STATE ACTION PLAN ON CLIMATE CHANGE (2010 - 15)

MIZORAM

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Government of Mizoram

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1 Introduction

1.1 Description of the state level context; statement of issues and problems

Mizoram is a beautiful state with rich bio-diversity. It is a state of rolling hills with about 21 major hill features running through the state; streams, deep gorges evergreen forests form part of the climate sensitive Himalayan eco-system. The region is also very vulnerable to the impacts of a changing climate and sometimes faces wrath of freak weather events. It also has a very low adaptability due to the socio-economic conditions and bio-physical conditions. The state is heavily forested (>70% of the geographical area) and has got additional incentive due to the conservation efforts. The forests of the region provide life supporting, provisioning, regulating, and cultural 'eco-system' services to millions of local as well as downstream people. The forests are of course highly susceptible not only to anthropogenic activities but also to climate change.

The valleys are hot and wet during summer and in the upper reaches it stays comfortably cool. It has a pleasant climate of 11^0C in winter and 20 to 30^0C. However, the effect of global warming has been experienced here with data showing increase in rise in mean and maximum temperature over the last 10 years. There are also frequent occurrence of violent storms during March and April that come from North-West Direction. Mizoram receives an average rainfall of about 3000mm in a year and this is evenly distributed and it is not drought or flood prone.

A recent report on climate change impact in India highlights that "extreme precipitation events may increase by 5-10 days in all the regions in the Northeast, the rise in temperature with respect to the 1970s ranges from 1.8°C to 2.1°C. Also, the number of rainy days is likely to increase by 1-10 days with intensity of rainfall in the region to increase by 1-6 mm/day. This may cause wide alarm in the region as many parts of the region are prone to landslides and flash floods which are only aggravated by heavy rainfall due to steep gradient. Flash floods leave very little scope for preparedness and also render crop and pastureland useless. In this context, the state climate change action preparation has been initiated. The initiative is supported under MoEF-GiZ partnership programme and facilitated by knowledge partner CTRAN.

1.2 National Priorities and NAPCC

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.

1.2.1 National Missions

On June 30, 2008, Prime Minister 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 core "national missions" running through 2017. The various missions are presented in the following diagram.

These missions converge to address issue relating to adaptation and as well as mitigation actions to contain climate change.

FIGURE 1 NATIONAL ACTION PLAN ON CLIMATE CHANGE

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.

1.2.2 Other Initiatives

Apart from this there have been several initiatives that have positive influence on mitigating the adverse impact of climate change. These include (a) establishment of creation 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. (c) other initiatives like Bio-Diversity Conservation, Wetland Management, Coastal Zone Management, etc.

1.2.3 National Missions and Objectives

1.2.3.1 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 photovoltaics 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 center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

1.2.3.2 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.

1.2.3.3 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;
- 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 efficient vehicles; and

- Incentives for the use of public transportation.

1.2.3.4 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.

1.2.3.5 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.

