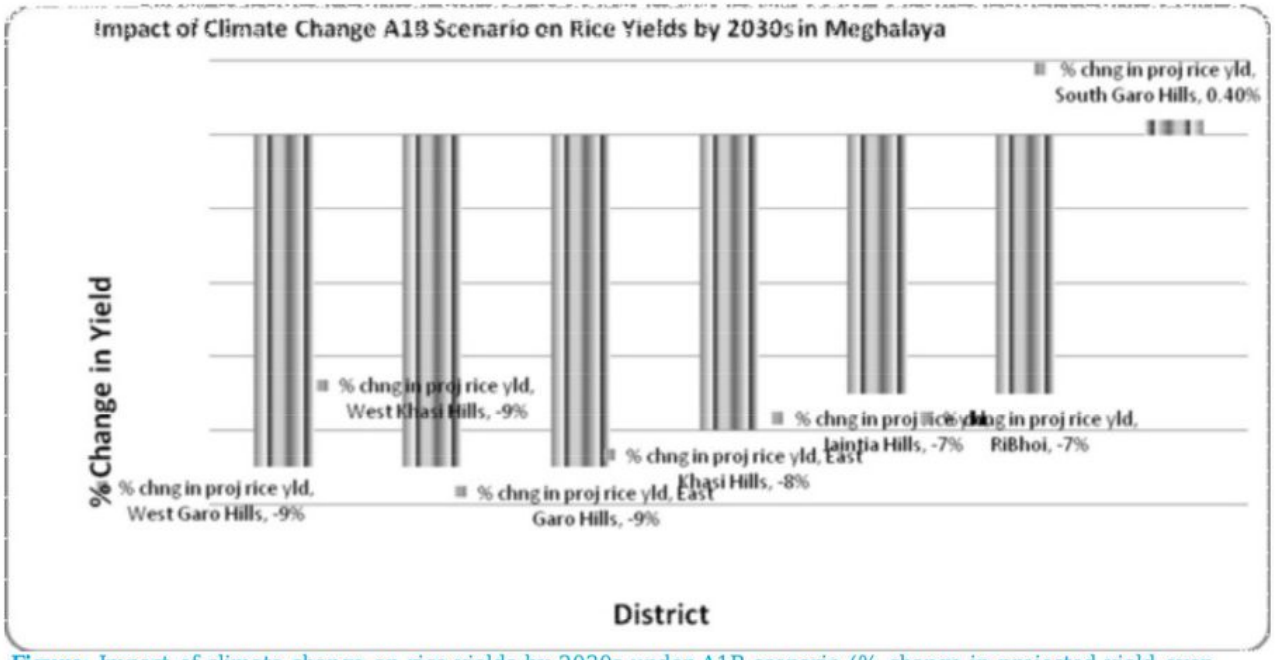


Figure: Impact of climate change on rice yields by 2030s under A1B scenario (% change in projected yield over current yield)

The rice yields projected to decrease by about 7 to 9% by 2030s scenario in almost all districts of Meghalaya except South Garo Hills, which shows a marginal increase of 0.40%. Thus the production of Rice one of the main crops of the state is projected to be adversely impacted by climate change. The results represent the output of only one crop model. Different crop models give different outputs depending on the input parameters used.

3.9.2. Agricultural vulnerability profile

Agricultural vulnerability assessment is an important pre-requisite for undertaking any planning work or developmental project aimed at climate resilient sustainable agricultural development. Indicators for agricultural vulnerability assessment were selected based on the dynamics of the region and data availability such as rainfall variability, area under rain-fed crops, rural population density, net sown area, area under high yielding crop varieties, amount of fertilizers and manure used, groundwater availability, mean crop yields, etc. These indicators were quantified mostly with data from secondary sources across districts and at the state level. Further, for the future scenario, the same set of indicators was estimated incorporating simulation trials for crop yield function. The assessment representing the year 2010 has been referred to as the 'baseline'. With the same set of indicators, impact projections for short-term (2021-2030) incorporating the outputs of climate model projections were assessed. The vulnerability profiles for the agricultural sector are developed for the two scenarios namely baseline/ current scenario and A1B scenario, a moderate climate scenario. Figure below shows the district wise agricultural vulnerability profile of Meghalaya for baseline as well as A1B scenario.

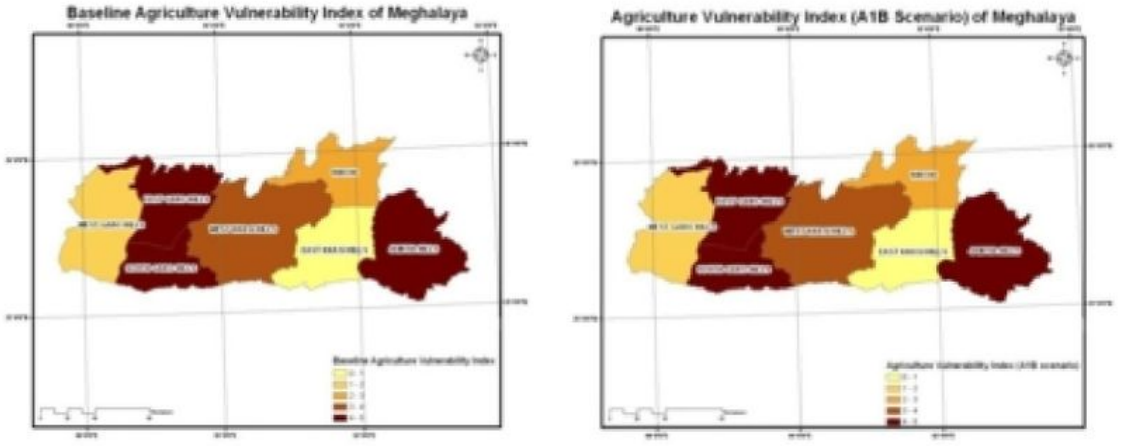


Figure: District-wise agricultural vulnerability profile of Meghalaya for baseline and A1B scenario *(0-1 represents very low vulnerability, 1-2 represents low vulnerability, 2-3 represents moderate vulnerability, 3-4 represents high vulnerability and 4-5 represents very high vulnerability)*

Out of the 7 districts considered, *East Garo Hills, South Garo Hills, Jaintia Hills, West Khasi Hills and Ri-bhoi* districts fall in the highly vulnerable to moderately vulnerable category.

3.10. Climate Change Impact on Water Resources of Meghalaya

The impacts of climate change on water resources have been highlighted in the Fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) indicating an intensification of the global hydrological cycle affecting both the ground water and surface water supply. The effects of climate change on water resources in India include increased drought, river system closure, reduced flows in Himalayan river systems, extreme floods, reduced river yields and reduced ecosystem resilience.

Different catchment areas are likely to respond differently to climate drivers, depending largely on catchment physio-geographical and hydro geological characteristics. The IPCC has predicted with high confidence that the drought affected areas will show increase in frequency as well as the severity of drought. The IPCC also predicts with high confidence that the area affected by drought will increase in South Asia, including India (IPCC, 2007).

3.10.1. Surface water resources in Meghalaya state

The northeastern state of Meghalaya is divided into West Garo Hills, East Garo Hills, South Garo Hills, West Khasi Hills, Ribhoi, East Khasi Hills and Jaintia Hills. The major river systems that drain Meghalaya are Brahmaputra (North Meghalaya) and Barak (South Meghalaya) river basins.



Figure: District map of Meghalaya (Source: http://meghalaya.nic.in/map_district.html, Accessed 21/3/2011)

The main rivers in Meghalaya in the Garo Hills are Simsang, Daring, Sanda, Bandra, Bhogai, Dareng, Nitai and the Bhupai. In the central and eastern section of the plateau, the important

rivers are Umkhri, Digaru, Umiam, Kynchiang (Jadukata), Mawpa, Umiew or Barapani, Myngot and Myntdu (Jain et. al., 2007). The Brahmaputra river and the Barak river shares the catchment area of Meghalaya equally, with the north flowing rivers such as Simsang sharing the Brahmaputra catchment area, while the south flowing rivers such as Kynchiang sharing the Barak basin.

The area of Meghalaya is 22,489 sq km, with the catchment area of Brahmaputra in the state being 53% (11,800 sq km) and the catchment area of Barak River being 10650 (47%) sq km. In spite of being one of the wettest places of the earth, these regions are experiencing decrease in potable water availability due to increasing droughts in the summer seasons. This is mainly due to the large-scale deforestation leading to run-off, thus water is not retained in the deep gorges causing water-scarcity *(http://www.indiaenvironmentportal.org.in/search/apachesolr_search, Accessed 27/3/2011)*. In addition, due to the unavailability of adequate pumping facilities, as well as lack of waste-water management facilities, there is often potable water scarcity in the towns of Meghalaya.

3.10.2. River Basin level analysis to understand the impact

The Brahmaputra River originates in the southwestern portion of Tibetan Plateau, and traverses through China, India and Bangladesh before joining the Bay of Bengal. The Brahmaputra basin is the largest in the world, with drainage of 5,80,000 sq.km, flowing through China (50.50%), India (33.60%), Bangladesh (8.10%) and Bhutan (7.80%). It flows through 6 states of northeast India, i.e. Arunachal Pradesh (41.88%), Assam (36.33%), Nagaland (5.57%), Meghalaya (6.10%) Sikkim (3.75%) and West Bengal (6.47%) *(Source: http://www.arunwrd.org/flood.html)*.

The Barak river system is the 2nd largest river basin in the northeast after Brahmaputra with 6 major tributaries named the Jiri, the Dhaleswari, the Singla, the Longai, the Sonai and the Katakhal. The river has a drainage area of 41,723 sq. km of which 23% is in Meghalaya. The Central Water Commission (CWC) estimates that the basin has a hydropower potential of 2,042 MW, which should be the primary source of energy for the growing energy needs of the population of northeast *(Source: http://www.cwc.nic.in/regional/shillong/welcome.html)*. The major environmental problem with Barak is the flooding due to heavy silting. The construction of embankments and drainage improvements help mitigate these measures to a degree, but during heavy flooding, breaching of these embankments happens resulting in loss of life and livelihood *(Source: http://brahmaputraboard.gov.in/English-AR.pdf)*.

3.10.3. Methodology

- **Tool: Soil and Water Assessment Tool (SWAT)** (http://swatmodel.tamu.edu/)
- **Data:** Spatial data and the source of data used for the study area include:
  - **Temperature and Precipitation**: IMD and CRU gridded dataset
  - **Digital Elevation Model**: SRTM (90 m resolution)/ ASTER
  - **Drainage Network**: Digital Chart of the World, 1992
  - **Soil maps and associated soil characteristics**: FAO Global soil
  - **Land use**: Global land use
- **Climate scenario**: IPCC A1B scenario

3.10.4. Impacts of climate change

The SWAT model for Brahmaputra basin has been run using PRECIS GHG climate scenarios for near and long term (2021 – 2050, IPCC SRES A1B). The outputs of these three scenarios have

been analyzed with respect to the possible impacts on the runoff, soil moisture and actual evapotranspiration. The results are provided in Table below.

Trend in water balance for baseline, near and long-term climate scenarios (IPCC SRES A1B) for Brahmaputra and Barak river basins

Basins	Scenario	Rainfall mm	Change over Baseline %	Water yield mm	Change over Baseline %	Actual evapotranspiration mm	Change over Baseline %
Brahmaputra	Baseline	2409.0		1922.3		391.4	
	Near-term	2361.4	-2.0	1841.3	-4.2	447.3	**14.3**
	Long-term	2637.5	9.5	2063.9	7.4	500.4	**27.9**
Barak	Baseline	2747.2		2074.4		603.3	
	Near-term	3114.1	13.4	2414.9	16.4	621.4	**3.0**
	Long-term	**3446.9**	**25.5**	**2693.2**	**29.8**	**672.7**	**11.5**

Results

- ***Brahmaputra basin***
  - Shows a reduction of precipitation by about 2% and an increase of about 9.5 % in near and long term scenarios, respectively.
  - The corresponding change in water yield shows a reduction by about 4.2 % in the near term and an increase by about 7.4 % in the long term.
  - On the contrary there is an increasing trend in evapotranspiration by about 14.3% and 27.9% respectively, probably due to warming.
  - The increased evapotranspiration may lead to water stress in the near-term future.

- ***Barak basin***
  - The increase in precipitation is about 13.4 and 25.5% in near and long-term scenarios, respectively in the Barak basin
  - An increase in the water yield by 16.4 and 29.8% in the near and long-term scenarios, respectively
  - An increase in evapotranspiration of about 3.0% and 11.5%, respectively in the near and long-term scenarios
  - The implications of increase in evapotranspiration are that crops may face water stress.

3.10.5. Water vulnerability profile

- **Method:** Index-based method, weighted aggregation of indicators.
- **Indicators Chosen:** Water Availability, Evapo-transpiration, Drought, Flood.
- **Vulnerability Profile Ranking:** District-wise, results in Table and Figure below.
- **Results:** The water vulnerability of Meghalaya is high to very high in majority of the districts in the current scenario. The two districts of Jaintia Hills and East Khasi Hills that exhibit low vulnerability are in the eastern part of the state. The water vulnerability is unchanged in the future short-term scenario.

Water vulnerability profiles of Meghalaya – Current and 2050 projections

District	Water Vulnerability Index	
	Baseline	Near-term
Jaintia Hills	2	2
East Khasi Hills	2	2
West Khasi Hills	4	4
South Garo Hills	4	4
Ribhoi	5	5
East Garo Hills	5	5
West Garo Hills	5	5

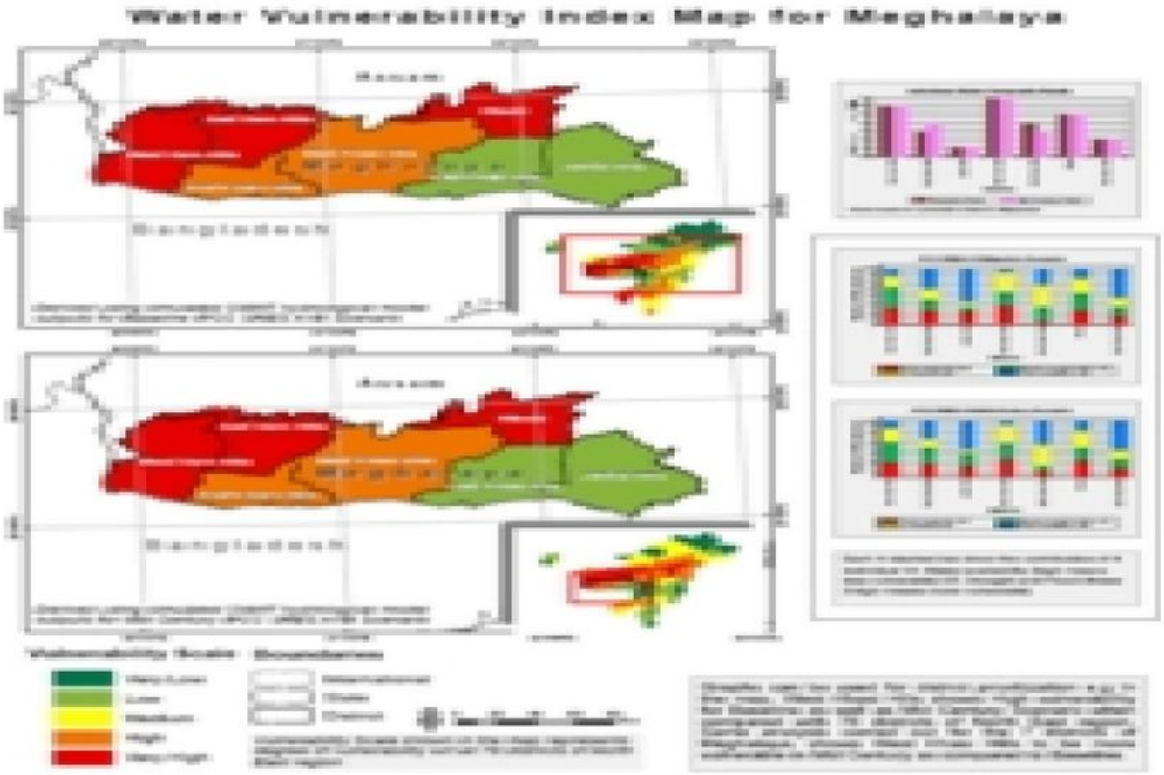


Figure: Spatial distribution of districts of Meghalaya according to vulnerability index under model (A1B scenario) derived current climate (baseline) and climate change (A1B scenario) for near-term.

Chapter 4: Key Sectoral Issues and Priorities to address climate Change in Meghalaya

4.1. Sustainable Agriculture

4.1.1. Introduction

The economy of Meghalaya is basically agrarian. Since, 70% of the state's population depends on Agriculture, employment and income generation also depends on agricultural developmental activities to a great extent. Rice is the predominant crop of the state. Other dominant crops are potato, pineapple, ginger, maize, areca nut, jute, bamboo, and a wide variety of fruits, flowers and spices.

The agriculture sector in Meghalaya contributes 22% to the Gross State Domestic Product (GSDP). Though, 70% of the population depends on agriculture, the net cropped area is only about 9.76 % of the total geographical area of the State.

The state is also very much vulnerable to the impacts of a changing climate and has faced wrath of freak weather events in the recent past. The state is prone to floods and soil erosion making the sector much more vulnerable. Cloudbursts resulting to flash floods may leads to loss of life and agricultural yield. Around 815,000 hectares in Meghalaya have been affected by soil erosion *(Venkatachary et al, 2001)*.

The degree of adaptability of the state towards climate change disasters is low due to fragile geo-environmental setting and economic under-development. In this region, the Temperature–Humidity Index (THI) is likely to increase during April-October with more than 80 leading to severe impacts on livestock health and productivity.

Under the National Action Plan for Climate Change, a separate National Mission on Sustainable Agriculture is included. The mission aims to make Indian agriculture more resilient to climate change. The prime focus is on rain fed agricultural zones. The key priorities identified in Meghalaya context are in line with the national policy. Issues affecting fisheries and Animal Resources are also covered under agricultural sector.

4.1.2. Key Facts about agriculture

The state is prone to floods and soil erosion; hence agriculture is vulnerable to flood effects. The state is deficit in food grains by 1.37 lakh tonnes annually to feed a population of 2.3 million *(Meghalaya Agriculture Profile 2006)*. This is due to a lot of constraints, such as the undulating topography, transport and communication problem, population dispersal pattern, inadequate credit support, poor marketing system, etc. To overcome these hurdles, future programmes are proposed, like increasing agricultural/ horticultural production and productivity, research system on the development of economically viable and location specific technologies in rain fed, flood prone areas, and increasing the utilisation of irrigation potential etc.

The land-use pattern of the state is broadly characterised as follows:

a) The land holding is mostly operational with little concept of permanent ownership under traditional land tenure system. Under such holding pattern there is no incentive for the holder to reclaim cultivable wastelands, utilise and develop fellow lands.

b) Broadly the low lying areas are put under paddy and pulses during Kharif, paddy, vegetables and oilseeds during the Rabi season depending on the availability of residual moisture and irrigation facilities.

c) Gentle slopes up to 20% are put under other crops like wheat, paddy, maize, pulses, oilseeds, vegetables, etc. which not only contribute towards food security but also yield substantial revenue returns per unit of land and labour. On such slopes the concept of watershed management of land and water is encouraged.

d) Horticultural crops are taken up on slopes above 20% and Border Areas, which are traditional horticultural areas, received special attention.

e) Forest cover in the State (41.98%) is below the national norm of 60% recommended for hilly areas. This is because a sizable proportion of the Forest area is reportedly under shifting cultivation resulting in depletion of the Forest Cover. A very meagre proportion of the geographical area (9.75%) is net sown area, including area under shifting cultivation. The potential net sown area could be increased if and when the fallow lands are utilised for cultivation purposes. The cultivable waste land of the state is 20.11% of the geographical area a part of which might be progressively utilised for cultivation purpose in the long run. The cropping intensity of the state is 121%.

Irrigation
The irrigation potential in the state is around 2.18 Lakh Ha of which 23,352 ha are under surface water irrigation and 1,913 ha underground water irrigation. The situation entail for creation of irrigation facilities and conservation and preservation for a longer period.

Mechanisation
Per hectare availability of mechanical power in the state of 0.358 hp is too low in compared to government of India's draft mechanisation policy target of 2 hp per year.

4.1.3. Facts about Livestock Management

Meghalaya is an agrarian economy and high demand for livestock like pig, cattle, goat, poultry essentially required for the overall food supply of the people. Pork consumption in particular is very high. The population of the state is mostly meat eaters and the consumption of milk is negligible. It indicates the need for requirement of livestock Management in the state. The livestock population is dominated by cattle (indigenous and crossbred cattle) and pig population is also considerable.
Temperature and rainfall variations have increased the incidence of vector-borne diseases. To minimize the impact of climate change on animal health and reduce the vector borne diseases, the state plans to carry out some research study on impact of climate change in livestock, piggery and poultry, ensure vaccination of farm animals against contagious diseases, de-worming and early disease warning system, develop a breeding policy and use biotechnology to breed genetically climate resilient breeds of farm animals, and increase the availability of and access to vaccines.
The topography, climate and Socio-economic conditions of Meghalaya makes the people to depend more on livestock and dairying activities mainly because of traditional agriculture in hilly areas allows only about 10 per cent of the land. Heavy rainfall in sloppy hills of Meghalaya not only causes soil erosion but also makes it acidic by removing the soluble basic part of the

soil by the solvent action of the run-off water and loss of productivity. Under such circumstances, livestock Management and dairy farming is the alternative options to take up by the villager for sustaining their life.