1.2.3.6 National Mission for a "Green India"

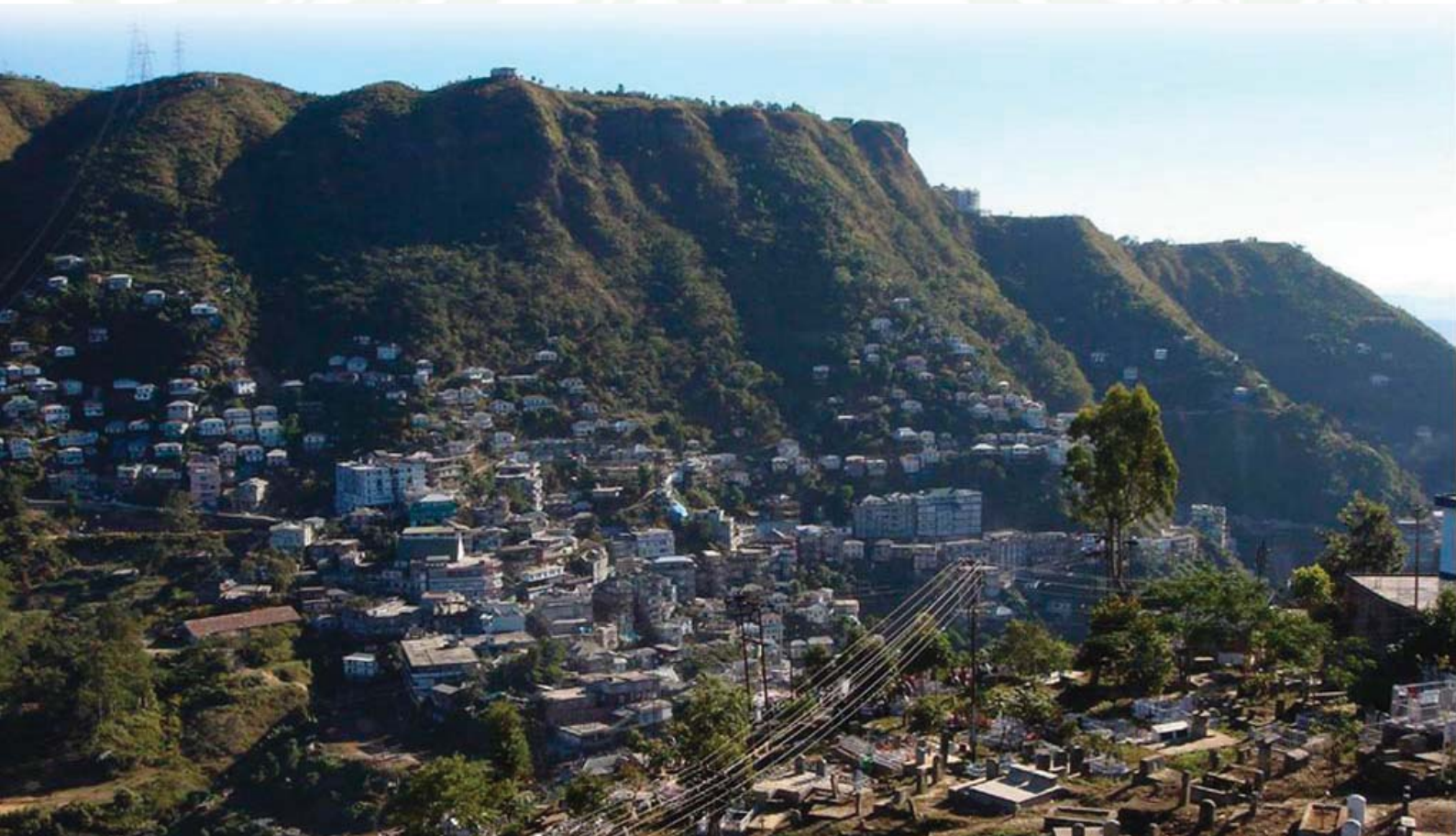
Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

1.2.3.7 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.

1.2.3.8 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 modeling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.



1.3 Mapping state development issues and Priorities with NAPCC

Some of the sectors that have clear relevance with the national missions are mapped below in the following table.

TABLE 1 : KEY SECTORAL ISSUES

S l No	Key Sectors	Issues/Priorities at the sub-national level	National Missions for strategic linkage
1	Agriculture and allied	More than 2/3rd are dependent on agriculture and climate change has significant impact. Require diversification, sustainable land use and pest management as well as input management	Sustainable agriculture mission
2	Energy	The state has a shortage of 50% during peak but a clean generator due to high potential for renewable and hydel power and high percentage of educated people can be made aware about energy conservation	Enhanced Energy Efficiency Mission, National Solar Mission
3	Forest	More than 70% of the state's geographical area is forested. However, The primitive slash and burn method of cultivation, or jhumming, in Mizoram has led to a massive destruction of forests and innumerable forest fires causing loss of human lives.	Green India Mission
4	Health	Vector borne diseases like Malaria is increasing the state and deterioration of the water quality too has a bearing on the health	There is no clear national mission addressing this, however, sustainable habitat, national water mission, rural health mission would address these issues
5	Sustainable Habitat	Rapid urbanisation and pressure on urban infrastructure, energy, water, waste handling and disposal	Sustainable habitat mission
6	Water	Water scarcity is a major issue in most part of the state and has become a major challenge	National Water Mission