Sub region	Agro-climatic features	Soils	Dominant geographic units
I	Humid and warm with an average rainfall between 1270-2032 mm	Light to medium texture, depth varying between deep to very deep	Hills and rolling and undulating pediment
II	Humid and hypothermic moderately cold in winter and warm in summer rainfall varying between 2800-4000 mm	Light to medium texture depth varying from deep to very deep	Upper and middle plateau
III	Humid and moderately warm summer and serve winter rainfall between 2800-6000 mm	Light to medium texture depth varying from deep to very deep	Upper and middle plateau
IV	Humid and warm high rainfall ranging from 4000-10,000 mm	Light to medium texture depth varying from deep to very deep	Severely dissected and undulating low hills gentle to steep slope and rolling pediment
V	Humid and hot, rainfall varying from 2800-4000 mm	Light to medium texture, depth varying from moderately deep to very deep	Rolling and undulating pediment and valley land having depression

4.1.4. Facts about fisheries

Meghalaya has 5600 km of river/ streams, 394 ha of lakes, 1944 ha of ponds and 3000 ha of other suitable water bodies. Fisheries and aquaculture can be an important source of revenue, food, employment and social security for the rural poor.

4.1.5. Key Issues

The low altitude areas, bordering Assam and the international border (India-Bangladesh) are frequently affected by floods. Flash floods have become a regular feature in these areas, mainly due to massive deforestation and unchecked *jhum* cultivation *(State Agricultural Profile 2006)*. The flood water carries huge amount of hill sand, stone, logs and trees, which are deposited in agricultural fields due to inundation of banks in the foot hills, thus causing immense damage to crops.

Bulk of the state's agriculture comprises of paddy fields and since paddy cultivation is entirely rain-fed, changes in local climatic factors is estimated to have maximum impacts on paddy cultivation. Increasing mean daily temperature will decrease the period from transplantation to maturity. Such a reduction in duration is often accompanied by decreasing crop yield *(Dr. S. Sudhakar and S. S. Kundu, NESAC, 2011)*.Paddy crops are vulnerable to climate induced stress such as prolonged submergence, variations in pH, minerals, and temperature etc. (especially impacted kharif growing season).

The key to the health of the farm sector in the state lies in the health of the forest cover in the state. According to the State Agricultural Profile, every square inch of the upper range of the hills need to be under mixed forest cover to protect the soil from leaching and erosion to help regulate and decrease the fury of streams and rivulets during the monsoon season. Vegetation

also helps to retain soil moisture and ooze it out during the lean winter months to balance vegetative stress caused by mono cropping in the valley; to bestow various other advantages which help maintain the fragile eco-balance. This would ensure continuous cultivation of crops in the farm sector.

4.1.5. Adaptation Pathway in Agriculture

Adaptation measures can offset the negative impacts of climate change on irrigated wheat and rice but in the case of rain-fed rice, growing of tolerant and high input efficient rice varieties with better management and assured irrigation only can reduce the climate change impacts. With such adaptation strategies, the positive impacts can be improved further.

For working out the comprehensive impacts, there is a need to link other influential biophysical and socio-economic driving forces those which are indirectly impacted by climate change but influence the agriculture of the state. Suitable agronomic management options can act as one of the important adaptation strategies to face climate change.

Issues	Impact	Pathways
Warm and Humid summer and cold winters	Erratic cropping season, crop loss	Local weather monitoring stations for data and timely predictions, temperature tolerant crop varieties
Heavy and erratic precipitation	Crop damage due to prolonged submergence or lack of timely precipitation	Stress tolerant varieties, water harvesting, mini-check dams and reservoirs
Traditional *Jhum* cultivation	Deforestation, reduction in carbon sinks, soil erosion, livelihoods affected	*Jhum* optimisation through catchment area protection, plantation crops, soil conservation
Reduced soil fertility/ productivity	Reduced food security	Organic farming
Increase in vector-borne diseases	High mortality of farm animals and also higher incidence of pathogens	Vaccination, breeding of climate resilient breeds/ cultivars
Variability in climate leading to variability in yield	Decline in yield of cereals and decreased fruit setting and quality deterioration in horticultural crops	Diversification, *insitu* moisture conservation and climate adaptive cultural practices

Effective and result-based measures should be supported for the development of approaches at all levels on vulnerability and adaptation, as well as capacity-building for the integration of adaptation concerns into sustainable agriculture development strategy in the state.

4.1.5. Key Priority actions

The section outlines various key priorities pertaining agriculture, livestock and fisheries. The following action points have resulted out of discussions between the working group members.

- **Assessment of soil quality & soil moisture content for better productivity through generation of climatic information**

  To address the lack of information on local weather data, rainfall patterns, soil quality, soil moisture content and other climatic parameters, the state emphasises on the need to establish state-wide monitoring stations for generation of primary information on weather, soil and water quality.

Further studies would be carried out on soil quality and soil moisture content in the context of increasing agricultural yield.

- **Impact assessment of paddy cultivation and promotion of rain water harvesting through construction of eco-friendly mini check dams**

Only about 15% of the state's total area under cultivation is irrigated at present. Bulk of the state's agriculture comprises of paddy fields and since paddy cultivation is entirely rain-fed, changes in local climatic factors is envisaged to have maximum impacts on paddy cultivation.

To address these impacts, studies on evolving stress tolerant varieties, impact of water quality on crops, impact of climate change on kharif crops have been proposed by the state to enable documentation of local climate-linked issues and traditional practices of climate adaptation.

For improved water availability, studies for promotion of rainwater harvesting measures and construction of eco-friendly mini check dams are being proposed.

- **Increasing the area under perennial fruit plantation crops and low volume high value crops to help cope with uncertain weather patterns**

The state has diversity in climate, topography, soil profile etc. A wide range and variety of horticultural crops like fruits, vegetables, spices and a variety of colourful and attractive flowers, ornamental plants and orchids can be found and successfully grown. In the context of climate change, there will be need to increase the area of plantation for perennial fruit and low volume high value crops. Promotion of fruit plantation will also help to enhancing carbon sinks. It is essential to encourage horticultural activities in the state and minimise the impacts of climate change on horticultural products.

To this effect, it is being proposed to carry out a detailed study on how to enhance the area under horticulture i.e. increase the area under perennial fruit and plantation crops, increase the area in respect of low volume- high value crops under protected condition, improve post-harvest management such as cold chain for perishable crops and encourage winter cultivation to increase double and multiple cropping.

- **Management of climate change impact on horticulture**

The state of Meghalaya is bestowed with natural growing conditions for several economically important horticulture produce like Pineapple, Oranges, Banana, Ginger, Cashew Nut, etc. The horticulture sector in Meghalaya is still vulnerable to predicted changes to rainfall and temperature that will impact on, plant growth, pest and disease risk breakout, product quality. To this effect, it is being proposed to carry out a detailed study on the impact of climate change on horticulture sector. The combined impact of the predicted changes to rainfall and temperature affects horticultural commodities and regions in a number of ways.

- **Improving post-harvest management such as cold chain for perishable crops and winter cultivation practices**

Processing and preservation of value added products are required in the context of climate change. There is a need to develop quality control measures, adequate packing and storage

techniques. The post-harvest loss negates all the efforts that have been made to produce the crop. Thus it is crucial to focus the research and development of post-harvest protection method on economically less demanding and consumer friendly alternatives for ensuring food security to people of Meghalaya. State planned training of growers on post-harvest crop management, establishment of good godowns and cold storage centres with grading facilities, market linkages etc.

- **Optimization of *jhum* cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops**
  Shifting cultivation (*Jhum*) practiced on the hill slopes of Meghalaya. In the hills, agricultural operations are carried out up to a maximum elevation of 5000 m with 'slash and burn' method. Flash floods have become a regular feature in the state, due to massive deforestation, unchecked *Jhum* cultivation. In order to offset and improve traditional *Jhum* cultivation, such as forest degradation and loss of top soil, the state would emphasise on conservation measures in arable land (such as contour bound, improvement of existing paddy fields, bench terracing), creation of water bodies / up scaling and upgrading of existing water bodies, catchment area protection and encourage parallel cultivation of plantation crops like rubber, cashew nuts etc.

- **Promotion of organic farming through usage of compost / vermicompost and IPM**
  The state has immense scope for organic agriculture as huge amount of organic manure beside vast resources of weed biomass, green manure and litter falls are available. The state realises the need to continue and expand traditional organic farming to reduce use of fertilisers that would lead to increasing the carbon sink and reduction of green-house gases in the atmosphere. Currently about 1000 ha area is under organic production system in different stages covering crops like turmeric, ginger, cashew nut, pineapple, etc. Promotion of compost/ vermicompost and Integrated Pest Management (IPM) requires mass awareness among farmers and growers which is also economically viable and has greater opportunity all over the state.

- **Breeding and production of crop varieties mainly rice with stress tolerant and resistant attributes**
  Current efforts seek to characterize the implications of climate change as a first step toward developing a strategy. Meghalaya will use genetic and molecular approaches for breeding rice varieties for stress tolerance. Breeding for disease resistance in rice is one of the major concerns as rice is the main staple crop of the people of the State. These improved rice varieties can help to a great extent in increasing production and productivity in Meghalaya. New vegetables and their improved varieties encourage farmers of Meghalaya to opt for diversification thus helping them to enhance their farm income. Breeding will improve varieties or hybrids of Indian vegetable crops resistant/ tolerant to biotic and abiotic stresses as a well as quality. The collaboration will sought to be made with the research programme on rice, currently carried out by IRRI, Manila.

- **Assessment study and demonstration of System of Rice Intensification (SRI) cultivation**
  The state rice production currently cannot entirely meet its own rice demand. The shortage of about 2 lakh tons of rice needs to be met through purchase from neighbouring states. SRI is a simple but every effective approach to the current food crisis. System of Rice

Intensification (SRI) cultivation will be introduced in all districts of Meghalaya and state is planning to promote SRI which is recognized to benefit the farmers in terms of reducing the cost of cultivation and increasing his total income and net profit and also contribute significant reduction of Green House Gases emission from rice cultivation.

- **Local mass production of such varieties for distribution to the farmers as substitutes to lesser tolerant varieties - setting up of 'Planting Material Production Centres'**
  In order to address the constraints like cold/ heat tolerance, flood tolerance, disease and pest resistant rice varieties with higher production potential, adequate support through research backup shall be provided in the form of developing resistant/ tolerant varieties, weather-based disease and pest forecasting models and molecular disease diagnostic systems. Meghalaya Government is planning to set up "Planting Material Production Centre" (PMPC) to strengthen for production of varieties tolerant to extreme climatic conditions. The main objective of the centre will be to establish viable seed enterprises to facility farmers gain access to high quality seed and planting material, production of Basic Seed and Planting Material, production and distribution of Certified Seed with contract growers, management of Government Seed Farms, seed Industry Development and Coordination, maintenance of Buffer seed Stocks, coordination of Seed & planting material supply Programme.

- **Capacity building to train farmers in latest cropping techniques specially evolved to counter adverse effects of climate change.**
  The agricultural communities in Meghalaya are largely primitive with limited use of modern farming implementation and techniques. The State in its attempt to adopt new technologies and processes, which are relevant to the climate and topical needs, would adopt lessons from pioneers in the field. Climate change is a new challenge affecting the agricultural sector. However, some of the progressive farmers in the State have adopted advanced farming techniques and have significant improvements in productivity. Substantive capacity building will be required for farmers in latest cropping techniques in Meghalaya. The agricultural department is promoting the use of Integrated Pest Management Techniques for certain crops like paddy and potato. The State will therefore have to focus on extensive capacity building among the farmers so that they can implement latest cropping techniques to adapt counter the adverse effect of climate change.

- **Assessment of impact of climate change in livestock and reduction of impact of vector borne diseases through vaccination of farm animals, breeding policy for climate resilient breeds**
  It is important to have a vector control program and pre-monsoon vaccination camp and other seasonal programmes and health checkups for the livestock's and poultry.
  Temperature and rainfall variations have increased the incidence of vector-borne diseases. To minimise the impact of climate change on animal health and reduce the vector borne diseases, the state plans to carry out a study on impact of climate change in livestock, piggery and poultry, ensure vaccination of farm animals against contagious diseases, de-worming and early disease warning system, develop a breeding policy and use biotechnology to breed genetically climate resilient breeds of farm animals, and increase the availability of and access to vaccines.

- **Development of water management in minor irrigation through construction of check dams, rain water harvesting and revival of existing water bodies as adaptation measures**

  Adaptation measures are needed to ensure sustainable water availability in times of water stress and water excess as a consequence of climate change. These include an increase in the quality and quantity (discharge) of water in existing minor irrigation schemes, construction of series of check dams, construction of rain water harvesting structures such as reservoirs and revival of water in existing water bodies.

- **Impact assessment of climate change on fishery and development of watershed vulnerable to climate variations**

  The state of Meghalaya is rich in water resources in the form of lakes and reservoirs that offer itself for exceedingly well for inland fisheries. The impact of long-term trends in climate change, in particular related to global warming, is less well-understood in fisheries but is beginning to receive attention. Being water dependent, the fisheries sector will be impacted by climate change though no directly attributable impacts have been recognized so far. The global warming can affect the spawning and breeding migration of the fish.

Some other suggestions that were considered are listed below:

(1) Agriculture:

- Cover cropping, *in-situ* residue management and restoration of degraded lands for soil moisture conservation and improved Carbon sequestration.
- Agro forestry with multipurpose trees, crops and animal components for improving hydrology.
- Integrated farming systems and watershed development with animal, fishery and hedge row cropping for soil and moisture conservation and nutrient recycling.
- Screening short duration varieties for their drought resistance.
- Popularization of technologies like system of rice intensification (SRI) and aerobic rice cultivation for water saving and mitigation of Green House Gas (GHG) emission.
- Rain water harvesting: in-situ (land configuration, mulching etc.) and ex-situ (Ponds, micro water harvesting structure –jalkund etc).
- Promotion of technologies that enhance biological N-fixation and improve nutrient and water use efficiency to reduce N_2O emission.
- Change in planting dates and crop varieties are another adaptive measure to reduce impacts of climate change to some extent. For example, the Indian Agricultural Research Institute study indicates that losses in wheat production in future can be reduced from 4 – 5 million tons to 1 – 2 million tons if a large percentage of farmers could change to timely planting and changed to better adapted varieties.
- Promote traditional, organic and sustainable agriculture. Preservation and management of germ-plasm, traditional varieties and seeds
- Reduce chemical fertiliser for NO_2 reduction and also encourage efficiency in irrigation to reduce CO_2 emission
- Crop diversifications
- Use varieties that can withstand weather stress and also varieties that can sequester carbon and other GHG; introduction of bio-technology
- Prevent diversion of agricultural land for non-agricultural use and ensure groundwater management

- Weather insurance for risk transfer

(2) Fishery:

- Livelihood planning for the fishermen and capacity building to adapt to climate change
- Modern technology for forecast at the local level and early warning
- Protection of fishery infrastructure and catch
- Research needed on impact of climate change on inland aquaculture and water-balance.

(3) Livestock:

- Research study on livestock disease and establishment of early warning system
- Capacity building of livestock keepers

Key priorities Agriculture

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Assessment of soil quality & soil moisture content for better productivity through generation of climatic information	Dept. of Soil Water Conservation/ Agriculture		1.0	GoM
2	Impact assessment of paddy cultivation and promotion of rain water harvesting through construction of eco-friendly mini check dams.	Dept. of Agriculture		8.0	GoM, GoI
3	Increasing the area under perennial fruit plantation crops and low volume high value crops to help cope with uncertain weather patterns.	Dept. of Horticulture		70.0	GoM, GoI
4	Management of climate change impact on horticulture	Dept. of Horticulture		1.0	GoM, GoI
5	Improving post harvest management such as cold chain for perishable crops and winter cultivation practices	Dept. of Horticulture		650.0	GoM, GoI
6	Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops	Dept. of Soil Water Conservation		200.0	GoM, GoI
7	Promotion of organic farming through usage of compost/ vermin-compost and IPM	Dept. of Agriculture		90.0	GoM
8	Breeding and production of Rice varieties with stress tolerant and resistant attributes	Dept. of Agriculture		10.0	GoM, IRRI
9	Assessment study and demonstration of Systematic Rice Intensification (SRI) cultivation	Dept. of Agriculture		10.0	GoM,IRRI
10	Local mass production of such Rice varieties for distribution to the farmers as substitutes to lesser tolerant varieties - setting up of 'Planting Material Production Centres'	Dept. of Agriculture		20.0	GoM, IRRI
11	Capacity building to train farmers in latest rice cropping techniques specially evolved to counter adverse effects of climate change	Dept. of Agriculture		10.0	GoM, IRRI
12	Assessment of impact of climate change in livestock and reduction of impact of vector borne diseases through vaccination of farm animals, breeding policy for climate resilient breeds.	Dept. of Animal Husbandry and Veterinary		30.9	GoM, GoI
13	Development of water management in minor irrigation through construction of check dams, rain water harvesting and revival of existing water bodies as adaptation measures	Dept. of Water Resource		105.0	GoM, GoI
14	Impact assessment of climate change on fishery and development of watershed vulnerable to climate variations.	Dept. of Fishery		70.5	GoM, GoI
Total				**1276.40**	

4.2. Sustainable Habitat

4.2.1. Introduction

Urbanisation in Meghalaya is much lower than the national average (28%) with an urban population of only 19.58% (Census 2001) and majority of the state's population continue to live in rural areas. However, urban population has maintained a steady growth over years. The state presently has 16 urban centres, comprising the Shillong Urban Agglomeration (including seven towns), Cherrapunjee, Nongstoin, Mairang, Nongpoh, Jowai, Tura, Williamnagar, Rasubelpara and Baghmara. Shillong and Tura altogether accounts for 71.93% of the total urban population.

4.2.2. Key Facts about urban sector in Meghalaya

The state envisages a huge gap between the demand and supply of basic urban services. Census 2001 reports that almost 71% of the urban population have access to drinking water through taps. Challenges in water supply include improvement in distribution system, inequitable distribution, water resource management and treatment, rationalisation of water use. Sanitation poses major problems with the absence of any sewerage system in urban areas resulting in drainage of domestic effluent into nearby rivers and streams leading to contamination of water sources. Moreover about 8.41% of the population have no sanitation facility. Absence of storm water drainage poses problems of water logging and flooding, causing landslides and soil erosion. Indiscriminate developmental activities also add to the problem by obstructing drains and encroaching rainwater flow paths.

Solid waste is a pressing urban issue for Meghalaya primarily because of its difficult terrain. Inadequate collection and improper disposal currently lead to spillage and contamination of soil and surface as well as groundwater streams. Presently within Shillong Urban Agglomeration area about 175 TPD Solid waste generates. Compost and vermicompost treatment plants have been established through PPP mode in Shillong and Tura respectively while several other urban centres have identified sites for the same. However operations of the existing plants are being severely affected due to absence of sanitary landfill to disposed rejects and inert.

The urban transport sector has been largely neglected in the State, characterised by heavy traffic congestion due to narrow roads, rapid growth in number of vehicles along with highly topographic and concentric development. Public transport is limited due to inadequate road network, poor infrastructure and scattered demand. Within the state about 22% of the urban population is estimated to be BPL population (according to town surveys as per old guidelines). 45 slums have been identified and notified, 5 more have been identified and yet to notified within the 6 towns in Meghalaya. Slum population constitutes around 42% of the population of these towns. A significant percentage of the urban poor of the state are devoid of basic civic amenities and basic services, especially sanitation.

Housing in urban Meghalaya is primarily characterised by medium density development with 4.5% of the urban population living in dilapidated condition. As per the 2001 Census, the condition of house used for residence and other purposes in the urban areas shows that 60.8% are in good condition, 34.7% in liveable condition and 4.5% in a dilapidated condition. The State Housing Policy formulated in 1998 emphasises on up-gradation of living conditions by way of subsidies on building material and soft loans to the urban poor.

Transport infrastructure is one of the most important requirements of the people of the state. Most of the towns within the state are very small and due to the narrow roads and yearly growth of vehicles the traffic congestion has already appeared in most of the roads. In most of the cases the major highways passes through the city or towns and as a result of which regional traffic comes in conflict with the local traffic.

4.2.3. Key Issues

Meghalaya being located in a highly seismic zone (Zone V) and is prone to frequent earthquake shocks and subsequent hazards. Also frequent rainfall makes urban living highly vulnerable to climatic impacts such as floods and landslides. For example, the river mouths near Shillong are known to get flooded frequently during heavy monsoons. In addition, poor management of solid and liquid waste, traffic congestion and vehicular pollution, clearance of green areas due to indiscriminate construction, and fossil-fuel energy consumption in city infrastructure contribute to climate change through increase in GHG emissions and reduction in carbon sinks in urban areas..Various features of urban agglomerations in the state interact with the climate and enhance the vulnerability of the city population.

Higher runoff: Hard surfaces prevent the absorption of heavy rainfall that is the characteristics of the cities in Meghalaya and this result in carrying the pollutants to the lakes and streams; simultaneously it also overwhelms the storm-water and city sewerage.

High Urban Concentration: Higher concentration of people in the cities confined to smaller pockets puts pressure on the vegetation, green spaces as well as the electricity and water supply system.

Longer distribution system: Because of continuous expansion of people to far flung areas puts pressure on the centralised distribution system as the distribution lines extend to far flung areas.

In order to combat these odds through a sustainable strategy for climate resilience, the state has envisaged the following key priorities in the urban sector.

4.2.4. Adaptation Pathways in Cities

Issues	Impact	Pathways
Warm and Humid summer and cold winters	Increased demand for cooling	Create awareness to retrofit building with green design; policy incentive for usage star rated HVAC products
Heavy and erratic precipitation	Increased storm-water runoff	Development of storm water management plan and investment in sewerage; re-assessment of master plans/land use plans of urban agglomerations, policy incentive use of permeable surfaces and incorporation in the PWD codes
Enhanced waste generation due to migration	Health hazards, soil contamination through leaching, odour pollution	Awareness for waste segregation and policies for landfilling
Transport system congestion and ageing	Congestion and higher emission	Phase out of old vehicles, integrated traffic study and congestion reduction plan
Energy Usage	Higher concentration and higher use	Utility DSM measures in street lighting, solar water heating

4.2.5. Key Priorities

The following action points have resulted out of several rounds of discussions between the working group members

Key Facts about urban sector in Meghalaya

- **Capacity Building on Climate Change Impacts and Preparedness**

The state emphasises on the need to enhance capacity of the officials on climate change implications and possible adaptive and mitigating measures so that they could include climatic considerations in their departmental planning as well as day to day operational and monitoring activities. Beginning with a training needs assessment for all relevant departments and agencies, training modules especially on waste management, water supply and service delivery, and urban management would be created and imparted. Capacity building would also be extended to awareness generation of residents on good practices such as source segregation of waste and energy efficiency.

- **Incorporate Climate Concerns in Urban Water Supply and Sewage Design**

In order to provide for unforeseen climatic extremes such as floods in urban design, building in provisions for storm water flow management, and preventing contamination of water streams due to flooding and other relevant aspects would be incorporated into the urban design.
It would include installation of liquid waste treatment facilities, constitution of water use societies for regular monitoring of services, leak detection and water quality monitoring and capacity building exercises.

- **Working Towards Greater Water Use Efficiency and conservation in Urban Areas**

Water conservation and enhanced efficiency would help in adapting to water shortage during climate induced dry spells. It would also lead to energy conservation by reducing energy consumption at pumping stations, wastewater treatment plants and other relevant facilities. Sub-activities would include household metering of drinking water and installation of rainwater harvesting systems in buildings of area over 100 sq.m.

- **Developing a climate friendly waste management system**

The activity is proposed to establish an integrated waste management plan for cities including measures to improve efficiency of existing solid waste and sewerage management systems, and incorporate a plan for management of construction and demolition (C&D) waste, biomedical waste, and domestic hazardous waste. Priorities include preparation of detailed project reports on solid waste management, especially for Jowai, Nongpoh and Tura, enforcing source segregation, conducting studies on feasibility of biomedical waste management and liquid waste treatment, and a survey on the existing land tenure system in context of urban development.

- **Development of satellite townships**

Establishment of satellite townships near the highly congested towns of Shillong and Tura have been proposed to reduce population pressure on existing cities and towns and improve efficiency in delivery of basic urban services.

- **Environmental Profiling and GHG Emissions Inventorisation for all urban bodies including upcoming satellite townships**

For regular monitoring of the city environment, it is essential to conduct an environmental and emissions profiling of the towns by collecting baseline data on environmental parameters, including emissions, establishing benchmarks for periodic monitoring, checking environmental degradation and identifying scope for mitigation in the relevant areas. This would require

setting up of monitoring stations across the towns and capacity building of personnel on monitoring techniques.

- **Energy efficient Street Lighting**

Energy conservation would be promoted by exploring the use of energy-efficient systems such as CFL or LED lamps in street lighting. Similar initiatives have been carried out using the Clean Development Mechanism (CDM) as a financing option and will be explored. A plan to scale-up the public private partnership and CDM approach to energy efficient street lighting across the state will be developed.

- **Improve enforcement to control vehicular pollution**

Transport sector contributes around 14% towards the global emissions of green house gases. To mitigate the emissions from transport sector, enforcement measures such as phase-out of old vehicles (more than 15 years) and checking of pollution control certificates of vehicles will be carried out. Further policies will be developed to control vehicular emission within the state.

- **Urban Poor Mapping to identify vulnerable urban population**

The urban population in Meghalaya is to the susceptible toward the vengeance of the climate change impact both from the point of the view of its eco fragile location, lack of adequate infrastructure to adequately reduce the impact of climatic variability like flood and incidence of poverty. Climatic variation could further multiply the vulnerability of the poor people by adversely affecting their health, livelihood and jeopardize growth opportunity. It is therefore essential to demarcate the section of society living below poverty line and are also vulnerable to the climatic variability and map appropriate adaptive action to reduce the impact.

- **Undertaking carrying capacity mapping**

Rapid urbanisation as well as unplanned mining activity has enhanced the stress over the infrastructure in few of the region. It is therefore highly essential to undertake a carrying capacity study and there after plan for further urban settlement or industrial development.

Key priorities Sustainable Habitat

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Capacity Building on Climate Change Impacts and Preparedness 1. Training needs assessment and planning 2. Capacity building for departments on solid waste management 3. Capacity building on Management and efficient distribution of water supply and service delivery (monitoring) 4. Capacity building on Urban Management 5. Awareness generation at the community level	Depts of Urban, PHE, Power, transport, Forest and Environment , SPCB, Ministry of Rural Development, GoI		5.0	GoM, GoI, External Agencies
2	Incorporate Climate Concerns in Urban Water Supply , Drainage and Sewage Design 1. Provision of adequate water supply and ensure water quality 2. Install sewage treatment system 3. Policy shift from 'Project- mode' to 'Mission-mode' 4. Constitute Water use Society/ Committee to ensure service delivery, water supply, cleanliness, waste collection, drainage etc. on a day to day basis 5. Initialization of proper drainage system	PHE, Urban Affairs	586.86 380.28 231.55	1198.69	GoM, GoI, UDISMT, JNURM
3	Working Towards Greater Water Use Efficiency and conservation in Urban Areas 1. Metering for drinking water conservation 2. Identification of existing buildings >100m^2 and assessment of installation option of RWH	PHE, Urban affairs		50.0	GoM, GoI
4	Developing a climate friendly waste management system	Urban affairs, revenue dept	123.22	123.22	GoM, GoI, UDISMT
5	Development of satellite townships 1. Preparation of DPRs 2. Conducting Environmental Impact Assessment	Urban Affairs		0.6	GoM, GoI
6	Environmental Profiling and GHG Emissions Inventorisation for all urban bodies including upcoming satellite townships	Urban affairs, Forest dept		0.5	GoM, GoI

	1. Setting up of environmental monitoring stations 2. Imparting monitoring training to personnel				
7	Energy efficient Street Lighting Assessment study and DPRs on energy efficient street lighting systems along with taking up of pilot initiative	Urban affairs, Power dept		27	GoM, BEE
8	Improve enforcement to control vehicular pollution 1. Phase out old vehicles (more than 15 years) 2. Enforce and monitor pollution under control certificates	Urban affairs, Transport dept, SPCB		00	GoM, GoI
9	Urban Poor Mapping to identify vulnerable urban population	Urban affairs		0.5	GoM
10	Undertaking carrying capacity mapping	Urban affairs, Transport dept, SPCB, industry		0.5	GoM
Total				**1406.01**	

4.3. Sustainable Forestry

4.3.1. Introduction

With more than two third of its land area still forested, Meghalaya – one of the eight states of North-eastern India - has high potential for the development and conservation of forest cover. There are, however, various constraints to the development of forest cover as demonstrated by the noticeable development of industries and mining activities along with rapid urbanization in the state and the dearth of real time information regarding the status of existing forest cover.

Climate change impacts can be minimized by increasing forest cover, its quantity and conservation of existing forests and biodiversity. The state has no proper land record to chronicle deforestation and overall degradation. Also there is huge potential for development of forest based enterprises within the state for which enabling forest policies need to be spelt out.

The State, however, contain areas of very beautiful scenery with evergreen forests and waterfalls as well as areas of unique floral and faunal varieties. The Reserved forests are managed under prescriptions of the working plan prepared for such forests by the Working Plan Unit of the Department. The protected forests are managed for preservation of the catchment areas of water sources. Climate change has contributed to substantial indigenous species range contractions and extinctions in the past and future projections indicate that climate change will influence species persistence leading to a disproportionate distribution of species along ecological zones. The consequences of biodiversity loss from climate change are likely to be the greatest for poor and marginalised people, who depend almost exclusively on natural resources. The major environmental problems result from population pressure, conversion of forest land into agricultural fields, deforestation, urbanization, mining and industrialization. The increasing anthropogenic stresses of various kinds are likely to further aggravate the environment in the future.

Under the National Action Plan for Climate Change there is a separate National Mission for Green India. This recognizes that forests constitute one of the most effective carbon sinks. Forest plays an indispensible role in the conservation of ecological balance and biodiversity restoration.

4.3.2. Key Facts about Forestry

The recorded forest area of the state is 9,496 km^2. Reserved Forests constitute 11.72%, Protected Forests 0.13% and unclassed forests 88.16% of the total forest area *(State Forest Report 2011)*. The control of unclassed forests rests with the Autonomous Tribal District Councils of Garo Hills, Khasi Hills and Jaintia Hills. Around 1000km^2 are maintained by tribals as sacred grooves.

Forest types are diverse in the state ranging from sub tropical pine forest to tropical semi evergreen and moist deciduous forest. The Meghalaya forest has rich floral biodiversity with rare species of orchids and medicinal plants. Meghalaya has overall forest cover of about 77.02% which is about 17,275 km^2 [2]and has 2 national parks and 3 wildlife sanctuaries which covers an area of 304 km^2 and constitutes 1.36% of the state's geographical area. Nokrek is the only Biosphere Reserve located in the state.

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[2] FSI 2011

District –wise forest cover in different canopy density classes along with changes compared to 2009 assessment and scrub

District	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of G.A	Change*	Scrub
East Garo Hills	2603	68	1104	1045	2217	85.17	-302	92
East Khasi Hills	2820	0	1084	716	1800	63.83	-279	110
Jaintia Hills	3819	99	1578	839	2516	65.88	-65	53
RiBhoi	2376	131	1092	898	2121	89.27	433	10
South Garo Hills	1849	44	1005	590	1639	88.64	-50	27
West Garo Hills	3715	0	1361	1613	2974	80.05	257	129
West Khasi Hills	5247	91	2551	1366	4008	76.39	-40	64
Total	**22429**	**433**	**9775**	**7067**	**17275**	**77.02**	**-46**	**485**

Change compared to 2009 assessment

The state has about 410 km^2 of very dense forest which is present mainly in Ri-bhoi district and also in Jaintia hills, West Khasi Hills and East Garo Hills, while West Garo Hills having lowest amount of very dense forest cover and East Khasi hills doesn't have any very dense forest cover. Moderately dense forest is found to be maximum in West Khasi Hills district and Open forest found mostly in West Garo Hills.

Primarily Very Dense forest is found in 0-500 m altitude and also in 500-1000 m altitude. Moderately dense and open forest also found mainly in low altitude area of 0-500 m (State Forest Report 2009). The primary forest type found in the state of Meghalaya is Tropical Moist Deciduous of about 61% and Subtropical Broadleaved Hills forests of about 18.24%. Also Tropical Wet Evergreen forests, Tropical Semi Evergreen forests ad subtropical Pine forests also found within the state.

Altitude zone wise forest cover

Altitude zone	VDF	MDF	OF	Total
0-500 m	229	4341	4037	8607
500-1000 m	197	2839	2192	5228
1000-2000 m	7	2595	838	3440
Total	433	9775	7067	17,275

(Based on SRTM Digital Elevation Model)

The state of Meghalaya is a part of Indo-Myanmar bio-geographical region, which is one of the mega biodiversity regions of the world. Nokrek Biosphere Reserve, Balphakram National Park, Nongkhyllem, Siju, and Baghmara Wildlife Sanctuaries and a large number of sacred groves found in different parts of the state are the main preserves of biodiversity. The floral diversity of Meghalaya is quite rich. It harbours about 3,128 species of flowering plants and contributes about 18% of the total flora of the country, including 1,237 endemic species. Besides, a wide variety of wild cultivable plants, edible fruits, leafy vegetables and orchids are found in the natural forests of Meghalaya.

The state of Meghalaya is rich in mineral resources. The major minerals present in the state are coal, limestone, clay and sillimanite. Besides, ores of iron, uranium, copper, granites, gold etc. are also found in the state. On an average, the annual revenue income of the state from these minerals is about Rs. 40 crore.

Meghalaya is among the states having the highest density of elephants *(State Forest Report 2009)*. Joint Forest Management (JFM) started in Meghalaya in the year 2003 and already there are 73 JFM committees managing 4000 ha of forest area *(MoEF, 2005)*.

4.3.3. Key issues

Some of the emerging problems leading to the loss of biodiversity and extinction of few of the endemic species over the past decades[3] are deforestation, Land tenure systems in the state, Clan-owned forests are mostly over-exploited and the District Council Acts, wherever applicable to these forests, are too weakly enforced, Overexploitation of ornamental and medicinal plants and animal products, conversion of mixed forests into monoculture forests and habitat destruction, conversion of forests areas into agricultural lands including shifting cultivation, encroachment, fragmentation of natural forest into isolated patches due to mining, Urbanization , Industrialization and other biotic pressure.

High rainfall and hilly terrain have further accentuated the impact of human activities on the forest. Almost the entire state is influenced by age-old practice of slash and burn agriculture, except some pockets of valley bottomlands. This practice destroys the protective and productive vegetation in preference to a very brief period of immediate crop production. In order to earn their livelihood people practice shifting cultivation and over-exploit forest resources, causing serious damage to the forest and biodiversity.

Industrial development in Meghalaya primarily due to increase of mining activities created a huge pressure of vegetation and biodiversity and destruction of natural forests. The community forests in Meghalaya are owned by clans, village durbars, Syiems, Sirdars, Dolois and Nokmas. Although such forests are supposed to be managed according to the provisions of the respective District Council Forests Act, in practice, there hardly exists any management system. Even the sacred forests maintained as community forests, are fast vanishing. A study reveals that barring only 1% of the total sacred forest area of the state is preserved in its pristine glory all other sacred forest areas is moderate to highly degraded.

4.3.4. Climate Change Adaptation in forestry sector of Meghalaya

Meghalaya has overall forest cover of 77.02% of the total land surface. In addition to adapting forests to climate change, forests can play a role in adaptation by helping human societies to adapt to climate change.

Adaptive management of forests will contribute to sustaining the livelihood of forest dependent communities in Meghalaya. Many existing forests within the state and most newly established stands will experience climatic conditions that deviate from conditions today. Compared to agriculture, decisions taken today for managed forests (e.g. tree species choice) remain irreversible for decades or even centuries. On the other hand, selection of seed provenances for altered climatic conditions will require time. In Meghalaya only 11.71% of reserved forests are intensely managed by state department. An equal proportion fulfils multiple functions at lower management intensity; the remainder is managed at low intensity or for protection, conservation or social services.

4.3.5. Adaptation Pathways in Forestry Sector

Issues	Impact	Pathways
Higher precipitation long dry spell and more extreme	Landslide, Forest fire and flood	Disaster risk reduction, Socio-economic adjustment (water

[3] Meghalaya state of the environment report 2005

Issues	Impact	Pathways
weathers		allocation management)
Slash and burn technique for agriculture	Increased degradation	Better dialogue and diversification of agro-forestry and agri-sylvicultural system
Diversion of forests for mining	Loss of cover eco-system disturbance	Payment for eco-system services or lost bio-diversity, requisite compensation mechanism and green cover in buffer areas of the mines and sustainable mine closure plan
Rainfall inhibition	Draught like situation and loss of vegetation, impact on food security and community livelihood	Conservation measures and policy formulation for forestry

Preliminary review indicates that concepts and contingency plans for adapting forests are rarely included in state plans. Several management options for intensively managed forests in regeneration, tending, harvesting, protection, conservation and management planning can be formulated state-wide. Intensifying assessment and monitoring, establishing new tools and indicators to rate vulnerability and targeting research efforts appear most promising to cope with climate change in these forests.

While this might be seen as primarily aimed at mitigating climate change, it has an adaptive component of preserving *species richness, continuity of forest ecosystems and resilience*. It is estimated that adverse climate change impacts will contribute to the destruction of forests and thereby promote the emission of greenhouse gases, which in turn will enhance global warming. Meghalaya formulated the key priorities in line with National mission. The following section will focus on the key priorities.

4.3.6. Key Priorities

- **Assessment of biodiversity and preparation of micro plans for conservation**

Meghalaya has rich biodiversity comprises with enormous species of flora and fauna. Around 9496 square kilometers of the total land area of Meghalaya being under the recorded forests and the main reason for such rich biodiversity in Meghalaya is its climatic condition which supports the existence of a large number of floral and faunal species. The floral diversity in Meghalaya includes a large variety of Phanerogams which includes variety of tree species and also shrubs and herbs. Apart from these, Meghalaya offers plants that offer rich timber such as teak (*Tectona grandis*) and sal (*Shorea robusta*) woods, plants with medicinal values such as Cinchona, *Taxus baccata* and plants that offer fruits and vegetables. But the most significant flora of Meghalaya is the orchids. More than 325 species of this beautiful flower are found at this north eastern state. State will make a study on biodiversity assessment to know the impact of climate change, to find out the endangered species and the species richness, and also to find out the adaptive species which can grow in extreme climatic condition. State will also prepare micro plans for biodiversity conservation in identified hotspots within the state.

- **Assessment of Afforestation-Reforestation for emission reduction and sustainable livelihood**

In recent times, threats to Meghalaya forests have become extensive, persistent, and diverse. Overexploitation of flora and fauna (logging, Non Timber Forest Products collection, hunting, wildlife trade), are common practice, encroachment of forest land for agricultural activity resulting habitat loss and degradation, on the other hand human settlement and unplanned infrastructure development resulting further habitat loss and pollution (agri-chemicals). These continuous threats are numerous indirect causes such as poverty and lack of sustainable opportunities, and a lack of funding of management bodies for the protection and management of natural resources. Reduce Emission from Deforestation and Degradation in Developing Countries (REDD) , a climate change mitigation mechanism that would compensate Meghalaya for keeping their forests standing and also conserve more habitat and ensure greater ecosystem services functions. In the context of Meghalaya working group agreed that Reduce Emission from Deforestation and Degradation could be an effective mechanism for mitigation of climate change vis-à-vis providing sustainable livelihoods to the local communities. So state should do a study on the feasibility of REDD and REDD+ in Meghalaya to boost conservation based livelihood in the local communities.

- **Institutional capacity building, implementation and evaluation for forest development and management for climate change**

  Forests in Meghalaya state, as also in many parts of India, are among the most important natural resources, which have played a fundamental role in supporting the livelihood of the poor rural people. Meghalaya joined the rest of the country when it notified the constitution of Forest Development Agency and application of the Joint Forest Management principles on 9th Sept'03. The Forest & Environment Dept registered 7 FDAs constituted in 7 (seven) Social Forestry Divisions covering all the districts of the State. The Joint Forest Management Committees formed by respective FDAs have been registered by the concerned Conservator of Forests (Social Forestry). The programme though introduced late in 2003 and already 73 JFM Committee has been formed and total number of Member is 7083. This programme has contributed significantly by mobilising JFM Members support to protect about 7400 Hectares of forest during 10th Plan Period. Since the main development objective of the Forest Development Agency is to enhance livelihood means of forest fringe communities on sustainable basis through participatory or Joint Forest Management. For increasing the forest cover and forest protection and reduce the climate change impact the evaluation of JFM is planned and proceeding to the next phase of JFM with better capacity building and training of the stakeholders and JFMCs.

  However it is being observed that the department lacks adequate number of human resource for enabling the forest policy, creating livelihood opportunity for the forest infringe as a forest conservation options and creating awareness amongst the community over the issues of climate change.

  Over and following are the action suggested

  a. Training need analysis of the concerned line department.
  b. Developing of training material and module.
  c. Training and capacity building of line department and community.

- **Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change**

  The state is rich in forest resources, this implies the need to encourage enterprise activities that will add value to its forest products and in the process, generate more income and employment

for its generally poor population. The primary forest products identified within the state are Bamboo (12 genera & 43 species), Charcoal (Volume of production marketed annually 9,673 MT), Dalchini (*Cinnamomum zeylanicum*) with Annual production around 89 MT, Fuel wood (Estimate annual production marketed is 491,635 MT), Timber (average production 7,068 m^3/ yr), Bay leaf (volume of production marketed annually 44,370MT), Broom grass (volume of production marketed annually 135,803 MT), Medicinal plants (more than 100 medicinal plants), Packing leaf (volume of production marketed annually 2,123 MT), Wild pepper (volume of production marketed annually 123 MT) and Wood lichen (volume of production marketed annually 127 MT). Meghalaya government will provide enterprise development support which will include the provision of business development and financial services and policy support for forest based sustainable livelihood promotion.

- **Undertaking study on valuation of forest resources (Non traded) and Monitoring of carbon stock and biodiversity at regular intervals**

In Meghalaya there are many uses of forest that are directly or indirectly consumptive and durable or non-durable. These are conservation, recreational benefits, the commercially available benefits (i.e. newsprint, cardboard, building materials, edible fruits, woods, fuel woods etc.), eco services (i.e. bio-diversity, climate regulation service, soil erosion control, etc.)