The sectotal classification also includes:

- Agriculture (horticulture, animal husbandry, fishery and sericulture, soil water conservation;
- Forestry (includes soil conservation and bio-diversity)
- Habitat includes transport and works, housing and urban development

1.4 Baseline assessments:

The population of Mizoram is 0.89 million according to 2001 census and is scattered over 9 districts, 26 blocks and 817 villages. The State has the density of 42 persons per sq. km. As against decadal growth rate of 21.54% at the national level, the population of the State has grown by 29.18% over the period 1991-2001. The sex ratio of Mizoram at 935 females to 1000 males is higher than the national average of 933. Female literacy of the State rose to 86.13% from 78.6% in 1991.

Mizoram commands a special status in terms of the Constitution of India. Article 371-G of the constitution provides for special safeguards to the religious and social practices and also respects for the customary laws, ownership and transfer of land requires ratification from the state legislature. There are three autonomous district councils (Mara, Lai and Chakma) have been created. This is significant in the context of climate change as issues relating to land use change, forest protection, sustainable cultivation and orderly development would require significant understanding and participation of the local community to make it legally tenable, socially acceptable and a driver of change for balanced growth of the state.

TABLE 2ADMINISTRATIVE SETUP

Description	Unit	Data
Area	Sq Km	21087
Districts	No.	8
Sub-Divisions	No.	23
Blocks	No.	26
Villages	No.	707
Towns	No.	23
City	No.	1
District Councils	No.	3

The state is predominantly agrarian. More than 70 per cent of the population depend on agriculture for their livelihood but low productivity of the sector its high sensitivity to climate remain a matter of concern.

TABLE 3 DEMOGRAPHIC DATA

Description	Unit	Data (2001)
Population	Nos.	888573
Density of Population	Per Sq Km	42
Rural Population	% of Total	50.37
Urban Population	% of Total	49.63
Scheduled Tribes	% of Total	94.46
Total workers to total population	%	52.57
Main workers	% to total	40.79
Marginal	% to total	11.78
Cultivators	% to total	54.90
Agriculture labour	% to total	5.70
Household Industry worker	% to total	1.50

Per capita income of Mizoram is Rs 45,982 (2009-10) which is higher than the national average. More than 60 per cent depend on agriculture and industry is virtually non-existent.

Key socio-economic and ecological predictors for the climate modelling:

TABLE 4 SOCIO-ECONOMIC AND ECOLOGICAL PREDICTORS

Parameters	Mizoram	North-Eastern Region	India
Area in Sq. Km	22,081	2,62,179	32,87,240
Forest area to total area (%)	79%	23.57	23.57
Population in lakh (2001)	8.98	389.84	10,287.37
Literacy Rate % (2001)	88.8	68.5	64.8
Poverty ratio based on MRP consumption (2004-05)[3]	9.5	13.9	23.6

These data can be used for a holistic projection of climate change impact.

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[1] FSI data 2009
[2] INCA report 2010
[3] INCA report 2010

1.5 Past and on-going climate change trends and risks

Due to its geo-climatic condition, the entire state is one of the most hazard prone states in the country. The state is annually swept by cyclonic storms, cloudbursts, hailstorms and landslides. To make matters worse, the State falls under Seismic Zone V, and thus liable to be hit by strong earthquakes. Small tremors are felt every now and then in and around the state. Although the State is enjoying abundance of rainfall during monsoon period, the dry spell during non-monsoon period is really hard for the people. Due to the steepness of the hillsides, underground water retention is minimal, causing perennial water sources to dry up during this period. This had been aggravated by the tradition custom of jhum cultivation, commonly known as slash and burn.The habit of felling trees and foliage of forests and burning them really destroy natural vegetation, thus causing ecological imbalances. Moreover, this usually led to unwanted spread of fire to forests.