Meghalaya forests provide some tangible benefits in the form of food, fuel, fibre, timber and other forest products and also some intangible benefits like soil conservation, watershed management, ground water recharge etc. Till date the intangible forest valuation not conducted in Meghalaya. Considering the natural forest in Meghalaya, the commercial and direct value of forest is not sufficient for evaluation of the forest resources. It has some indirect values, which cannot be determined from the market. Meghalaya Government is planning to conduct and economic valuation, when markets fail to generate the true prices of the resources. But at present, estimation procedure of non- marketed forest products, indirect values and non-use values of forest do not properly appear in the state accounts. Forest valuation is required in the state to identify the actual forest revenue and its contribution to State GDP.

- **Study on Climate change impact on forest cover (Temperature and Rainfall regime) and indicative adaptation measures**

Climate change impacts are mainly expected in terms of rise in temperature and change in rainfall volume and pattern. The changes are the result of increased concentration of CO_2 and other GHG gases. Rise in temperature is leading to various affects such as Glacier depletion, shift of tree line forest, change of cropping pattern (due to less productivity, etc.) and they act as indicators. It is very important to study the changes (if any) in forest cover that can be attributed to change in temperature regime or rainfall regime. The indicators of climate change at state level need to be found out. The following studies are proposed to be taken up in a systematic way on priority basis.

i. Temperature regime change over 100 years in Meghalaya.
ii. Rainfall regime change over 100 years in Meghalaya.
iii. To find out indicators of climate change the following studies
    a. Forest cover change, degradation over 30 years through decadal change monitoring.
    b. Biodiversity hotspot and their change in species richness.
    c. Fragmentation of vegetation cover.
    d. Land feature changes and impact of human dimensions.
    e. Water resource change, surface water and ground water depletion and wetland regime change.

After establishing certain indicators adaptation measures to be studied in field in correlation with change to climatic factors mainly the temperature and rainfall pattern. Finally after understanding temperature and rainfall pattern changes over a long period through predictive models, district wise prioritization can be done for development of adaptation and mitigation measures. [4]

- **Site identification and survey demarcation and PRA for community Forest land**

  Communities hold management rights and authority for much of the upland forests in Meghalaya, there is little formal acknowledgement or documentation of community forestry areas. The absence of a systematic inventory of community forestlands has undermined their formal stature and constrained forest department capacity to support them. Forest department of Meghalaya will review all unclassified state forestlands and reclassify those under community and local government jurisdiction as community forestlands. Communities will be assisted to map and demarcate their forest areas, using participatory mapping, cadastral surveys or 3D mapping, depending on their preference. The mapping process will be supported by the autonomous district councils of the state, forest departments, experts and community support networks existing in the concerned areas. Community and clan forests will be registered by autonomous district councils.

- **Adaptive species identification for effective plantation through establishment of Permanent Nursery**

  Climate change is expected to have significant impacts on Himalayan forest ecosystems. It is necessary to evaluate the long term effects of climate change on species diversity and determine what to do now and in the future to respond to this threat. The state has rich plant diversity with 3128 species of flowering plants including 1237 endemic species. Most of the endemic and threatened species confined to protected forests and sacred groves within the state. Species that were common about 20 to 30 years ago have become rare (e.g. *Dipteris wallichii sp., Cyathea gigantean, Ilex embeloides, Styrax hookerii sp.* etc.) due to overexploitation, deforestation and habitat destruction. Forest department will promote plantation of local fruit trees like *Myrica negi sp., Myrica esculenta sp., Prunusnepalensis sp.* etc. of high medicinal values. Research studies to address the issues of adaptation concerning tree genotypes particularly indigenous tree species suitable to Meghalaya climatic condition will be undertaken by the forest department. Tissue culture and permanent nurseries will be planned for preservation of endangered and threatened species along with species with high climate change adaptability.

- **Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions**

  For promotion and development of eco-tourism in forest areas, it is not required that entire forest area would be used in any location. Only a small degraded or barren land may be put to the use along with the landscaping, plantation, regeneration and protection components which would be jointly managed by the Department of Tourism, GoM and Department of Forest, GoM with the help of local community for which no specific diversion may be required. According to Government of India, Meghalaya has 101 Sacred Groves (SGs) which can be used as potential ecotourism site. According to the Meghalaya State Forest Department, SGs cover an approximate area of 1000 sq. km in the State. Out of 101 SGs in Meghalaya 16 located in East and West Garo Hills, 47 in East Khasi Hills, 20 in West Khasi Hills, 15 in Jaintia Hills and 3 in Ri-

[4] This study will supplement finding of Indian Institute of Science, Bangalore

Bhoi district. SGs are the loose ends of relict virgin forests which are quite different from the surrounding degraded forests. Thus these serve as micro-level biodiversity hotspots. According to researchers, about 54 species of rare and threatened plants are occurred in the SGs of Meghalaya. To secure the necessary funding for the Forestry Administration and to manage the protected area into the future, the development of ecotourism as a financing mechanism can be one of the best options for Meghalaya. As a result, Meghalaya Government will develop a project to promote conservation of natural resources and ecotourism initiatives in collaboration with local communities, with the aim of protecting the landscape and generating new, alternative jobs for local people to replace hunting and commercial logging that threaten the forest.

- **Increase plantation and ecological restoration on non-forest and degraded forest land through different plantation and soil conservation programme**

  In Meghalaya, Reserved Forests constitute 11.72%, Protected Forests 0.13% and un-classed forests 88.15% of the total forest area *(State Forest Report 2011)*. Meghalaya also have 101 Sacred Groves which will be utilised for plantation purposes. Ecological restoration in terms of reforestation and afforestation of degraded agricultural land which is important to reduce the ill effect of climate change. The practice of ecological restoration will develop through block plantation, agro-forestry, farm forestry, reforestation of urban and peri-urban institutional lands and soil moisture conservation measures. Meghalaya already set up a plan and target for 35700 Ha of block plantation, 4500 Ha of agro-forestry and 11100 Ha of Farm Forestry and 100 Ha Urban and peri-urban forestry to minimize the negative effects of climate change within the state.

- **Assess additional threats to biodiversity and wildlife and mitigation of man- animal conflicts due to Jhum cultivation in elephant corridors**

  As per the 1979 report of North Eastern Council a total of 4116 km^2 was placed under jhumming, of which 760 km2 of land was used at one point of time every year by 68000 jhummias, i.e., families involved in jhumming *(DSWC 1995)* in Meghalaya. The Meghalaya including Garo Hills is one of the richest botanical regions of India *(Awasthi, 1999)*. The Garo Hills Elephant Reserve spread over 3500 km^2 and supports approximately 1700 elephants. However, developmental activities and clearing of forest for 'jhumming' or swidden (shifting cultivation) has resulted in degradation and fragmentation of habitat. The problem is more complex due to the fact that most of the forest area is under community or local control. Faced with increasing man-elephant conflicts, the Meghalaya government has decided to create another reserve for the animal. On an average, four to five people are killed in the State by elephants every year apart from their attacks on humans, their property and crop land. The Siju-Rewak Corridor and Rewak-Emangre, Emangre-Nokrek corridor located in the Garo Hills, protects an important population (thought to be approximately 20% of all the elephants that survive in the country), by addressing the problem of forest fragmentation which is a serious threat to the elephants' survival. The man-elephant conflict in the state is quite intense. The government has initiated land purchase directly and is managing two elephant corridors in the state of Meghalaya.

- **Encourage continuance of existing community forests by way of giving inputs towards sustainable livelihood options**

  Basically being an agrarian state, people take up agriculture as a source of sustenance. Many times community forests which had provided them fuel wood, timber, climate amelioration,

water, wild edible fruits and vegetables due to population pressure have been mercilessly cut down for agriculture and other purposes. Reckless commercial mining has also taken a heavy toll on the forests. By way of REDD+ projects, many areas of ecological significance need to be identified and green dividends provided for conservation of community forests.

- **Work to establish new systems to support for public awareness building through Establishment of ENVIS Centre**

  The present thrust of forest department of Meghalaya is all round restoration of forest ecosystems. The Climate change action plan will emphasize on the creation of public awareness and greater involvement of people in climate change mitigation and adaptation programmes. It is necessary to sensitize the public and generate awareness in the line of conservation and effect of climate change on local ecosystems. District-wise Environmental Mass Awareness Campaign presently organised by Meghalaya State Pollution Control Board since April 2007. These kinds of initiatives will be integrated with the proposed ENVIS centre within the state for better access of state level information among the public and other stakeholders.

Key priorities : Sustainable forestry

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Assessment of biodiversity and preparation of micro plans for conservation	Forest dept., Biodiversity Board, Meghalaya State Pollution Control Board	0.00	4.7	GoM, GoI, External Agencies
2	Assessment of Afforestation-Reforestation for emission reduction and sustainable livelihood	Forest dept.	0.00	0.65	GoM, GoI, External Agencies
3	Institutional capacity building, implementation and evaluation for forest development and management for climate change	Forest dept. National and International institution	0.00	707.66	GoM, GoI, External Agencies
4	Undertaking studies and investment promotion of NTFP and indigenous forest resources for adaptation of climate change	Forests Dept.	0.00	8.78	GoM, GoI
5	Undertaking study on valuation of forest resources (Non traded) and Monitoring of carbon stock and biodiversity at regular intervals	Forests Dept.	0.00	0.5	GoM, GoI
6	Study on Climate change impact on forest cover (Temperature and Rainfall regime) and indicative adaptation measures	Forest Dept., NESAC , FSI, ICFRE	0.00	5.0	GoM, GoI
7	Site identification and survey demarcation and PRA for community Forest land	Forest Dept., Revenue dept.	0.00	7.0	GoM, GoI
8	Adaptive species identification for effective plantation through establishment of tissue culture and permanent nursery	Forest Dept.	0.00	7.0	GoM, GoI, External Agencies
9	Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions	Forest Dept., Tourism Dept.	0.00	10.38	GoM, GoI, External Agencies
10	Increase plantation and ecological restoration on non-forest land through different plantation and soil conservation programme	Forest dept, Agriculture Dept., Urban Dept.	0.00	231.74	GoM, GoI, External Agencies
11	Assess additional threats to biodiversity and wildlife and mitigation of man- animal conflicts due to Jhum cultivation in elephant corridors	Forest Dept., Agriculture Dept.	0.00	1.5	GoM, GoI
12	Encourage continuance of community forests by way of giving inputs towards sustainable livelihood options	Forest Department	0.00	5.5	GoM, GoI
13	Work to establish new systems to support for public awareness building through Establishment of ENVIS Centre	Forest Dept., SPCB	0.00	1.0	GoM, GoI
Total				**991.41**	

4.4. Sustainable Water Management

4.4.1. Introduction

Meghalaya ranks amongst the wettest regions in the world. Rivers, streams and lakes distribute themselves throughout the state. Annually the state records an average rainfall of 1200 cm. The climate exhibits strong seasonality, with warm and wet summers that last about 8 months. The winter season from October to March is comparatively drier. Sohra (Cherrapunjee) receives about 12000 mm of rainfall annually, in spite of which the locals face extreme water scarcity during the winters. Climate data from recent years as well as modelling results for the future predict decreases in winter (dry), and increases in summer (wet) precipitation. In addition to this, climate change is set to increase uncertainty in weather patterns as well as increases in frequency of extreme weather events. These can have adverse consequences for agriculture, water security and the safety of its people. Therefore it is essential for Meghalaya to synthesize an adaptation strategy that can protect its citizens from these climate risks.

4.4.2. Key Facts about Water resource

The state is having abundant water resources. The potential is not completely explored for hydro-power, fishery, eco-tourism etc. Since Meghalaya receives huge amount of rainfall, it needs to be utilised for rain water harvesting and ground water recharging. The state is having ground water potential of 1226.44 million cubic meters (MCM) out of which only 1041.99 MCM is utilised for irrigation. In Meghalaya about 3300 Km length of rivers are present with an area of 8400 Ha of Reservoirs, 3734 Ha of Tanks and ponds, 390 Ha of Swamps. The state has many rivers most of which are rainfed and are seasonal. The important rivers in the Garo hills region in the west of Meghalaya are Daring, Sanda, Bandra, Bhogai, Dareng, simsang, Nitai and the Bhupai. In the central and eastern section of the plateau, the most important rivers are Umkhri, Digaru, Kynchiang, Mawpa, Umium, Myngot and Myntdu. The state can be divided into 2 river basin firstly the river that flows northwards into the Brahmaputra and secondly the rivers that flow southwards into Bangladesh. The state has three major catchments, eight sub catchment, thirty five watersheds and one hundread and seventy nine sub water sheds.

The water resource in the state are currently threatened with contamination, siltation and pollution primarily contributed from coal mining. The water in these areas is highly acidic with silt and suspended solids were deposited at the bottom of these water bodies. The agricultural field in the state thus turn into unusable infertile land.

The irrigation potential of the state is approximately 2.18 Lakhs Hectares. Out of the total 23351.72 Hectares is under surface water and 1913.45 Hectares under the ground water. There are huge potential in minor irrigation in both the surface and ground water within the state. However, very small percentage of the total potential has been utilised. In Meghalaya only 18.52 % of gross sown area is having irrigation facilities. Within the state about 25 watersheds are present which are further divided into 179 sub watersheds. The water management mission of the state would provide 350 Kms of waterways, irrigation for 35 lakh acres, generate 1500 MW of power and provide drinking water for 60% people in the state.

4.4.3. Key Issues

The water resource in the state is largely linked to the Himalayan Ecosystem. Himalayan glacial snowfields store about 12,000 km^3 of freshwater. About 15,000 Himalayan glaciers form a unique reservoir which supports perennial rivers such as the Indus, Ganga and Brahmaputra.

Brahmaputra and its tributaries is the lifeline of millions of people within the region. Roughly about 10% of this volume of water comes from the melt water contribution which is very vital for the dry season flows. The remaining amount is generated from rainfall. The glaciers act as buffers and regulate the runoff water supply from high mountains to the plains during both dry and wet spells.

The total ground water potential of the state is estimated to be around 1226.44 mcm, of which about 85% is utilized for irrigation, while only and 184.88 mcm (about 15%) is potable. This groundwater source is tapped inefficiently. Measures must be undertaken to ensure aquifer recharge, in order to increase availability of and access to suitable drinking water.

In the monsoon the rivers and streams experience heavy siltation. This has accentuated due to deforestation and land degradation. Siltation has also resulted in the disappearance of several perennial streams and natural springs.

There have been few studies on the hydrology of the state. However further studies have to be undertaken to assess climate risks at river basin and catchment levels.

Another major issue is that of pollution (especially in the downstream areas of the mines). Studies on water quality of major rivers in the state report low pH of water and high amounts of pollutants.Low pH (between 2-3), high electrical conductivity, high concentration of ions of sulphate and iron and toxic heavy metals, low dissolved oxygen (DO) and high BOD are some of the physico-chemical and biological parameters which characterize the degradation of water quality. Acid Mine Drainage (AMD) originating from mines and spoils, leaching of heavy metals, organic enrichment and silting by coal and sand particles are major causes of degradation of water quality in the area *(Swer and Singh, 2004; SoE, 2005)*. Pollution of water poses health risks and threatens ecosystem damage. All of this necessitate the need of a mitigation policy that incorporate 'polluter- pays' type principle and enforce strict compliance with the same.

4.4.4. Adaptation Pathways in Water Sector

Land and water management are critical to addressing poverty. There is also equity issue involved in its management. There are perceived conflicts in its availability, usage, distribution, allocation both sectorally and inter-sectorally. The resource-based livelihoods of the rural poor, and the vulnerable living conditions of the urban poor, pose enormous development challenges throughout the state. The anticipated impacts of climate change will exacerbate most of these challenges and further imperil poverty reduction efforts.

Issues	Impact	Pathways
Higher variability in monsoon and storm frequency	Landslide, affecting systematic crop planning	Diversification of cultivars, improved soil-water management practices,
Exacerbated flash floods and landslides in upland areas	Variability in water flow regimes may also affect hydropower production, yield of major crops and transport	Identification and development/ promotion of drought-tolerant, water-resistant varieties and their
Changing rainfall patterns and elevation and discharge areas	Decrease in grazing area and shift in pastoral livelihood system	Innovative approaches to co-management have supported more equitable tenure arrangements, and addressed conflicts between different pastoral and sedentary groups.
Reduction water quality due to heavy siltation downstream	Water-logging, uneven hydrology and diseases and pest incidence	Improved management of irrigation channels and pond construction, combined with soil

Issues	Impact	Pathways
		erosion control
Carriage of pollutants from the closed/ open mining areas	Water quality reduction and impact on human, livestock and aquatic health	Integrated water resource management; Payment for eco-system services or lost bio-diversity, requisite compensation mechanism and green cover in buffer areas of the mines and sustainable mine closure plan

4.4.5. Key Priorities

The NAPCC has established a National Water Mission. Its broad obective is to ensure Integrated Water Resource Management, and plans to achieve this by efforts in the areas of water conservation, waste minimization, and inter as well as intra state water equity. Basin level management strategies will be reconsidered to deal with rainfall variability and changes in water flows. The mission will seek to optimize the effeciency of existing irrigation systems as well as expand irrigation networks. Measures to inrease storage capacity will also be considered. A framework to increase water use effeciency by 20 % is also being developed. This will incorporate initiatives to redue fresh water use in urban areas.

Meghalaya has already begun addressing these issues, with focus on retarding watershed degradation and development of degraded areas. However, it is essential that such efforts are in line with the addressal of climate change concerns, and with the National Action Plan of Climate Change. Below is a list of high priority actions combining mitigation and adaptation strategy.

- **Formulation of water use policy**

There is no such water use policy in the state. Now as per the suggestions made by different working group members, the state should prepare an appropriate water use policy for judicious and equitable management of water resource in the context of climate change.

Water stress is already high, improved management is critical to ensure sustainable development. Water resources management affects almost all aspects of the economy, in particular health, food production and security; domestic water supply and sanitation; energy and industry; and environmental sustainability. If addressed inadequately, management of water resources will jeopardize progress on poverty reduction targets and sustainable development in all economic, social and environmental dimensions. Hence, such policy initiative will address and involve the practitioners and policymakers of water resources management, sectoral decision-makers as well as those who shape policy regarding climate change.

- **Expansion of hydrometric network**

There is no such hydrometric station run by the state and rainfall data is not available with any state department. Data pertaining to water resources becomes even more important as variations in availability are caused due to climate change. This will provide a better assessment of water availability and extreme events and information for effective water resource planning. As suggested by the water resource department there should be an autonomous state level hydrometry directorate which will function as the data centre for surface water. Under this initiative, selected locations will be identified and hydrometry stations installed to expand the network. This network will process raw data received from its own and other sources to provide for analysis by different users.

- **River health monitoring and environmental flow study:**
  With climate change and other environmental impacts the river health and its ecosystems becomes vitally important. Under this initiative, a research study should be done in different basins to determine the environmental flow that will be required to sustain the health and the aquatic ecosystems. Based on the outcomes of this research study, the thrust action will be identified, planned and implemented.

- **Restoration and creation of water bodies**
  In water scarce areas, there is a potential for climate change to make water availability even more acute. There should be proper identification of areas for new creation as well as renovation and protection of water bodies. Ground water recharges options to take care of both domestic and agriculture options in the region.

- **Preparation and implementation of water management plan:**
  As indicated in the National water Mission, promotion of integrated water resource management will get an additional focus as an effective response to climate change. In this context, preparation of a water management plan with Integrated Water Resource Management (IWRM) approach will lead to conserving water, minimizing waste and ensuring equitable distribution across various applications. There will be further capacity building of the concerned stakeholders to make it operational.

- **Agricultural zoning and capacity building of farmers**
  Water availability to the farmer's field will be an important issue in the context of climate change. The state falls into different agro-climatic region and accordingly there is variance of agro-implements and water requirement. So it is required to build the farmer awareness of scientific crop management to be adopted in the context of varying water availability. Apart from sensitization, agro-climatic zones to be created with a view to provide weather based information for decision making to the farmer on a periodic basis.

- **Micro-hydel projects**
  The project consists of a run of river diversion type hydropower station. Such project contributes to the development of renewable energy and the reduction of greenhouse gas (GHG) emissions. The Project will not only supply renewable electricity to grid, but also contribute to sustainable development in the local area. The project activity contributes towards reduction of pollutants by displacing fossil fuel based electricity generation. In addition, the project encourages local resident to substitute electricity for firewood, reducing the destruction of the forest. There is scope to develop such projects in the state because of its favorable terrain set up and will be highly beneficial for the sparsely spread population. Once the system is operational local people need only pay a small charge to cover the maintenance costs. The system can last for at least 20 years if it is properly looked after.

- **Development of flood/ drought forecasting models**
  One of the climate change impact is flood and drought. For forecasting models are required to assist in preparedness and response actions. Under this initiative, a prototype information system will be developed, demonstrated and validated for effective near-real time flood and drought forecasting, warning and management.

- **Establishment of River Basin Authority**

  The Government of the Meghalaya has recently made a move to establish the Meghalaya River Basin Authority with the principal objective of ensuring sustainable development and equitable utilization of common water resources of the existing river basins. Integrated river basin management is now widely accepted approach and includes the water catchment areas, reservoirs, rivers, wetlands, and adjacent ecosystems. With this approach the proposed River Basin Board of the State will include best management practices for erosion control, water conservation, downstream release issues, non-point source pollution control, nutrient loading reduction, improved irrigation methods, protection and promotion of livelihood options and broad scale changes in land use patterns that could result in improvement in of the water quality and other environmental benefits.

Key priorities: Water Sector

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Formulation of Water Use Policy	PHE, SWC, Power, Agriculture, Urban Affairs, SPCB, fisheries, horticulture, Rural Development, Law and Forest		0.50	GoI, External Agencies
2	Expansion of hydrometry network/ creation of state meteorological department. upgradation/ expansion of existing number of stations	S&T		10.00	GoI, External Agencies
3	River health monitoring and environmental flow study	MSPCB		10.50	GoI, External Agencies
4	Restoration & creation of water bodies	SWC, WR and Forest		120.00	GoI
5	Preparation and implementation of water management plan	WR, River Basin Authority and Forest		1.00	GoI
6	Agricultural zoning and capacity building of farmers	Agriculture, Horticulture, SWC, WR, C&RD		1.50	GoI
7	Micro-hydel projects- Identification of locations for Micro Hydels / water mills and pilot implementation in selected clusters	Power, WR		2.00	GoI, External Agencies
8	Development of flood/ drought forecasting models.- Development of flood+ Drought forcasting networks and regular dissemination of information to relevant depts and community cluster cooperatives	WR, MSDMA, NESAC		100.00	GoI, External Agencies
9	Establishment of River Basin Authority	Water Resources, SWC, PHE and Forest		2.5	GoI, External Agencies
10	Creation of Ground Water Board/ authority	Water resource, planning department		5.0	GoI, External Agencies
11	Documentation of Traditional Water Conservation and Management Techniques	SWC, WATER RESOURCE		1.00	GoI, External Agencies
12	Roof top RWH	SWC , Urban and Housing		10.0	GoI, External Agencies
13	Creation of water inventory, information database for monitoring, evaluation and surveillance	WR,RS		5.00	
14	Awareness Programmes and capacity building for natural resource users (mining, industries) regarding water pollution prevention and facilitating of a social agreement/ self-regulatory measures towards the same	MSPCB, Water resources, I&PR		10.00	
15	Institutional Capacity Building and knowledge sharing- Training of trainers			10.00	
Total				**289.00**	

4.5. Mining Sector

4.5.1. Introduction

Meghalaya is rich in mineral resources. The major minerals present in the state are coal, limestone, clay and Silimanite. Iron ore, uranium, copper, gold, quartz, feldspar, base metal and granite are also found in the state. Coal and limestone are the only minerals being mined in the state at present. Mineral resources have great bearing on the economy of the state. The Uranium located at Domiasiat in West Khasi hills is of higher grade as compared to deposits being mined elsewhere in the country. Therefore sustainable mining has tremendous is a key concern.

List of Mineral resources

Sl No	Minerals	Resources (Mill Ton)
1	Coal	559
2	Limestone	2462.5
3	Kaolin	4.5
4	Sillimanite	0.045
5	Quartz	0.076
6	Feldspar	0.096
7	Uranium	0.0135
8	Base metal	0.18

Release of methane, diversion of forest area and net reduction of green cover aids the climate change. Mining combines both adaptation and mitigation. There is also possibility of release of GHG from open cast mines. Mining is a sensitive issue in Meghalaya due to its impact on lives of people. Its importance in the economy is also acknowledged. Therefore, sustainable mining is a desirable goal.

4.5.2. Key Facts about Mining sector

Meghalaya is extremely rich in mineral resources. Though the level of exploitation is poor and the captive utilisation is low. Most of the coal reserves are on private lands and the method employed in Meghalaya is the age old rat-hole method. The rate of recovery of coal is very low in this method.

Unscientific coal mining in the state has caused major damage to the environment primarily land degradation. The sulphur present in the coal makes the water acidic and has already converted many agricultural fields into unusable infertile land.

Mining also adds dust to the air through fugitive emission leading to health hazards of the local inhabitants. Increasing vehicular movement also contributes to the air pollution through SPM, SO_X and NO_X emission.

In Meghalaya very high quantity of uranium have been found which is about one-sixth of India's total Uranium reserves. The state has also large deposits of limestones of high quality along the southern border. The total production of limestones in 2002-03 was 640,992 Tonnes which is gradually increasing. Apart from these white clay deposits, sillimanite, phosphorite, glass sand, multi coloured granite and black granite, quartz and feldspar, gypsum, gold and base metals.

4.5.3. Key Issues

However, there are severe environmental impacts associated with the mining sector. Unscientific coal mining in the state has caused major damage to the environment. One of the most perceptible damages caused by the rat-hole mining is the degradation of land. These rat-hole pits get filled up with water during rain and percolate into ground water or floods into

rivers, streams and pollutes the water resources. In addition, the soil extracted from these mines washes away to nearby rivers, streams, lakes causing siltation and increasing the risk of flood. The Sulphur present in the coal makes the water acidic and has converted many agricultural lands infertile. Pollution from increased vehicular traffic due to mining activities, suspended particulate matter and gaseous emissions makes matter worse.

Being energy intensive, this sector is a major contributor to state's greenhouse gas emissions. Since much of the land is privately owned, mining in the state is largely unregulated and unscientific. All of this emphasizes on the need for an effective policy on mitigating emissions and minimizing impacts. At the same time it is necessary to set up institutions and undertake capacity building exercises, as part of an adaptation strategy, in order to ensure sustainable mining and economic development. Therefore, mining is highly regulated sector on environmental aspects and basic environmental awareness is substantive. Mining is also a contributor to global green house gas emissions. There are various initiative planned to mitigate as well as adopt climate change. All these initiatives pertain to three goals- emission reduction, capacity building and adaption measures. Below is a list of high priority actions outlined by the state, which reflects these concerns.

Issues	Impact	Pathways
Diversion and degradation of forest	Reduction of carbon sink	Compensatory Afforestation and green buffer zone
Erratic precipitation and water logging	Damage to hydrology, water quality, health impact	Investment in tailing dam, diversion structures, sustainable mine closure
Open cast mining and emission	Emission of GHG, air pollutant, loss of bio-diversity	Sustainable Mining Plan, Preservation of Bio-Diversity, assisted regeneration
Transport of dirty cargo or stock-piled emission	Emission, heat island effect	Dedicated corridor for freight, management of the stock, awareness building, reclamation planning

4.5.4. Key Priorities

Key priorities rest on the adaptation planning around existing and new mines that are proposed to be operational in the state. Policy should reflect the climate change concerns.

- **Incorporate climate concerns in state mineral policy and state industrial policy e.g. 'polluter pays principle'**

The state mineral policy is in the draft stage. It provides the guidance and direction to realizing the enormous potential for mineral development. Exploring the mineral resources in a scientific manner and using it in a sustainable way are part of the draft mineral policy. While preparing the climate change action plan for the state, it is required to review the draft mining policy. The state mineral policy may be revised to incorporate and integrate climate change considerations. The implementation of the revised policy will ensure the tracking of green house gas emissions from this sector.

- **Analyzing appropriate policies to promote energy efficiency**

Mining process and mineral transportation requires energy. The use of this resource cannot be stopped but can be handled more scientifically. In order to move this sector into an energy

efficiency path, new policy instruments are required to encourage efficient energy use. Research studies to be carried out to determine the kind of policy instruments will be appropriate in Meghalaya context.

- **Exploring potential of Low Grade Mineral Beneficiation**
  There is lot of scope in the beneficiation of low grade minerals like iron ore, copper, limestone, sillimanite etc. A research study needs to be carried out to identify the potential across the various minerals and propose methods/ approaches to realize this potential.

- **Strengthening environmental monitoring and introducing environmental safeguards**
  Mining is seriously confronted with local environmental challenges. Monitoring of environmental parameters both local and global pollutants is required. Presently the current monitoring system is not so robust. Particular mining clusters which are environmental sensitive to be identified and improved environmental monitoring system will be established. Based on the monitoring results, appropriate modifications will be made in these clusters and climate change abatement measures will be initiated.

- **Identification and maintenance of green zones in mining clusters**
  Creation and maintenance of green zones in major mining clusters is a regular activity and that will be enhanced further. These green zones will be developed under green belt development programme which will improve the floral environment of the area. It will serve as additional carbon sinks and also contribute towards building local environmental benefits. Suitable green zones will check the fugitive emission and noise pollution level from mining activities.

- **Capacity building and generating awareness among local community, mining personnel and government departments:**
  Generating awareness and building capacity of the concerned stakeholders is highly important. Integration of climate change measures in mining sector only can be achieved through capacity building initiatives. Training on clean development technology, cleaner production / low carbon / efficient technologies and climate abatement measures will be organized both within the Govt of Meghalaya(Directorate of Mining & Geology, State Pollution Control Board and associated stake holders like Indian Bureau of Mines and Mining Lease Holders).

- **Protecting and managing water bodies around mining areas**
  Water resources will be affected due to climate change. Mining activities causes various effects on the existing water bodies such that soil erosion and siltation. Particular water bodies to be identified around such mining areas and protection measures need to be initiated. Water pollution and capacity reduction will be arrested. These water bodies will be restored as a climate change adaption measure to climate change. There will be regular monitoring of surface runoff which may be taken up to assess the run off potential for storage and augmentation of ground water resources.

- **Forest clearance and EIA**

Environmental crisis is now more shocking in Meghalaya and far-reaching than the other crises. Meghalaya has rich mineral resources and unscientific mining is the main practice for excavation of minerals. To control improper and unsustainable industrialization practices, environmental regulation is very much necessary. Environment Impact Assessment (EIA) is now one of the key instruments using in India as a safeguard against the disturbing impacts of unplanned and careless industrialization. The law says that major development, infrastructural and industrial projects require an EIA, which must include a comprehensive survey and investigation — including environmental, social and economic repercussions — and be cleared by the Expert Appraisal Committees formed by the Ministry under the Environment Protection Act, 1986. In January 19, 2009 the new EIA notification came into force with some additional requirements of analysis. To safeguard Meghalaya's environment and forests Government of Meghalaya has decided that no mining should be permitted without a revised Environmental Clearance on the basis of a fresh EIA study and public hearing.

- **Checking unscientific mining and introducing improved technology for excavation and better management for storage and transport**

  Rapid Industrialization in Meghalaya and income generation is the main driving force for increasing demand for coal and other minerals. The high demand for minerals is creating a pressure on vegetation specifically in the State vegetation cover and biodiversity. Due to Unscientific and unplanned mining, state forest resources are degraded as well as it is affecting the water resources. The Acid Mine Drainage from mines and leaching of heavy metals have contaminated many water bodies and in the vicinity of mines. To control the reduction of forest cover, biodiversity loss and water resource contamination State has planned to introduce improve technology for excavation and better management for storage and transport.

- **Improved mining operations within the purview of the Environment Management Plan**

  Due to the large scale destruction of natural areas for mining operations in Meghalaya, a mining management plan is needed. In mining management plan, restoration is major concern and emphasis is given first to build soil organic matter, nutrients and vegetation cover to accelerate natural recovery process. Reclamation is another priority area by which neglected or highly degraded lands are returned to productivity and through reclamation some measure of biotic function and productivity is restored. Tree plantation can be used as a tool for mine spoil restoration as they have ability to restore soil fertility and ameliorate microclimatic conditions. To reduce the impact of mining operation on environment, restore-reclamation and improve the operation of mining, Government of Meghalaya has decided that Environment Management Plan is mandatory for each and every mining projects.

- **Land Use Planning and Regulation**

  The major direct impacts on existing land use during the pre-mining phase are the removal of vegetation and resettlement of displaced population. There may also be land use changes with respect to agriculture, fisheries, recreation sites, housing, forestry areas etc. Land reclamation/ restoration of mined out lands may give rise to enhanced beneficial land use. The establishment and functioning of any mining will be governed by the environmental acts/ regulations besides the local zoning and land use laws of the States.

- **Devise a mechanism to implement a system of compensatory water harvesting and storage around mining clusters**

  The water resources within the state will be affected due to climate change. The major issue with coal mining in Meghalaya is the unscientific way it is carried out, the absence of post-mining treatment and poor management of the mined areas. The water bodies near the mining areas will be identified and proper protection measures will be taken. State will formulate a policy for compensatory water harvesting and storage near mining areas to arrest the depletion of water resources due to pollution. These compensatory water bodies will be restored as a climate change adaptation measures.

Key priorities: Mining Sector

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Incorporate climate concerns in state mineral policy and state industrial policy e.g. 'polluter pays principle'.	Industry, DMG		0.05	GoI, External Agencies
2	Analyzing appropriate policies to promote energy efficiency	DMG, Dept. of Energy		5.0	GoI, GoM
3	Exploring potential of Low Grade Mineral Beneficiation	DMG		0.07	GoI, External Agencies Agencies
4	Strengthening environmental monitoring and introducing environmental safeguards	MSPCB,		0.25	GoI, external
5	Identification and maintenance of green zones in mining clusters	Forest		15.0	GoI/ external
6	Capacity building and generating awareness among local community, mining personnel and government departments.	DMG		7.00	GoI/ external
7	Protecting and managing water bodies around mining areas	WR, MSPCB		49	GoI, External Agencies
8	Forest clearance and EIA	Forest		0.40	GoI, External Agencies
9	Checking unscientific mining and introducing improved technology for excavation and better management for storage and transport.	DMG		0.01	GoI, External Agencies
10	Improved mining operations within the purview of the Environment Management Plan	Forest, MPCB		0.05	GoI, External Agencies
11	Land use planning and regulation	Forest		0.5	GoI, External Agencies
12	Devise a mechanism to implement a system of compensatory water harvesting and storage around mining clusters	Water resource, SWC		15	GoI, External Agencies
Total				**92.33**	

4.6. Energy Sector

4.6.1. Introduction

Energy usage has a dichotomous relationship with the socio economic development. The availability of energy mainly from the secondary and to some extent the primary sources have a strong linkage or dependency on nature and natural resources.

The energy sector action plan is strategized to address both the issues of reducing the emission intensity and formulate effective adaptation measures towards reducing the impact of actual or proposed effects of climate change. From mitigation aspects the action plan will portrays pathway towards reducing the emission intensity or roadway towards low carbon economy as well as rooting the mitigative capacity in sustainable development path. From adaptation aspect anticipatory and planned action are formulated towards sustenance and proper functioning of the sector in light of the current scenario as well as future growth plan.

4.6.2. Key Facts about the Energy Sector

Meghalaya as a state is yet to achieve the coveted level of economic and infrastructural growth in course last three decades widely reflected from economic indicator like state domestic product (Gross and Net) and also the energy scenario[5]. Availability of uninterrupted, abundant and cheap supply of energy is a key towards sustainable economic development. Meghalaya which used to be considered among few states with surplus power generation in early 90's is now facing serious dearth of power.

Present unrestricted Demand	610 MW
Industries :	
Released Load	260 MW
Pending Load	220 MW
Domestic	130MW
Demand forecast	
End of 11th Plan	796 MW
End of 12th Plan	1281 MW

The installed capacity of 185.20 MW of power generation in the state is totally Hydro based which results in around 450 million units insufficient to meet up the peak and demand shortage.

Year	Peak Demand (in MW)	Energy Consumption (inMkWh)	Energy Generation (in MkWh)
2000-01	120.90	764.40	657.86
2001-02	148.47	786.89	675.59
2002-03	179.26	947.92	526.97
2003-04	192.20	1080.11	526.97
2004-05	196.81	1393.30	637.65
2005-06	197.10	1386.11[6]	514.44

To address the current scenario of demand supply gap in the state and the growing demand because of liberalised industrial policy the state government has begun to explore the

5 Per capita consumption of electricity in Meghalaya is 317.77 kWh is far low in compared to the natural average of 373kWh.

[6]The energy consumption during 2005-06 as compared to 2004-05 is lower because of non-availability ofpower due to less rainfall & inter-state transmission constraints

possibility of enhancing its power generation to about 2000-2500 MW of which 700-980 MW[7] is from thermal and 1400-1530 MW from hydro.

In spite of the fact that generation capacity addition is highly essential for the socio economic growth of the state the fact also remains that increasing of either from hydro[8] or coal based thermal power plant will contribute to GHG emission.

The current demand of the state is met from its own generation and through import of power from NE grid. Import of power is however due to lack of transmission infrastructure and transformation constraint. Over and above the supply constraint forty per cent of the villages are still un-electrified and have no access to electricity. The level of lower electrification in the village level is result of both difficult terrain and high incidence of rural poverty. Such constraint also owes to social structure, scattered settlements which collectively pose several formidable problems to service delivery systems.

From the prospect of the state power scenario it is therefore highly essential that increase of additional generation capacity should be supported by adequate transmission infrastructure for evacuation of power. To add to the lack of transmission network is the immediate requirement of modernisation and renovation of exiting electricity network to reduce the degree of losses and increase the evacuation/ transmission capacity. The stability of power sector in the state is confronted by challenges like:

Year	Unrestricted Peak Demand	Power Availability			Total Availability
		State Generation	Central Sector Share		
			Total Share	Actual Drawl	
2004-05	220	67.75	78.91	66.39	146.66
2005-06	280	58.76	82.70	78.07	141.46
2006-07	350	44.60	73.60	94.70	118.20
2007-08	385	75.60	85.35	82.79	160.95
2008-09	425	64.40	98.90	91.60	163.20

a. Lower installed capacity in respect of existing demand

b. Peak demand shortage and energy demand shortage

c. Lack of transmission and distribution infrastructure both for evacuation of power from upcoming generation project and also obtaining power from regional grid.

d. Lack of funds for further enhancing of power generation capacity, rehabilitation and modernisation of transmission and distribution infrastructure

e. Higher AT&C losses, lack of metering

f. Unscheduled and prolonged outages

Year	T&D loss%	AT&C losses%
2005-2006	35.76	46.32
2006-2007	36.80	42.78

Household energy requirement for purpose of heating and cooking is predominantly met from fuel wood[9] gathered which in turn increases the drudgery of woman.

[7]Meghalaya has a considerable amount of high quality coal reserve of 564 million tonne with calorific value ranging from 5694-9772 kCal/kg with low ash and high sulphur content.

[8]Review of Green house gas emission from creation of hydro power reservoirs in India, Background paper: Strategies for Low carbon growth, World Bank 2008

Type of fuel used	Rural	P. C to total household
Firewood	310373	94.1
Crop Residue	4623	1.4
Cow dung cake	148	0
Coal/ charcoal	2067	0.6
Kerosene	4194	1.3
LPG	3551	1.1
Electricity	2754	0.8
Biogas	392	0.1
Any other	253	0.1
No Cooking	1323	0.4

Promotion and use of renewable based option will not only reduce the strain on the existing forest but will also promote low carbon growth. Biogas is a potential option at village level to provide clean energy for cooking and lighting. Construction of around 950 numbers of biogas units of three metre cube has already demonstrated substantial impact on reducing the carbon footprint. A plan of around 2000 unit is projected across the current plan period considering availability of dung of around 10 lakhs tonne/ year.

Energy conservation can be a vital tool for reducing the current demand but it is still at infancy owing to lack of infrastructure.

Sector	Energy Usage Pattern
Agriculture	0.61%
Public Lighting	1.5%
Industrial	60%
Commercial	4%
Domestic	22%
Public Water Works& Sewage Pumping	3%
Others	22%

The sectors however has considerable scope of energy saving.

Sector	Saving potential (MU)
Agriculture (78 numbers of diesel pump set)	
Commercial sector	20-30%
Municipalities	25%
SME cluster	No energy intensive industries in SME level
Domestic Sector (42 million	20-25%
Industries	7-10%

4.6.3. Key Issues

Outlook towards linking climate change and energy sector are usually centred on mitigation effort because the current fossil fuel based energy generation method is a major contributor to climate change. Developing options of low carbon growth and reducing carbon footprint are important activities towards limiting the degree of future climate change.

Energy and water sector are closely and dynamically linked. All human devised energy system have water footprint to one degree or others including non-consumptive transfer of river flow in case of hydro power or consumptive use of water in thermal plant and bio fuel plantation.

The projected impact of the variation of precipitation level due to climate change will severely impact the hydropower generation which in turn will change the energy supply scenario at the

[9]Census of India 2001

state level where hydro-generation has a lion's share. Also the lower availability of water and enhanced temperature level resulting from heat waves will severely impact the cooling process of thermal power project. Power station other than hydro that bank on availability of water for its operation (for cooling and also as heat transfer fluid) may have to shut down if water level or availability gets too low. Higher ambient temperatures may affect the efficiency and capacity ratings of fossil-fuel-powered combustion turbines. In addition, electricity transmission losses may increase due to higher ambient temperatures. Even increased threat of flooding in flood prone area which is projected as possible impact of climate change will lead the power plant vulnerable.

On demand side regions that will face warmer temperature and lower precipitation level will result in increase of electricity demand because of higher use of electric gadget and farm irrigation resulting to knock on effect on energy consumption and will thereby enhance the pressure on electricity distribution network through increased seasonal demand.

Impact of extreme events due to climate change on energy sector can damage economic and social infrastructure because of the fact that centralised power plants tend to serve large catchment of population and are also sensitive to climate change.

Biomass still dominates the state energy profile e.g. fuel wood, agricultural waste, dung, etc. are more vulnerable to adverse effects of water cycle changes on river catchment affecting the poorest segment of the society.