A study by remote sensing center in Mizoram that tracks climatic parameters (namely rainfall, temperature and humidity) of Aizawl City for a period of twenty years (1986 . 2005) in Aizawal city has been summarised below. The data were compared and analyzed for two decades taking an average data for 10 years interval as well as 5 years interval to arrive at brief conclusive results on the overall climate change in Mizoram.

1.5.1 Rainfall pattern

Pattern of rainfall in Mizoram during the past 20 years i.e, from 1986 to 2005 follows the usual expected trend in which maximum downpour occurred during the monsoon seasons and declines during the rest of the seasons. However, when analyzed on a yearly basis the trend shows a gradual decline and then a sudden increase from 1990 to 1995. Infact, during the span of the 20 years study period, 1995 recorded the highest rainfall of 3185.98 mm whereas 1994 had the lowest rainfall with a measure of 2278.29 mm only. From here onwards, the trend does not show either a sharp increase or decrease in rainfall.

When analyzed on an average monthly basis per year, the trend shows a gradual increase from January and reaches its peak maximum during July-August and then continues to decrease sharply by the end of the year. Anyway, when taken as a whole the average annual rainfall for the studied 20 years accounts to 2793.67 mm which can be credited to the contribution of downpour recorded during the monsoon seasons. On analysis of the two decades, the monthly average rainfall during 1996-2005 when compared to the previous decade of 1986-1995 shows a gradual increase during the month of March, May, September and then a remarkable increase during the month of July

Thus, it can be interpreted that there is change in the rainfall trend when analyzed and compared between the two decades, but not on an extremely large scale which again shows that this trend can further change the pattern for the consecutive 10 years rainfall data. If this usual small scale change in trend continues, then Mizoram is not expected to experience a sharp decrease in rainfall unless there are other climatic elements that unexpectedly alter the usual trend, which is mostly above the 2000 mm mark.

1.5.2 Temperature

Temperature data has also been analyzed using 20 years temperature data collected and studied for two decades. The average monthly maximum temperature taken during the

decade of 1996-2005 shows an increase over the previous decade of 1986- 1995, during the early part (January-February) as well as later part (November-December) of the years.

However, not much increase is observed during the rest of the months on comparison and the trend is somewhat parallel to each other. However when analyzed on a whole, there has been an increase in the average maximum temperature during 1996-2005 by +0.28^{O}C over the decade of 1986-1995, which denotes a trend in increase in temperature during the last decade. The same increase is also reflected in the average minimum temperature recorded for the decade of 1996-2005 which is +0.30^{O}C, much higher than that recorded for the previous decade of 1986- 1995. The rate of increase is clearly reflected when the overall monthly average temperature recorded for both decades shows an increase of +0.29^{O}C. The overall trend in temperature also shows a gradual increase during the 1996-2005 decade. The increase in temperature as per the data indicates that there might be further rise in the heat wave in the years to come.

1.5.3 Humidity

Humidity is another climatic element that has close relation to temperature and rainfall and also plays a key role in affecting the climate of a region. Average data on humidity for 20 years was collected and analyzed for a period of 5 years each. The results studied for each period clearly indicated that there was a gradual and progressive increase in humidity during the entire span of 20 years. In each of the 5 years period data that was analyzed, the trend seemed to decrease during the month of February but then gradually increased till August where it reached its maximum and then decreased during the end of each year. All the data recorded were within the wide range of +50% to +90% relative humidity, with the highest percentage recorded during June to August.

Taken as a whole, the average relative humidity studied at 5 years interval for a span of 20 years indicated a gradual increase from 73.14% in 1986-1990 to 81.42% in 2001-2005, a marked increase of +8.28% during last two decades.

Data that have been used to study climate change in this context are necessarily simplified representations of the climate system prevailing during 1986-2005. Despite the inevitable limitations, the climate data simulations more or less accurately reproduce the large-scale seasonal distributions of pressure and temperature. In addition, the large-scale structure of precipitation (rainfall) and heat flux (temperature variations) also closely resembles the observed estimates on a global scale (which was +0.3 and +0.6° C during the last 150 years).