Energy System	Energy System Component	Climate Change Influence on the sector	Adaptation Pathway
Electric Power Sector	Hydro Power	Increase variability in river flows. Impact like prolonged drought will result in power generation restriction.	Integrated water resource planning, investment in basin planning
	Existing CPP in industrial Facility and for planned Thermal Power Plant	Reduction in river flow/ water availability May be a concern in heavily modified river basin	Super critical technology for higher capacity project.
Household energy	Fuel wood Agricultural waste	Sub-catchments under multiple stresses, reduced fuel wood yields Hydraulic functions of forest ecosystems reduced	Higher awareness for sustainable NTFP collection, residue management.
Profligacy in End Use	End use efficiency	Higher fossil fuel use and GHG emission	

Assessing the vulnerability of energy supply to climatic events and longer term climate change needs to be formulated with tailor made. A strategic approach is therefore required to be framed up to ensure that timely and effective adaptation measures are taken, ensuring coherency across different sector and level of governance to reduce the sectors vulnerability to the impact of climate change. A robust predictive skill is required to ensure that any adaptation programmes adopted now will still function adequately if altered climatic conditions prevail in the future.

4.6.4. Key Priorities

The following key priorities for the sector were identified after detailed deliberation in the working groups. The priorities are in line with the concerns raised due to the negative effect of the climate change and the states response.

- **Undertaking hydrology study of existing Hydro power source in light of observed and projected impact of climate change and framing adaptation measures**

The state power generation is totally hydro based. The objective of the study is to analyse the link between outputs due to climate change and hydrology models with economic-energy-environment models to integrate water-energy and climate change in the context of hydro power project. Such study will form the basis of strategizing adaptive measures to prevent immediate breakdown of the sector in case of changing of the water scenario of the state. This is planned through following sub activities:

1. Formation of Project Management unit under the MECL and provide adequate infrastructure to the nodal department for undertaking similar activity.
2. Framing the detailed study objective and hiring of agency to take up the study
3. Undertake study on the impact of rainfall, river water level and availability of water in relation to the power generation at the existing hydro project site and emergency preparedness measure along with capacity building requirement.
4. Framing up detailed adaptation strategy
5. Prepare risk management strategy and emergency preparedness plan based on the outcome
6. Capacity building of the existing resources based on the developed strategy

- **Functional Reorganisation and Institutional development of State Energy Department**

The State of Meghalaya is facing a formidable challenge of power shortage, transmission constraints for evacuating and import of power, lack of distribution infrastructure for electrification in off grid area, high AT&C losses, lack of infrastructure and human resource base required for overall improvement of power sector.

The requirement of sectoral reform includes functional reorganisation of the line department and institutional development of department towards achieving a coherent roadmap which include Corporatisation and Restructuring of State Electricity board.

Restructuring of the sector will facilitate, encourage and empower private sector participation in energy sector and will on one side facilitate the growth and development target and on other hand will relive governments debt burden and allow limited financial resources to be allocated to social sector like health, education and rural empowerment. The fulfilment of the overall objective is planned through following sub activities:

1. Formulating reform agenda, implement critically needed investment, strengthen ownership and build wider public and departmental support for the program.
2. Restructuring and functional reorganisation of the nodal department of energy sector including nodal department for improving energy efficiency, promotion of renewable(REDA), energy corporation and regulatory department to achieve efficient functioning and implementation of energy conservation, promotion of renewable energy generation capacity, enhanced generation capacity and improved transmission and

distribution network. The option also includes capacity building of the existing staff to facilitate objective.

3. Implantation of existing Generation policy needs to be facilitated on first track
4. Strengthening evacuation infrastructure to facilitate evacuation of power from upcoming power project to the state grid.
5. Develop operational plan for power trading.
6. Promotion of renewable power project in PPP and IPP mode.
7. Capacity building is required to enhance the knowledge about the policy and how to implement the policy.
8. Training of the member of the working group or their representative of different departments and organisations on sector specific climate change issue. All of these have a direct and indirect bearing on the carbon emission of the sector.

- **Establishment of Evacuation Corridor and strengthening of transmission and distribution network**

The power sector of the state is heavily impacted due to the lack of proper transmission network. The requirement of evacuation corridor is planned to promote evacuation of power from decentralized renewable energy power projects including hydro, IPP, CPP and promote high voltage transmission infrastructure for power evacuation and import of power from regional grid. High voltage transmission or evacuation of power will reduce the degree of losses. The fulfilment of the overall objective is planned through following sub activities:

1. Undertaking carrying capacity study and resource mapping of each of the districts for setting up possible power project
2. Preparation of techno economic Feasibility report for the requirement of transmission network
3. Applying for Budgetary provision through international funding and private sector investment
4. Implementation of evacuation corridor

- **Demarcation of Hydro power potential in the state with site specific capacity mapping**

The objective is demarcation of Hydro power site is based on current water availability pattern and reassess site specific potential of hydro power generation as per the capacity- Micro/ mini / Large. The demarcation of power project with proper feasibility survey report will support in identifying investor to set up project through Private sector investment or PPP mode. Complying of the action plan is planned through following sub activities:

1. Identification of sites for both on grid and off grid applications
2. Survey and investigation
3. Preparation of Prefeasibility report
4. Selection of Entrepreneurs
5. Developing Policy framework for provisioning clearance of small, medium, mini and micro hydro project
6. Capacity building of State Nodal Energy and Water resources department on technological and regulatory aspect
7. Lowering of wheeling charges

- **Life Cycle Analysis of Existing hydro power plant and implementation of R&M measures**

The operating efficiency of the existing hydro power project in the state is impacted due to longer period of operation, higher silting and water quality. The objective of the action plan is to estimate the current efficiency level and scope for improving efficiency. Such activity will help in increase in the efficiency of hydro power plant that will result in Improvement in power generation in existing power plant and up gradation of existing capacity. The action plan will be implemented through following sub activities:

1. Estimate the operating efficiency of existing hydro power project
2. Implementation of activity where analysis has already being carried out
3. Preparation of DPR for which study is carried out and applying for funding

- **Reduction of AT&C losses**

Reduction of T&D losses is a prime focus of the energy sector since reduction of losses will directly result in reduction of green house gas emission and address energy security. Complying of the action plan is planned through following sub activities:

1. To assess the current T&D loss pattern and plan implement measures to reduce losses through increase of energy efficiency and reducing pilferage.
2. Renovation of Existing transmission and distribution network
3. Replacement of Existing Transformer with star rated transformer
4. 100% consumer metering to reduce AT&C Losses - Involving Installation of SCADA system and metering arrangement for on-line remote monitoring system right from grid sub-station up to the consumer end having a connected load of 20 kW and above
5. Implementation of feeder level metering at distribution level
6. Consumer level metering a cell should be formulated and carry out Vigilance activity
7. To introduce franchise model in distribution to reduce commercial losses and better management of the distribution system
    a. Formulation of Project management unit to facilitate for franchisee for 3 years
    b. Impart training
    c. Training and imparting support to prospective entrepreneurs.

- **Facilitating overall village electrification**

Providing electricity to rural household is a key step towards reducing the vulnerability of the section of the society who is more impacted to changes in climatic condition. Providing electrical energy will empower the people residing at most difficult terrain in the country with the option to sustain under severe impact of climate change be it the increase in temperature or unavailability of water for farming (facilitate irrigation). Complying of the action plan is planned through following sub activities:

1. Undertaking study for electrifying remote villages in decentralised mode
2. Preparation of DPR
3. Undertake implementation

- **Implementation of Pilot Energy Efficiency Project and IGEA**

The Objective of the pilot initiative is to demonstrate the possibility of energy efficiency through implementation of energy efficiency measures. Such action will enhance the capacity of the state nodal agency to undertake similar initiative in the future and also promote taking up such activity amongst the sector. Compliance of the action plan is planned through following sub activities:

1. Implementation of Energy Efficiency Measures in 8 Government building in Meghalaya where energy audit is carried out by the Nodal Department.
2. Implementation of Pilot energy Efficiency one of the identified pumping Station.
   a. Undertaking IGEA
   b. Taking up Pilot Implementation
3. Implementation of Pilot Energy Efficiency Street lighting Project in one of the ULB area.
   a. Undertaking IGEA
   b. Taking up Pilot Implementation
4. Identifying and empanelling ESCO companies.
5. Supporting state level entrepreneurs to become ESCO.
6. Taking up joint pilot project with ESCO companies

- **Promoting Energy Efficiency Practices in the State**

The objective is to create awareness among the sectors (domestic, commercial and industrial) about the benefit and necessity of taking up energy efficiency measures and also the pathway of achieving the same including promotion of use of star rated gadget. Complying of the action plan is planned through following sub activities:

1. Identification of Agencies for taking up activity
2. Undertaking sectoral and scoping study of the possibility of energy efficiency across each sector and barrier of taking up the energy efficiency initiatives.
3. Undertaking Training Need Analysis Study for the department, preparation of manual and carrying out pilot workshop
4. Carrying out awareness campaign towards taking up energy efficiency measures and use of star rated devices.

- **Creating State Energy Conservation fund**

The objective is to prepare a Strategic plan towards establishment of state energy conservation fund in order to mobilise available funding under Ministry of Power for taking up energy efficiency initiatives on a large scale. Complying of the action plan is planned through following sub activities:

1. Creation of energy conservation fund with the request that the state government to provide opening fund and for study purpose to develop the financial model to create energy conservation fund
2. Mobilise budgetary provision from state budget to mobilise fund from MoP.

- **Maximising harnessing of Renewable Energy for the purpose of Power Generation**

To the extent the use of stand-alone or grid interactive renewable based power generation option will emphasised/ promoted the extent of greenhouse gas emission both direct and fugitive emission due to use of fossil fuel for the purpose of power generation will reduce substantially. The promotion of renewable based power generation will include:

1. Stand alone and grid interactive Solar PV Power project
2. Stand alone and grid interactive biomass power project (both thermal and gassifier based)
3. Grid interactive wind power project

The state has initiated on solar photo voltaic and biomass power project in a pilot mode like 3350 number of solar home lighting system,170 number of 3kW capacity SPV power project, one number of 250 kw biomass power project. The extent of wind power generation is also

limited to pilot mode with the total installation is in the range of one number of 3.2 kw unit and fifteen number of 6.4kw unit. The following steps will help in the compliance:

1. **Harnessing Biomass potential**
   a. Study of existing policy and develop investment friendly policy to promote additional biomass application
   b. Conducting detailed feasibility study for scoping biomass power project
   c. Developing biomass supply chain involving agro, agro industrial and other biomass resources
   d. Promoting biomass based gassifier project in agro based industries
   e. Raising awareness
   f. Creating conducive scenario for investment
   g. Implement demonstration and pilot project if necessary
2. **Promoting Grid based wind power generation**
   a. Wind mapping and demarcating zones
   b. Improve infrastructure for power evacuation
   c. Frame up policy to facilitate investment
3. **Maximising use of Solar energy resources**
   a. Survey and investigation to identify appropriate sites
   b. Framing promotional policy incentives
   c. Developing feasibility report
   d. Facilitating pilot project of higher capacity
   e. Awareness and capacity building of the nodal department
   f. Strengthening of manufacture base

- **Maximising and judicious utilisation of renewable energy resources for household energy requirement**

The household energy requirement in the state is met through the use of firewood obtained from forest resulting in increase in the strain over the existing forest. This not only reduces the carbon sink but also enhances the vulnerability of the area in light of the proposed impact of climate change like top soil denudation in case of flood or other impact. The sub activities proposed are:

1. Increased use of Solar energy for the purpose of water heating and cooking
2. Replacing inefficient cook stoves with improved cook stoves
3. Awareness creation and capacity building for incremental usage
4. Promoting household biogas system.

Key priorities: Energy Sector

Sl.No	Key Priorities	Department / Organisation	Sub Activity Budget (Rs in Crore)	Budget (Rs in Crore)	Source of funding
1	Undertaking hydrology study of existing Hydro power source in light of observed and projected impact of climate change and framing adaptation measures 1. Formation of Project Management unit under the MECL and provide adequate infrastructure to the nodal department for undertaking similar activity. 2. Framing the detailed study objective and hiring of agency to take up the study 3. Undertake study on the impact of rainfall, river water level and availability of water in relation to the power generation at the existing hydro project site and emergency preparedness measure along with capacity building requirement 4. Framing up detailed adaptation strategy 5. Prepare risk management strategy and emergency preparedness plan based on the outcome 6. Capacity building of the existing resources based on the developed strategy	MECL, Water Resource		1.0	GoM
2	Functional Reorganisation and Institutional development of State Energy Department 1. Formulating reform agenda, implement critically needed investment, strengthen ownership and build wider public and departmental support for the program. 2. Restructuring and functional reorganisation of the nodal department of energy sector including nodal department for improving energy efficiency, promotion of renewable(REDA), energy corporation and regulatory department to achieve efficient functioning and implementation of energy conservation, promotion of renewable energy generation capacity, enhanced generation capacity and improved transmission and distribution network. The option also includes capacity building of the existing staff to facilitate objective. 3. Restructuring of the state department designated under BEE for undertaking the Energy Efficiency activity and Program a) The post of Nodal officer should be upgraded from the rank of Senior Electrical Inspector to the rank of Chief Engineer so that the nodal office could have adequate human resources. b) Recruitment and retaining of Energy Auditor and Energy Manager to support the Nodal	Energy Department, MECL, REDA, State nodal department designated under BEE		1.45	GoM

	Officer (3 years period). c) Recruitment of officials, engineers to support the nodal officer in undertaking the initiatives d) Upgrading of office Infrastructure. 4. Restructuring and capacity building of MNREDA including adding up human resource base and infrastructure 5. Implantation of existing Generation policy needs to be facilitated on first track 6. Strengthening evacuation infrastructure to facilitate evacuation of power from upcoming power project to the state grid. 7. Develop operational plan for power trading. 8. Promotion of renewable power project in PPP and IPP mode. 9. Capacity building is required to enhance the knowledge about the policy and how to implement the policy. 10. Training of the member of the working group or their representative of different departments and organisations on sector specific climate change issue.				
3	Establishment of Evacuation Corridor and strengthening of transmission and distribution network 1. Undertaking carrying capacity and resource mapping of each of the districts for setting up possible power project 2. Preparation of techno economic Feasibility report for the requirement of transmission network 3. Applying for Budgetary provision through international funding and private sector investment 4. Implementation of evacuation corridor	Dept of Energy and MECL		1300	External Funding Agencies
4	Demarcation of Hydro power potential in the state with site specific capacity mapping 1. Identification of sites for both on grid and off grid applications 2. Survey and investigation 3. Preparation of Prefeasibility report 4. Selection of Entrepreneurs 5. Developing Policy framework for provisioning clearance of small, medium, mini and micro hydro project 6. Capacity building of State Nodal Energy and Water resources department on technological and regulatory aspect 7. Lowering of wheeling charges	Dept of Energy, MECL, Water Resource		125	State govt , External Funding Agencies
5	Life Cycle Analysis of Existing hydro power plant and implementation of R&M measures 1. Estimate the operating efficiency of existing hydro power project 2. Preparation of DPR and applying for funding 3. Implementation of activity where analysis has already being carried out	Dept of Energy, MECL	]	252	State govt , External Funding Agencies
6	Reduction of AT&C losses 1. To assess the current T&D loss pattern and plan implement measures to reduce losses through	Dept of Energy, MECL		282	State govt , External Funding

	increase of energy efficiency and reducing pilferage. 2. Renovation of Existing transmission and distribution network 3. Replacement of Existing Transformer with star rated transformer 4. 100% consumer metering to reduce AT&C Losses - Involving Installation of SCADA system and metering arrangement for on-line remote monitoring system right from grid sub-station up to the consumer end having a connected load of 20 kW and above 5. Implementation of feeder level metering at distribution level 6. Consumer level metering a cell should be formulated and carry out Vigilance activity 7. To introduce franchise model in distribution to reduce commercial losses and better management of the distribution system 8. Formulation of Project management unit to facilitate for franchisee for 3 years 9. Impart training 10. Training and imparting support to prospective entrepreneurs				Agencies, APDRP
7	Facilitating overall village electrification 1. Undertaking study for optioning electrifying remote village in Decentralised mode 2. Preparation of DPR 3. Undertake implementation	Dept of Energy, MECL, MNREDA		50	State govt, Private party , RGGVY, DDG, Central finance assistance , MNRE, IREDA, REC
8	Implementation of Pilot Energy Efficiency Project and IGEA 1. Implementation of Energy Efficiency Measures in 8 Government building in Meghalaya where energy audit is carried out by the Nodal Department. 2. Implementation of Pilot energy Efficiency one of the identified pumping Station. a. Undertaking IGEA b. Taking up Pilot Implementation 3. Implementation of Pilot Energy Efficiency Street lighting Project in one of the ULB area. a. Undertaking IGEA b. Taking up Pilot Implementation 4. Identifying and empanelling ESCO companies. 5. Supporting state level entrepreneurs to become ESCO. 6. Taking up joint pilot project with ESCO companies	Dept of Energy, State nodal department designated under BEE		1.262	State govt, Private party, BEE
9	Promoting Energy Efficiency Practices in the State 1. Identification of Agencies for taking up activity 2. Undertaking sectoral and scoping study of the possibility of energy efficiency across each sector and barrier of taking up the energy efficiency initiatives.	Dept of Energy, State nodal department designated under BEE		0.70	State govt, BEE

	3. Undertaking Training Need Analysis Study for the department, preparation of manual and carrying out pilot workshop 4. Carrying out awareness campaign towards taking up energy efficiency measures and use of star rated devices.				
10	Creating State Energy Conservation fund 1. Creation of energy conservation fund with the request that the state government to provide opening fund and for study purpose to develop the financial model to create energy conservation fund 2. Mobilise budgetary provision from state budget to mobilise fund from MoP	Dept of Energy, State nodal department designated under BEE		0.1	State govt, , BEE
11	Maximising harnessing of Renewable Energy for the purpose of Power Generation 1. Harnessing Biomass potential a. Study of existing policy and develop investment friendly policy to promote additional biomass application b. Conducting detailed feasibility study for scoping biomass power project c. Developing biomass supply chain involving agro, agro industrial and other biomass resources d. Promoting biomass based gassifier project in agro based industries e. Raising awareness f. Creating conducive scenario for investment g. Implement demonstration and pilot project if necessary 2. Promoting Grid based wind power generation a. Wind mapping and demarcating zones b. Improve infrastructure for power evacuation c. Frame up policy to facilitate investment 3. Maximising use of Solar energy resources a. Survey and investigation to identify appropriate sites b. Framing promotional policy incentives c. Developing feasibility report d. Facilitating pilot project of higher capacity e. Awareness and capacity building of the nodal department 4. Strengthening of manufacture base	Dept of Energy, MNREDA		21.46	State govt, MNRE, IREDA, External Funding Agencies
12	Maximum and judicious utilisation of renewable energy resources for household energy requirement 1. Increased use of Solar for the purpose of water heating and cooking 2. Replacing inefficient cook stove with improved cook stoves 3. Awareness creation and capacity building for incremental usage 4. Promoting household biogas system	Dept of Energy, MNREDA		207.00	State govt, MNRE, IREDA, External Funding Agencies
Total				**2241.97**	

4.7. Health

4.7.1. Introduction

Human health is undeniable and intricately linked to the development efforts and vital pathway in the process of development. Climate change poses a formidable challenge to public health system globally with variance on the type and degree of impact depending on the demography, socio economic scenario of the region, preparedness and awareness among the population. It is worthwhile to note that the health scenario should not only be viewed and discussed on the basis of physical well being of the population but also from the aspects of social and psychological well beingas a key step towards ensuring sustainable development and attainment of millennium development goal.

It is evident from the research study that climate change as one end profoundly catalyses the propagation of infectious, communicable as well as life threatening vector borne diseases(some of the vectors are highly climate sensitive as regards to temperature and rainfall)on other end is envisaged to increase the human exposure to climate extremes (storms, flood, cyclone, drought etc), changes in water quality, air quality (assuming the current emission levels continue air quality in urban areas will deteriorate. Increase exposure to ozone and other air pollutant could increase morbidity and mortality), food quality and quantity, ecosystem, livelihood and infrastructure leading to death, disability, suffering, increasing vulnerability for the weaker section of the society especially amongst the set of population which has lower capacity to sustain the impacts and has lower accessibility to medical facilities and most vitally reduces the capacity of adaptability to the changes amongst the population. The direct impact because of climate change can be in form of heat strokeswhich might enhance the morbidity or mortality principally amongst the older age group and urban poor. The indirect impact can vary widely including enhancement of transmission window for the vector borne diseases, increased incidence of water borne and communicable diseases, malnutrition/ deterioration of nutritional health and consequent disorder(including those related to child growth and development), food security (resulting from reduced crop yield), increase in poverty/ economic decline, population displacement and even loss of livelihood due to outbreaks of natural disaster. Climate changes may impart an additional pressure on the public health system that is already burdened to cope with the existing level of health issues including communicable and non communicable diseases.

The state of Meghalaya, lying in the far flung area of the country is extremely vulnerable to the extremes of climate change due to its location in the fragile ecosystem and limited access with the rest of the country. Barring the scenario profiling of the health condition towards determining the possible impact of climate change on the health status and modelling the impact reduction framework, it is also essential to have a clear understanding of the socio economic scenario of the regionthat creates a conducive environment for occurrence and spread of diseases. The socio economic indicators like education, gender, poverty, housing, amenities and employment provide a background towards understanding of the health scenario of the region.

Though National Action Plan on Climate change does not identify human health as separate National Mission, Govt of Meghalaya decided to focus upon on health sector envisaging the possible impact of climate change on human health.