Considering all the results obtained from the study, it can be said that the climate parameters studied, have either direct or indirect relation to increased atmospheric concentrations of the principal anthropogenic greenhouse gases (CO2, CH4, N2O, CFCs) which have subsequently increased in significant amount during the last two decades. Elevated concentrations are predicted to persist in the immediate atmosphere for years to come if we do not reduce emissions of greenhouse gases by the end of the next decade. Moreover, the increased atmospheric levels of these gases, especially CO2, increase the IR (Infrared) energy absorbed by the atmosphere, thereby producing a warming influence at the ground level and sub-surface as a result raising the mean temperatures by a few more degrees.

Assessment of Vulnerabilities to Climate Change

2.1 Climate Variability and Climate Change Projections for Mizoram

2.1.1 Current climate variability in Mizoram

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 to variations in natural (e.g. solar and volcanic) and external forcing (external variability).

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

2.1.1.1 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 for modelling. 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.

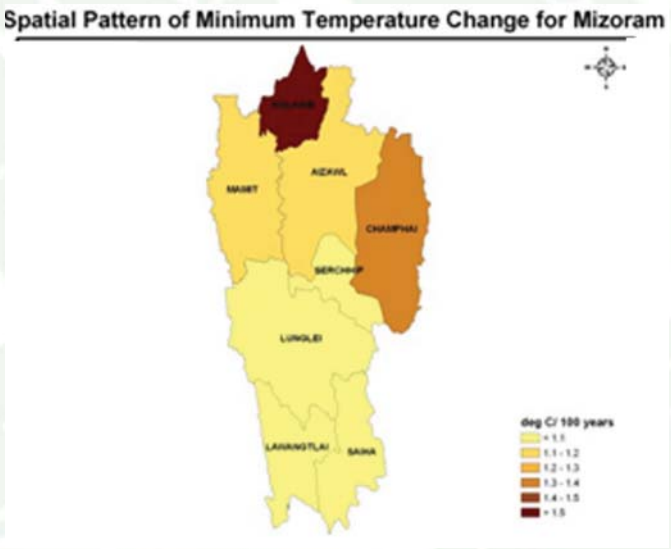
2.1.1.2 Rainfall variability

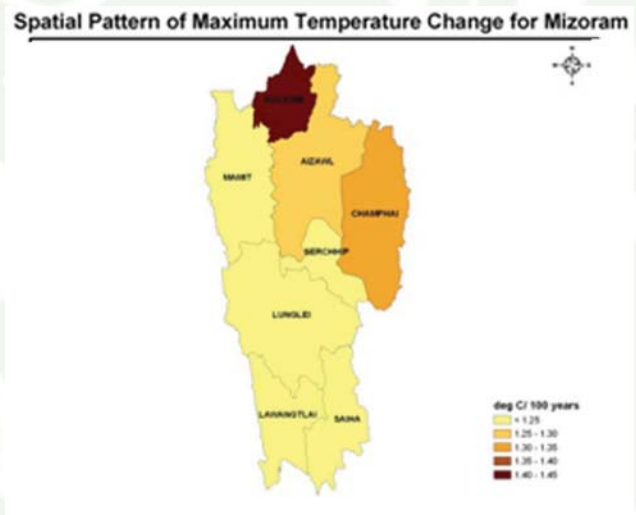
Majority of districts of Mizoram experienced an increase in precipitation in the past 100 years (Figure 2). There are just slight differences between the absolute values of increase in precipitation, the Champhai district observing the highest increase in precipitation over the last 100 years, (⩾13%). The districts of Mamit, Serchhip, Lunglei, Lawngtlai, and Saiha had an increase in precipitation of 3.62 mm/day/100 years. These districts are primarily in the South and the West of Mizoram. Kolasib also observed an increase in precipitation.

FIGURE 2 : DISTRICT-WISE PRECIPITATION TREND (MM/ DAY PER 100 YR) OF SOUTHWEST MONSOON SEASON (JUNE-SEPTEMBER) FOR THE PERIOD 1971-2005.

2.1.1.3 Temperature variability

The analysis of temperature records for Mizoram shows a steady warming trend in both the minimum and maximum temperatures (Figure 2).





The spatial pattern of minimum temperature trend (Figure 3-left panel) shows an increase all over the region.

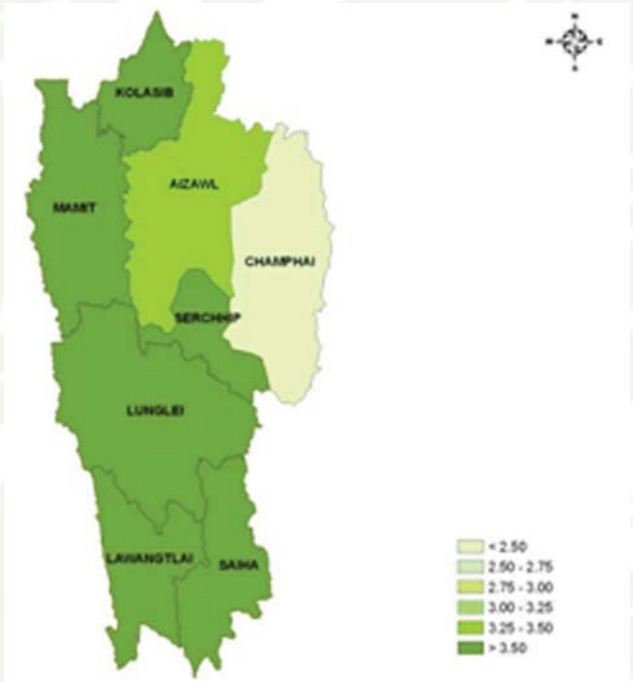
The minimum temperature trend (Figure 3-left panel) indicates an increase of ≥ 1.5°C in Kolasib which is located in the northern-most tip of the state. The districts in the northern part of the state show a higher increase in minimum temperature than the southern districts.

The maximum temperature trend (Figure 3-right panel) shows an increase in of ≥ 1.2°C in all the districts, with northern districts exhibiting a higher increase in maximum temperature.

Overall, the minimum temperature trend is higher in absolute terms than the maximum temperature trend.

2.1.2 Projected changes in rainfall

Figure 4 shows the projected change in total annual rainfall and for the southwest monsoon season (June, July, August and September months abbreviated as or JJAS).



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:

The entire state of Mizoram is projected to receive an increase in precipitation.

- The southern and western districts of Mizoram are projected to obtain higher rainfall.
- The northern-most tip of the state, Kolasib is also projected to receive an increase in precipitation of more than 10%.

2.1.3 District-wise projection of extreme events in precipitation

An increase in the number of extreme rainfall days is projected for the state.

- The eastern part of the state, Champhai, Serchhip and Saiha observed more than 1 day of extreme precipitation (Table 5).
- The Northern and Western part of the state, Kolasib, Aizawl, Mamit, Lunglei and Lawngtlai exhibited an increase in extreme event of at least 1 day more

TABLE 5 : DISTRICT-WISE CHANGE IN THE NUMBER OF DAYS (IN A YEAR, ON AN AVERAGE) WHEN THE RAINFALL EXCEEDS 100 MM PER DAY FOR MIZORAM

S. No.	District	Annual increase in extreme event days
1	Champhai, Saiha, Serchhip	1.0 – 2.0
2	Mamit, Aizawl, Lawngtlai, Lunglei, Kolasib	0.0 – 1.0

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

2.2 Future climate projections for Mizoram

2.2.1 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 (see 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. CO2, CH4, N2O, 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.

2.2.2 Projected increase in average temperature

Figure 5 shows the projected increase in average temperature in the state by mid 2030's.