The action plan is strategized in order to reduce the impact of climate change related direct and indirect human health relevant exposure, combat the incidence of diseases and promotion of sustainable development. The strategy is framed on the basis of assessment of the scale of impact at regional level, determining the priority and scale of actions and strategising adaptation measures towards reducing vulnerability of climate change. Such strategy broadly includes enhancement of awareness and uptake of effective clinical and public health intervention in high need regions for reduction of impact.

4.7.2. Key Facts about the Sector

- **Health Status in the state**

1. Infant Mortality Rate – 49
2. Birth Rate – 25
3. Death rate – 7.5
4. MMR – 450

- **Proposed physical Target**

1. IMR to be reduced to 30/ 1000 live birth
2. MMR to be reduced to 100/ 1000,000.
3. Malaria Mortality rate reduction – 50% upto 2012
4. 34 health centre to be upgraded to Indian public Health Standard
5. Utilisation of First referral unit to be increased from less than 25% to 75%

- **Infrastructure**

The public health infrastructure in the state is build on 3 tier system

- Community health centre for a population of approximately 80,000
- Primary Health centre for population of 20,000
- Sub centre for population of 3000

At present the state with 7 districts consisted of 9 hospital, 28 CHCs, 104 PHCs, 405 Subcentres, 9 dispensaries and 12 primary health centre. With the current population of 27.52 lakhs the number of shortfall in the sub centres, CHCs and PHCs are 412, 3 and 18 respectively. With the Population growth the numbers of health care facility required by 12th Plan period and 2020 are 801 and 1021 sub centres, 36 and 38 CHCs and 144 and 153 PHCs respectively.

4.7.3. Key Problems identified in health sector

1. Persistent gap in manpower and infrastructure specially at secondary and tertiary level
2. Sub optimal and improper utilisation of infrastructure
3. Various health institution suffers from lack of diagnostic and therapeutic services and drugs.

4. Low absorption capacity of programme fund

5. Sub optimal inter sectoral co-ordination, poor co-ordination among various service provided by directorates

6. Lack of innovation and adaptation

7. Poor exposure to technological advances

8. Growing dual burden of communicable and non communicable diseases because of demographic, environment transition and lifestyle.

9. Increasing cost of health care facility

10. Lack of adequate MIS for planning, monitoring and evaluation.

4.7.4. Proposed activity the Sector

1. Development of infrastructure comprising of

    a. Medical institution

    b. Equipment's

2. Taking up Maternal and Child health & Family welfare programme

3. Convergence of Activities including but not restricted to setting up of high level co-ordination committee at state and district level

4. Promoting Monitoring, Accountability and Transparency

5. Enhancing infrastructure facility in PPP mode

6. Popularisation of Alternative Medicine system like AYUSH

7. Access to essential drugs

8. Focussed and integrated approach to National programme of diseases control

9. Integration of NRHM with National Health programme

4.8. Strategic Knowledge management

Future actions need to focus on widening the awareness and understanding of the issue of climate change in the state, including their contribution to biodiversity protection and supporting sustainable development, and especially their value to indigenous peoples and local communities. Such action will facilitate towards enhancing livelihood resilience and adaptive capacities of rural and vulnerable people in state. The apex council shall act as the inter-sectoral coordinating body for the state to take the process forward. Some of the processes that will be undertaken in the first step.

4.8.1. Mainstreaming the agenda of climate change into the sectoral policies and practices

This will involve building in climate change related triggers/ indicators in the planning, monitoring and evaluation processes. For example if there is a sectoral programme like soil water conservation, in the micro-planning process itself the indicators shall be built in and actions have to be prioritised.

4.8.2. Knowledge management

Climate change related knowledge is very limited at the state level. The localised indicators, investments in generating local dataset for modelling, forecasting and tracking will be essential. There is a need to identify the drivers and indicators of climate change. Here also, because of

uniqueness in geographic location of the state, the profile of either drivers or indicators of climate change could be different from elsewhere. State machinery also needs to take equal interest in assessing these drivers and indicators as they are the nucleus of all studies related to climate change.

The data base will be needed to construct baseline for several sectors to assess the cost and benefit of specific adaptation action. Also, it is to be noted that the climate projections given by different global and national centres are general in nature and have global coverage. These projections lack in providing statistics of extreme events and high impact weather, which are required for development of regional and local adoption strategies. Also, the anomaly projections for temperature, rainfall, etc are in most cases given as annual mean. Such seasonal changes shall have severe impact on local weather, biosphere, human health, etc. While large scale global changes will be driven by changes in global average values, estimation of regional and seasonal climate projections are important for development of effective and meaningful mitigation and adaptation strategies for states. Modelling studies studies with objective of regional (spatial scale of the order of 25 km ~ 0.25 degree) level climate predictions for next 100 years with seasonal variation (summer, autumn, winter) of critical parameters should be attempted.Baseline data would also be necessary for the co-benefit to be harnessed from market mechanism like Clean Development Mechanism, Payment against ecosystem services, perform achieve and trade, etc. Particular emphasis will be placed on web-based communication and interaction and websites will be integrated as part of the state level climate change Knowledge Management System. These websites will be designed as part of the programme to serve the needs of the key officials and would also reach out to the wider community.

4.8.3. Climate Change and Media

Popularized publications on the values of bio-diversity, issue based features on climate change at the state level, through targeted Opinion Editorial Pieces and other media forms will be pursued. A concerted communication effort focused on the value of sustainable development reduction of GHG emission and low carbon lifestyle will be of special interest. Local media persons will be involved in this process.

4.8.4. Capacity Building and Skill Development

A green growth would also require green jobs and green entrepreneurs. The state has proposed an institutional framework for green entrepreneurship development, eco-system governance. The state is planning that a separate group may be identified to conduct research on climate change science with objective of giving district level seasonal climatic forecast, develop exclusive mitigation measures (in addition and in sync with national guidelines), conduct study on impact, vulnerability and risk assessment of climate change.

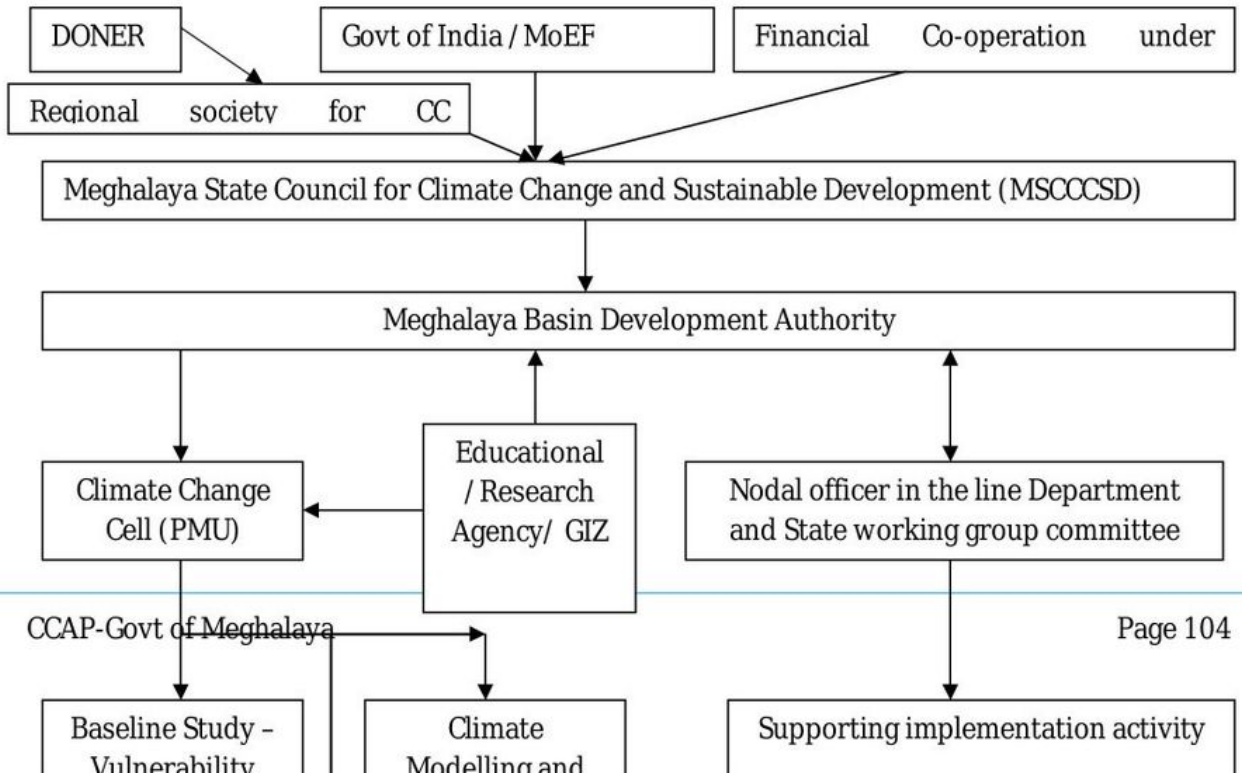
4.8.5. Awareness

It is essential to impart greater level of awareness and understanding of CCA approaches with a broader view of mainstreaming SAPCC approaches and achievement through convergence with other department.

4.8.6. Institutional Arrangement

The state action Plan on climate change revealed the inter-sectoral and inter-departmental nature of response action. In preparing the Climate Change Action Plan, different groups have

been constituted through representation from various departments. These deliberations revealed that implementation also requires strong inter-sectoral and inter-department co-ordination. To meet this need, a dedicated Climate Change Agency is constituted and put in place to facilitate and monitor the implementation. This will have an advisory and coordinating role on climate change issues. This body will be a single-window contact for dealing with the state government and other external funding agencies in issues pertaining to uptake of climate change related proposed actions. The agency will be constituted under the Meghalaya Basin Development Authority governed by Meghalaya State council for Climate Change and sustainable development under the supervision of the Principal Secretary (Planning) of the state. However, the agency's role will include and involve all sectors and all departments. It is envisaged that this agency will function in an independent and autonomous manner so that it can execute its various roles, responsibilities and duties in a smooth, quick and effective manner. The Agency will be equipped with appropriate quality manpower, resources and infrastructure that are commensurate with the requirements and challenges faced. The Agency's functioning style will be collaborative and inclusive, not only within Departments of the Government but also with the different external stakeholders. The climate change institutional structure is illustrated as follows:



As outlined in the programme structure above the climate change adaptation initiative including the supportive action will be undertaken by Meghalaya Basin Development Authority in support with the CCA PMU housed towards rendering technical support to MBDA for undertaking actions proposed under state CCAP. The PMU will support to undertake the following tasks

1. Baseline analysis, Micro level planning (Participatory and bottom up) towards prioritisation of potential adaptation measures (mapped under CCAP) that will contribute towards increasing climate change resilience of the most vulnerable communities/ clusters/ viallge including development of investment proposition , project prioritisation based on the level of the vulnerability

2. Training need analysis – capacity building of the local resource personal and facilitates capacity building of the local communities- awareness generation.

3. Preparing working documents – Program and project design document – DPR for design and Implementation of sub-projects, baseline establishment - O&M concepts- Monitoring and evaluation of subprojects, performance based incentive schemes.

4. Pre-screen of sub-project applications- Developing screening criteria – supporting implementation agency in sanctioning of sub-projects, etc.

5. Project management – Activity schedule, indicators in a participative manner with stakeholders and implementing agencies & administration.

Chapter 5: Cross-Cutting issues to tackle Climate Change in the State

There are several cross-cutting issues in the climate change debate. Elsewhere, in this report, it was mentioned that Climate Change is a multi-objective problem. It requires multi-sectoral coordination and commitment of multiple stakeholders. Although not new, collaboration across the sectors—private, public and civil society—has traditionally been defined by a single issue or geography. 'Convergence' is a more complex form of collaboration involving multi-stakeholder coalitions, seeking to affect systemic change on wide-ranging issues, focused on outcomes rather than inputs to deliver scalable and sustainable change. To understand the cross cutting issue the following process was adopted. The following diagrams give the details.



While looking at the environmental effectiveness in choosing a key priority one has to see whether the cost is localised (area specific, state-wide, national or global). In this context if we take the example of a coal-fired power plant, then the environment cost is localised but it helps in electrification in the North-Eastern Region. The state can even earn revenue through open access by exporting power other regions of the country. However, if it has to opt for a clean technology like a combined cycle plant or capture the carbon and store it or to have a supercritical boiler, then the costs have to be considered and additional investment need to be negotiated from non-local stakeholders. This will tie up with the other arguments like equity, flexibility in approach not to obstruct anything or everything that has an environmental cost. The state also has to address the issue of complementarities to avoid duplication of efforts or resource deployment.

It has to negotiate with multiple players and based on the development priority of the state decide on the implementation agenda.

The priority actions where such dilemma exists have been deliberated keeping these criteria in mind and treated as a cross-sectoral issue.

The table below gives some idea about cross-sectoral relevance of the some contemplated actions.

Cross-sectoral challenge	Sectors-Involved	Actions	Typology of action	Anticipated conflict
Containing Damage to the housing and storage infrastructure in flood prone areas	Agriculture, Water, Housing	Change in crop storage structure and raised plinth	Adaptation	Medium
Containing Food Insecurity during extreme weather conditions	Agriculture, Horticulture, Rural Development	Food preservation, seed bank, homestead garden	Adaptation	Low
Management of water scarcity	Agriculture, Rural Development, Water, PHED, Health	Raising the plinth of tube-wells	Adaptation	Medium
Alternate livelihood during flooding conditions	Agriculture, Animal Husbandry, Fishery	Duck rearing, seed storage, Banana cultivation	Adaptation	Low
Basin/ Flood Plain Management	Water, Agriculture, Industry, Energy	Integrated water resource management at basin level should determine the apportionment of water different sectors	Adaptation	High
Promoting sustainable agricultural practices	Agriculture, Rural Development, Forestry	Prevention of slash and burn type shifting cultivation and moving to better agro-sylvicultural pattern	Adaptation	High
Preserving the bio-diversity	Forest, Fishery, District autonomous councils	Requires a holistic action to preserve the flora as well as the fauna including the aquatic ones of a specific area	Adaptation	Medium
Institutionalising Energy use efficiency	Energy, Industry, Works, Agriculture	A multi-layered approach to change the mindsets, methods and appliances to improve end-use efficiency and process efficiency	Mitigation	Medium
Promoting green infrastructure	Energy, Works, Urban, Transport	Green topped road, promotion of renewable and energy saving measures in the housing sector	Mitigation	Medium

5.1. Common Cross-cutting needs and capabilities

The following are the common crosscutting needs and capabilities that have emerged from the working group deliberations. Government of Meghalaya understands the common needs that emerge across sectors and has proposed several institutional mechanisms to move forward.

This includes the apex council, building capacity of the district councils, an institution of Governance, looking at program monitoring and impact assessment, an entrepreneurship development institute to promote skill building in general with a special emphasis on the green skills.

Geography Strategies	Local	State level	Linkages to national programmes/ missions
Awareness	Creating local level awareness is a first step, e.g. barefoot workers, framer field schools may promote descaled climate change concerns	Building awareness of legislators, policy makers on socio-economic and socio-political cost of climate change	Participation in national networks, interface with the national knowledge network and research systems
Capacity	Monitoring, observation Awareness/ assessment at state/ district/ community levels	Scientific assessment, measurement, models, with state level technical institutions like SPCB, Watershed Mission, Regional Centres of National Institution, Universities	Special regional modelling and assessments, best practices study and resource leveraging from various missions and mission resource centres and technical secretariats
Generation of Knowledge/ Information	Locale specific databases, scenarios and assessment, local monitoring networks, rapid assessment for input to state inventory	Research networks, Compilation of state level GHG inventory and input to National databases(e.g. NATCOM), scientific and policy models, state-wide and area specific scenarios, technology inventory	Interface with IPCC assessments, interfacing with regional/ global databases, scenarios and assessments, technology inventory database
Institutions/ Partnerships	Community initiatives, Early warning networks, Disaster management teams	Stakeholders networks, public/ private programs	Standardised Climate impacts assessment both academic as well more applied ones for result based management and programming
Policy/ Instruments	Local specific adaptation plans, community based adaptation programs	Science-policy linkage, mainstreaming climate change agenda in sectoral policies of the state (agriculture, mining, industry, energy, water, forestry, etc.) economic instruments (e.g. insurance, R&D funds), integration with national development/ planning process	Adaptation funds, Interface with private sector participants for fund under market mechanisms like CDM, REDD& REDD+
Technology	Locale specific technology adaptation	Targeted R&D, Technology transfer protocols, demonstration/ pilot projects	Scientific exchange, technology transfer

Chapter 6: Conclusions and Recommendations

6.1. Key Outcome

The state has undertaken massive exercise of identifying key priorities in each sector. About 150 actions have been identified across six sectors. Out of which 66 actions have been prioritised.

Climate change has been mentioned as a cross-cutting sector in the annual plan of the state.Institutional Arrangement has been worked out and notified. The cross-sectoral working groups have shown commitment in producing these drafts by working together and moderating the different positions.

6.2. Financial Budget

The budget for the Climate Change Action Plan which is purely indicative at this stage is presented below. The budget only pertains to priority actions to be undertaken in the short term.

Sl No	Sector	No of Priority Actions	Indicative Budget (in Rs Crore)
1	Sustainable agriculture	14	1276.40
2	Sustainable Habitat	10	1406.01
3	Sustainable Forestry	13	991.41
4	Sustainable Water Resources	15	289.00
5	Mining	12	92.33
6	Energy	12	2241.972
	Total	76	6297.122

The total budget for the climate change action plan works out to be approximately Rs 6298 crore.

6.3. Governance

Meghalaya state council for climate change and sustainable development (MSCCCSD) constituted under the chairmanship of the chief minister of the state. MSCCCSD and MBDA will function with Chief Secretary as the convener.

6.4. Institutional Arrangement

The institutional arrangement has been enshrined in the notification and has been approved by the cabinet. Meghalaya State Council on Climate Change and Sustainable Development will be the apex body for coordinating and approving climate change related work. There will be a project management agency to be supported by experts to develop the implementation guidelines in each sector and work with departments and agencies to develop baseline, emission inventory, have consultation across departments and networks. This will help in building the capacity of line department staff.

Meghalaya Basin Development authority (MBDA) is already established as a registered society for implementation of SAPCC. An additional PMU is proposed under SAPCC to support MBDA in implementation of SAPCC . The role of the PMU will be to support MBDA over the following issues:

1. Supporting development of the project proposal and DPR for the priority action proposed under the SAPCC and support MBDA in sourcing funding from Govt institution or external funding agency
2. Supporting preparation annual plan and budgeting for the climate change action proposed under SAPCC.
3. Supporting preparation of progress report and co-ordinating with nodal department of SAPCC of other state.
4. Coordinating with the working group and state missions for planning and convergence.
5. Monitoring project input, activities and impact.
6. Maintenance of MIS, supporting preparation of participatory micro planning.
7. Promote knowledge management and policy advocacy through workshop, seminar and participatory village level programme.

6.5. Staffing and stakeholders

From the range of issues / concerns, it is quite clear that even though climate change is an environmental challenge, the response requires non-environmental professionals. Resolving climate change issues cannot be done in isolation by the environmental or climate change fraternity alone. The issues/ problems are so fundamental and deep in the sectoral context that the respective sector professionals have to address these problems. Policy-makers, economists, planners, engineers, scientists, development programme specialists and others have to be encouraged to contribute towards resolving climate change problems in a structured way.

In order to ensure successful implementation of SAPCC it is important to ensure involvement of stakeholders, particularly community, in a more proactive way in the CCA planning (micro level and participatory) implementation. This involvement will relate to

(i) Promoting much greater climate change awareness within community,
(ii) Identifying problematic issues relevant to climate change,
(iii) Support in monitoring of climate-induced problems and
(iv) Ensuring greater accountability to the people on climate change issues.

Stakeholder involvement will be an effective tool in bringing out the solutions. If stakeholder involvement as described here is not initiated, then stakeholders are bound to look at government as an adversary and not as a partner.

6.6. Capacity Development

Climate change and its possible consequence over the life and livelihood of the people, scope for adaptation and undertaking of mitigation initiatives are relatively a new concept in the state. Consequently the limited awareness on the broader issues relating to concept of vulnerability, climate proofing , climate resilience across all implementation level, line department will be unsuccessful unless the critical capacities are developed in regard to the above issues. The

outcome of SAPCC is largely dependent on developing the required capacities at different level of administration and also at the grass root level.

Adequate training programme should therefore be planned as part of strategic knowledge mission, moreover state nodal agency should organise participatory level awareness workshop at the regional level to promote similar initiatives. Even participatory micro level CCA planning can be encouraged towards promotion of traditional knowledge and adaptation practice. Capacity building of the CBO, NGO should also be a part of the planned programme. Following action can be implemented and organised through state level PMU with subject matter specialist.

6.7. Monitoring and Evaluation

Monitoring and evaluation is a critical part of the programme implementation. A programme level MIS will be developed and ensured that information are routinely collected, imputed and analysed during the programme period. As a part of the monitoring framework baseline studies will be conducted during first year and follow up assessment will be carried out depending upon the length of the programme. Inputs and activity monitoring will be based on information routinely gathered at different levels using the programme MIS e.g. numbers and quantities of different activities and investments carried out and their costs. On an annual basis, the programme review processes will involve comparison of what was planned and what actually achieved. This will provide an annual assessment of the progress and will assist in the early identification of the problem areas to be address during the subsequent year. As part of the project proposal developed for sourcing of funding and implementation of the SAPCC an indicator based frame will be developed and will be reviewed on a periodic basis.

Area	Key impacts to monitor	Targets to monitor	Key programme to evaluate	Frequency	Feedback loop

6.8. Key Conclusion

A multidisciplinary, integrated and co-ordinated convergence approach will be adopted in implementing the SAPCC. MSCCCSD will adopt a proactive, preventive and preparedness oriented approach rather than a reactive approach. Different sectors have different key priorities to be addressed through different initiatives over different timeframe. MBDA under MSCCCSD will implement its initiatives relevant to their key priorities within themselves and in close integration with different departments and stakeholders involved. During this SAPCC implementation, MBDA will demonstrate, promote and encourage different initiatives through policy changes and implementation actions as a response to climate change.

Following the implementation of this first SAPCC, awareness and knowledge on climate change issues / concerns would be developed across the state. Therefore, the overall capacity of both Government staff across all levels as well as those of the external stakeholders will be considerably higher. Once built, this capacity should be collectively and gainfully used in a consultative, participatory and inclusive manner in determining the focus areas of attention in the next version of the SAPCC. While all sectors were directly or indirectly covered in preparing the SAPCC, there were some departments that were not actively engaged, e.g. Education

department. The overall focus on capacity building addresses an educational goal / target but this is not implemented through the formal systems of the Education department. It is therefore proposed that these departments that have not been directly engaged should be encouraged to be involved so that new perspectives and approaches emerge.

Annexure

Annexure 1 Working Groups/ Experts

Sl. No.	Sector	Convenor	Working group members	
			Name/ Designation	***Department/ Organisation***
1	Cross cutting issues and Meghalaya Climate Change Adaptation Project	Additional Secretary/ Principal Secretary, Planning		
			Director	Community and Rural Development
			Director	Health Services
			Director	Planning
			Director	Social Welfare
				NEDFI
				Financial Institutions
2	Forest and Biodiversity	Principal Secretary/ Commissioner and Secretary- Environment and Forests Department		
			PCCF or his representative	
			Director	Agriculture
			Director	Community and Rural Development
			Director	Fisheries
			Director	Horticulture
			Director	Information Technology
				Meghalaya State Biodiversity Board
				Meghalaya State Medicinal Plants Board
			Director	Mining and Geology
			Director	North Eastern Space Applications Centre (NESAC)
			Director	Sericulture and Weaving
			Director	Soil and Water Conservation
			Director	Tourism
			Scientist In-charge	Botanical Survey of India
			Scientist In charge	Zoological Survey of India

			Joint Director	Forest Survey of India
			Prof. B K Tiwari	NEHU
3	Water resources	Commissioner and Secretary, Water Resources		
			Director	Agriculture
			Regional Director	Central Ground Water Board
			Director	Fisheries
			Senior Official	Forest Department
			Scientist In charge	Geological Survey of India
			Director	Health
			Director	Horticulture
			Director	Information Technology
			Director	Meghalaya State Disaster Management Authority (MSDMA)
			Member Secretary	Meghalaya State Pollution Control Board
			Director	Mineral Resources
			Senior Electrical Inspector	Power Dept
			Chief Engineer	Public Health Engineering Dept
			Director	Soil and Water Conservation
4	Sustainable Agriculture	Commissioner and Secretary, Agriculture Department		
			Director	Agriculture
			Director	Animal Husbandry and Veterinary
			Scientist In-charge	CSIR
			Director	Fisheries
			Senior Official	Forest Department
			Director	Horticulture
			Director	Information Technology
			Zonal Project Director	ICAR
			Director	Soil and Water Conservation
			Director	Water Resources
5	Energy	Additional Chief Secretary/ Principal Secretary, Power Department		

			Director	Agriculture
			Director	Industries
			CMD	Meghalaya Electricity Corporation Ltd
			Member Secretary-cum-Director	MNREDA
			Director	Science and Technology
			Director	Water Resources
6	Mining	Principal Secretary/ Secretary, Mining and Geology Department		
			Director	Agriculture
			Senior Official	Forest Department
			Director	Industries
			Commissioner	Labour
			Member Secretary	Meghalaya State Pollution Control Board
			Director	Water Resources
7	Sustainable Habitat/ Urban	Principal Secretary/ Secretary, Urban Department		
			Senior Official	Forest Department
			Director	Health
			Director	Housing
			Member Secretary	Meghalaya State Pollution Control Board
				Municipal Boards and Town Committees
			Director	Power
			Chief Engineer	Public Health Engineering Dept
			Chief Engineer	Public Works Division
			Commissioner	Transport
			Director	Water Resources
8	Knowledge Management and Skill Development	Principal Secretary, Education		
			Joint Director (SWC) R&T	Conservation Training Institute
			Director	Education (Educational Research and Training)

			Director	Information Technology
			Commissioner	Labour
			Director	Meghalaya State Disaster Management Authority (MSDMA)
			Director	Planning
			Director	SIRD
9	Improving Governance Framework in relation to Climate Change Agenda	Additional Chief Secretary		
			Director General	Home
			Principal Secretary	District Council Affairs
			Senior Official	Forest and Environment Department
			Director	Information Technology
			Commissioner and Secretary	Personnel Dept
			Director	Planning
Note:	*1) The Convenor for each sector has the liberty to co-opt any other official or department or institution as and when deemed necessary.*			
	2) Relevant Central Government Departments/ Institutions/ University to be identified by the respective working groups, as deemed fit.			

Annexure 2: Comprehensive list of Activities Considered for Agriculture sector

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
1	Assessment of soil quality & soil moisture content for better productivity through generation of climatic information	Dept. of Soil Water Conservation	H	AD	S	RS	ST
2	Promotion of agro forestry model and capacity building for climate change	Dept. of Agriculture/ Dept. Of Forest	L	AD/ MI	S	PA	ST
3	Impact assessment of paddy cultivation through agricultural inputs such as crop varities, kharif crops and promotion of rain water harvesting and construction of ecofriendly mini check dams for irrigation.	Dept. of Agriculture	H	AD	S	RS	ST
4	Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops	Dept. of Soil Water Conservation	H	AD	A	IP	LT
5	Documentation of indigenous and traditional knowledge in agriculture in adaptation of climate change	Dept. of Agriculture/ Dept. Of Forest	M	AD	S	PA	ST
6	Increasing the area under perennial fruit plantation crops and low value high volume crops to help cope with uncertain weather patterns.	Dept. of Horticulture	H	AD	A	IP	LT
7	Management of climate change impact on horticulture	Dept. of Horticulture	H	AD	S	RS	ST
8	Improving post harvest management such as cold chain for perishable crops and winter cultivation practices	Dept. of Horticulture	H	AD	S	IP	ST
9	Promotion of organic farming through usage of compost and vermicompost	Dept. of Agriculture	H	AD/ MI	S	PA	ST
10	Assessment study and demonstration of Systematic Rice Intensification (SRI) cultivation	Dept. of Agriculture	H	AD/ MI	A	PA	ST
11	Breeding and production of rice varities with stress tolerant and resistant attributes	Dept. of Agriculture	H	AD	S	PA	ST
12	Research study on livestock disease and establishment of early warning system	Dept. of Animal Husbandry and Veterinary	M	AD	S	RS	ST
13	Capacity building of livestock keepers	Dept. of Animal Husbandry and Veterinary	M	AD	S	CB	LT
14	Assessment of impact of climate change in livestock and reduction of impact of vector borne diseases through vaccination of farm animals, breeding policy for climate resilient breeds.	Dept. of Animal Husbandry and Veterinary	H	AD	S	PA	ST
15	Capacity building to train farmers in latest rice cropping techniques specially evolved to counter adverse effects of climate change	Dept. of Agriculture	H	AD	S	CB	ST
16	Preparedness to tackle emerging scenarios of pests	Dept. of Agriculture	M	AD	S	PA	ST
17	Development of water management in minor irrigation through construction of	Dept. of Water Resource	H	AD	S	IP	LT

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
	check dams, rain water harvesting and revival of existing water bodies as adaptation measures						
18	Capacity building and welfare activities of fishing communities	Dept. of Fisheries	L	AD	A	CB	LT
19	Local mass production of such rice varities for distribution to the farmers as substitutes to lesser tolerant varities- setting up of planting material production centres	Dept. of Agriculture	H	AD	A	IP	LT
20	Impact assessment of climate change on fishery and development of watershed vulnerable to climate variations.	Dept. of Fisheries	H	AD	A	RS	ST
21	Climate risk management studies	Dept. of Agriculture/ Dept. of Horticulture	M	AD	S	RS	ST
22	Research study on livestock disease and establishment of early warning system	Dept. Of Animal Husbandry	H	AD	S	RS	ST

Annexure 3: Comprehensive list of Activities Considered for Sustainable Habitat sector

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
1	Capacity Building on Climate Change Impacts and Preparedness	Depts of Urban Affairs, PHE, Power, transport, Forest, SPCB	H	AD	S	CB	LT
2	Incorporate Climate Concerns in Urban Water Supply and Sewage Design. E.g. Liquid waste Management	PHE, Urban Affairs	H	AD/ MI	S	PA, CB, OM	MT
3	Working Towards Greater Water Use Efficiency and conservation in Urban Areas	PHE, Urban affairs	H	AD	S	PS, OM	LT
4	Developing a climate friendly waste management system	Urban affairs, revenue dept	H	AD/ MI	A	RS, PA	LT
5	Development of satellite townships	Urban Affairs	H	AD	A	IP	LT
6	Environmental Profiling and GHG Emissions Inventorisation for all urban bodies including upcoming satellite townships	Urban affairs, Forest dept	H	AD/ MI	A	RS, OM	MT
7	Energy efficient Street Lighting	Urban affairs, Power dept	H	MI	A	PS, PA	MT
8	Improve enforcement to control vehicular pollution	Urban affairs, Transport dept, SPCB	H	MI	S	PA	LT
9	Urban poor Mapping to Identify vulnerable urban population	Urban Affairs	H	AD	S	RS	LT
10	Developing climate- responsible master plans for selected city/ ies (CDP)	Urban Affairs	L	AD/ MI	S	OM	MT
11	Promotion of solar water heating and lighting in buildings through policy mechanisms	Urban Affairs	M	MI	S	IP	MT
12	Developing models of urban storm water flows and capacities of existing drainage system	Urban Affairs	L	AD	S	RS	ST
13	Assessment of carbon emissions from the transport sector	Urban Affairs	L	AD/ MI	S	RS	ST
14	Integrating urban and transport planning	Urban Affairs	L	AD	S	PA	LT
15	Quantitative assessment of the impact of climate change	Urban affairs	M	AD	S	RS	LT
16	Taking up study to estimate the impact of the upcoming construction to GHG contribution	Urban affairs, SPCB	M	AD	S	RS	LT
17	Piloting low carbon highways	Urban Affairs	L	AD	S	IP	LT
18	Restructure land tenure policy to enable sustainable urban development	Urban Affairs	L	AD	S	PA	LT

Annexure 4: Comprehensive list of Activities Considered for Sustainable Forestry

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
1	Assessment and mapping of biodiversity and identification of hotspots in the state, micro plans for biodiversity conservation	Forest dept., Biodiversity Board, Meghalaya State Pollution Control Board	H	AD	A	RS/ PA/ IP	ST/ MT
2	Study on REDD feasibility and REDD+ for afforestation and reforestation and sustainable livelihood promotion	Forest dept.	H	MI	S	RS/ PA	ST
3	Training and capacity building of JFMCs, Institutions, departments to adapt to climate change, implementation and operation through JFMCs and FDAs and evaluation	Forest dept.	H	AD	S	CB/ IP/ OM	MT
4	NTFP inventory, mapping, value addition and establishment of market linkages for investment promotion and employment generation	Forests Dept.	H	AD	S	RS/ PA/ IP	ST/ MT
5	Adaptive species identification for effective plantation through establishment of Permanent Nursery	Forest Dept.	M	AD	A	RS/ IP	MT/ LT
6	Site identification and survey demarcation and PRA for community Forest land	Forest Dept., Revenue dept.	M	AD	S	RS/ OM	ST
7	Assess fire management strategies	Forests Dept.	M	AD	A	PA/ IP	MT
8	Study on valuation of forest resources (Non traded) items and Monitoring of carbon stock and biodiversity at regular intervals	Forests Dept.	H	AD	S	RS/ OM	MT/ LT
9	Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions	Forest Dept., Tourism Dept.	H	AD	A	RS/ PA/ IP/ DP	ST/ MT
10	Decrease people dependence on firewood and timber and increase use of improved stoves (chullhas) and wood substitutes	Forest Dept., Meghalaya Non-Conventional and Rural Energy Development Agency	L	MI	S	PA/ IP	LT
11	Work to establish new systems to support for public awareness building through Establishment of Envis Centre	Forest Dept., SPCB	M	AD	A	PA/ IP	MT
12	Increase plantation and ecological restoration on non-forest land through block plantation activities, Agro Forestry activities, Farm Forestry activities, A-R programme on Urban and peri urban institutional Lands, Soil moisture conservation programme	Forest dept, Agriculture Dept., Urban Dept.	H	MI	A	PA/ IP/ DP	ST/ MT

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
13	Assess additional threats to biodiversity and wildlife. Forest consolidation, linking forest fragmentations, habitat development and mitigation of man-wild animal conflicts due to Jhum cultivation in elephant corridors	Forest Dept., Agriculture Dept.	H	AD	A	RS/ PA/ IP	ST/ MT
14	Encourage continuance of existing community forests by way of giving inputs towards sustainable livelihood options	Forest Dept.,	H	AD	S	PA	ST/ MT
15	Land reclamation through reforestation activities of abandoned mines	Forest Dept., Dept. of Mining	L	AD	A	PA/ IP	MT/ LT
16	Formulation of framework for scientific forest governance to minimize climate change impact	Forest Dept.	M	AD	S	PA/ CB	ST/ MT
17	Study on Climate change impact on forest cover (Temperature and Rainfall regime) and indicative adaptation measures	Forest Dept., NESAC	H	AD	S	RS	LT
18	Conservation of wildlife sanctuaries in private partnership model	Forest Dept., Dept. of Tourism	L	AD	A	PA/ IP/ OM	ST/ MT
19	Increase of commercial forestry activities for increase of carbon stock	Forest Dept.	M	AD	S	PA/ IP	ST/ MT

Annexure 5: Comprehensive list of Activities Considered for Sustainable Water Management

Sl. No.	Response Activity Title	Ad/ Mi/ Both	Primary Department Involved	Other Departments Involved	Scale	Nature of Activity (Research Study / Policy Action / Pre-investment Study / Demonstration Project / Investment Project / Capacity Building / Regular Operation & Maintenance)	Importance of Activity
1	Formulation of Water Use Policy	A	Water Resources	PHE, SWC, Power, Agriculture, Urban Affairs, SPCB, fisheries, horticulture, Rural Development, Law	State wide, but implementation would consider catchment as unit	PA	High
2	Preparation and Implementation of Water management Plan	A	Water Resources	River BasinAuthority	SW	PA	Medium
3	Creation of State Met Department	A	Planning Department	S&T, CSTE	SW: At least one in every district	RS, PIS,DP,IP,CB,RO&M	High
4	Identification of Micro Hydro Power Points	A	Power	Water Resources	SW	PIS	
5	Integrated river basin management with stakeholder dialogue	A	River Basin Authority	Water Resources, SWC, PHE	SW		High

6	Agricultural Zoning and Capacity Building of Farmers	B	Agriculture	Horticulture, SWC, WR, C&RD	SW	RS, CB	High
7	Creation of water inventory, information database for monitoring, evaluation and surveillance	A		Water Resources		RS	
8	River health Monitoring and Environmental Flow Studies	A	SPCB		SW		High
9	Creation of State G/W Authority	A	Planning Department	SWC, PHE, WR	SW	IP	High
10	Documentation of Traditional Water Conservation and Management Techniques	A	C&RD	SWC, Agriculture	SW	CB	High
11	Roof top RWH	M	SWC	Agriculture	SW	RS, CB, IP	High
12	Restoration and Creation of Water Bodies	B	SWC, WR		SW	IP, CB, RO&M	High
13	Awareness Programmes and capacity building for users (mining, industries) for water pollution prevention	A	SPCB	Mining & Geology, Industries	SW	CB	Medium
14	Institutional Capacity Building	A	SWC	WR, Forests	SW	CB	High
15	Development of flood+ Drought forecasting networks	A	WR	MDMA, NESAC	SW	IP, CB, RO&M	High

Annexure 6: Comprehensive list of Activities Considered for Mining sector

Sl. No.	Response Activity Title	Ad/ Mi /Both	Primary Department Involved	Other Departments Involved	Scale	Nature of Activity (Research Study / Policy Action / Pre-investment Study / Demonstration Project / Investment Project / Capacity Building / Regular Operation & Maintenance)	Importance of Activity
1	Forest clearance and EIA	M	Forests		State wide		High
2	Checking unscientific mining and introducing improved technology for excavation and better management for storage and transport.	M	DMR		SW		High
3	Improved mining operations within the purview of Environment Management Plan	M	PCB	Forests	SW: At least one in every district	CB,RO&M	High
4	Eco-restoration of abandoned mines and land in the vicinity affected by mining	M	Forests		SW	RS, CB	High
5	Land use planning and regulation	B	Forests		SW		
6	Protecting and managing water bodies around mining areas	B	Water Resources	PCB	SW	CB, RO&M	High
7	Water quality monitoring of both surface and ground water around mining areas	A	Water Resources	SWC, PHE, Central G/W board	SW	IP	High
8	Devise a mechanism to implement a system of compensatory water harvesting and storage around mining clusters	M	Water Resources	SWC	SW	PIS, IP, RO&M	Low

9	Strengthening environmental monitoring and introducing environmental safeguards	B	PCB		SW	IP, CB, RO&M	High
10	Organize awareness programs to educate the people inhabiting mine-affected areas about the environmental hazards associated with mining.	A	DMR		SW	CB	High
11	Capacity building and generating awareness among local community, mining personnel and government departments e.g. directorate of mines	A	DMR		SW	CB	High
12	Devise a sensitization program for adoption of CDM in mining sector through seminars and other awareness programs; also capacity building and training w.r.t. CDM	M	DMR	PCB	SW		Medium
13	Incorporate climate concerns in state mineral policy and state industrial policy e.g. 'polluter pays principle'	B	DMR	Industries	SW	PA	Low
14	Strengthen DoM with respect to human resources, technology and development of database	A	DMR		SW	cb	High
15	Identify a host training institute to assess the training needs of related agencies and prepare training modules	A	DMR		SW	IP	High
16	Extraction of minor minerals including stone quarrying and sand extraction	M	Forests	PCB	SW		High

Annexure 7: Comprehensive list of Activities Considered for Energy sector

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
1	Undertaking hydrology study of existing Hydro power source in light of observed and projected impact of climate change and framing adaptation measures	MECL, Water Resource	H	AD	S	RS, PA, PS, CB	ST
2	Functional Reorganisation and Institutional development of State Energy Department	Energy Department, MECL, REDA, State nodal department designated under BEE	H	MI	S	RS, PA, PS, CB, DP	ST
3	Establishment of Evacuation Corridor and strengthening of transmission and distribution network	Dept of Energy and MECL	H	MI	S	RS, PA, PS, CB, IP	MT
4	Demarcation of Hydro power potential in the state with site specific capacity mapping	Dept of Energy, MECL, Water Resource	H	MI	S	RS, PS, CB	ST
5	Life Cycle Analysis of Existing hydro power plant and implementation of R&M measures	Dept of Energy, MECL,	H	MI	S	RS, PS, IP,OM	LT
6	Reduction of AT&C losses	Dept of Energy, MECL,	H	MI, AD	S	RS, PS, IP,OM	MT
7	Facilitating overall village electrification	Dept of Energy, MECL, MNREDA	H	MI	S	RS,PS, DP, IP	ST
8	Implementation of Pilot Energy Efficiency Project and IGEA	Dept of Energy, State nodal department designated under BEE	H	MI	S	RS,PS, DP, IP, PA	ST
9	Promoting Energy Efficiency Practices in the State	Dept of Energy, State nodal department designated under BEE	H	MI	S	PA, CB	MT

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
10	Creating State Energy Conservation fund	Dept of Energy, State nodal department designated under BEE	H	MI	S	PA, IP	ST
11	Maximising harnessing of Renewable Energy for the purpose of Power Generation	Dept of Energy, MNREDA	H	MI	S	RS,PA,PS,DP, IP,CB	MT
12	Maximum and judicious utilisation of renewable energy resources for household energy requirement	Dept of Energy, MNREDA	H	AD	S	RS,PA,PS,DP, IP,CB	ST
13	Facilitating Demand Side Management - Industries - irrigation to reduce peak load demand	Dept of Energy, MECL	L	MI	S	PA,IP	LT
14	Mandating Energy Efficiency and use of Star Rated Equipment	Dept of Energy, State nodal department designated under BEE	L	MI	S	PA	LT

Legend:

Priority: H - High, M - Medium, L - Low; **Type:** MI - Mitigation, AD - Adaptation; **Scale:** S - State-wide, A - Particular / Focused Area

Nature: RS - Research Study, PA - Policy Action, PS - Pre-investment Study, DP - Demonstration Project, IP - Investment Project, CB - Capacity Building, OM - Regular Operation & Maintenance; **Timeframe:** ST - Short-term, MT- Medium Term, LT - Long term

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