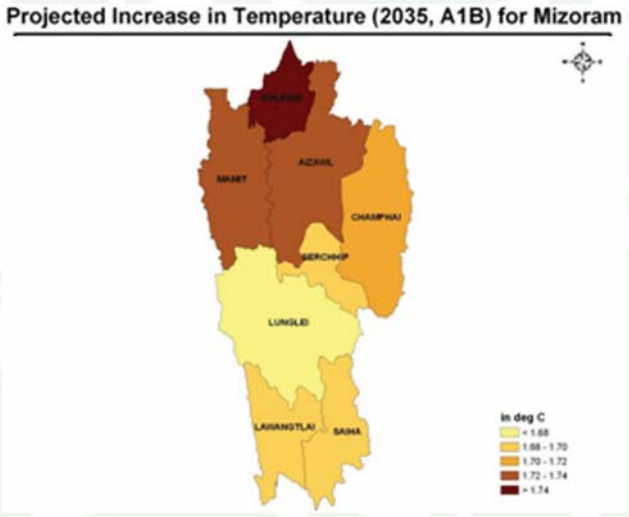


FIGURE 5DISTRICT-WISE PROJECTED INCREASE IN ANNUAL AVERAGE TEMPERATURE (°C) FOR THE PERIOD 2021-2050 (A1B SRES SCENARIO) COMPARED TO BASELINE (1975), PROJECTED BY THE HADRM3 MODEL. THE SOLID BLACK LINES SHOW THE DISTRICT BOUNDARIES.

We note that:

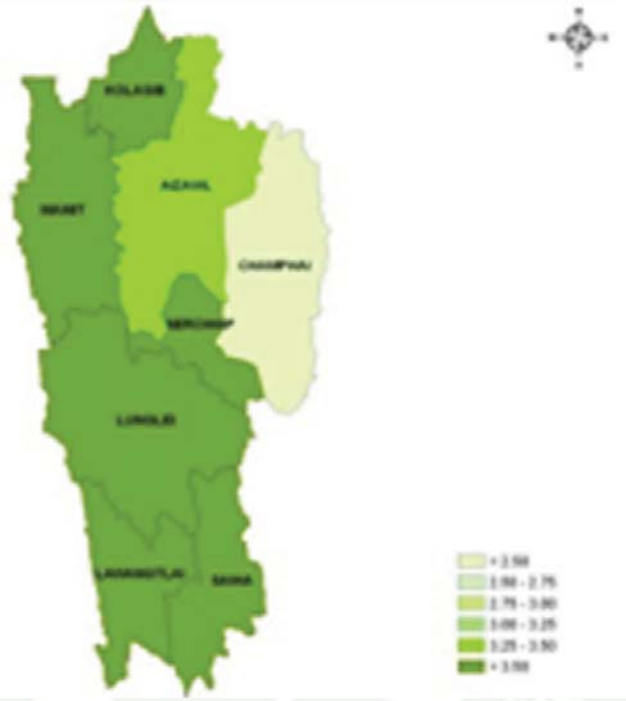
The state is projected to experience an increase in temperature above 1.6°C and lesser than 1.75°C.

The projected increase for annual average temperatures for the northern most district of Kolasib is highest.

The southern districts are predicted to have a lesser increase in average temperature than the northern districts.

2.2.3 Projected changes in rainfall

Figure 6 : shows the projected change in total annual rainfall and for the southwest monsoon season (June, July, August and September months abbreviated as or JJAS).



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2.3 Assessment of the physical and economic impact of and vulnerability to climate change

2.3.1 Sectoral Vulnerability: Agriculture

2.3.1.1 Impact of climate change on crop yield

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 impacts on rice production. It can be used for a variety of applications at field, farm and regional levels. The various inputs required by the model include information on rice variety sown, location, soil type, type of sowing, irrigation, fertilizer application, climate data, pest type and diseases. Two model runs were performed-the first simulation called "baseline" using climate data averaged over the period 1975-2005 and fixed CO2 concentration at 370 ppm and the second simulation incorporating changes in precipitation and temperature for 2035 and with a CO2 concentration of 466 ppm.

Figure 7 shows the district-wise impacts of climate change on rice yield in Mizoram. It is observed that there will be a reduction in rice yield by 2035 in the 5 districts of Mizoram. The district Mamit, on the western region of the state is projected to experience a decrease of 5% in rice yield, while the districts of Lunglei, Aizawl and Kolasib are projected to experience a decrease of 8% rice yield. The results represent the output of only one crop model. Different crop models give different outputs depending on the input parameters used.

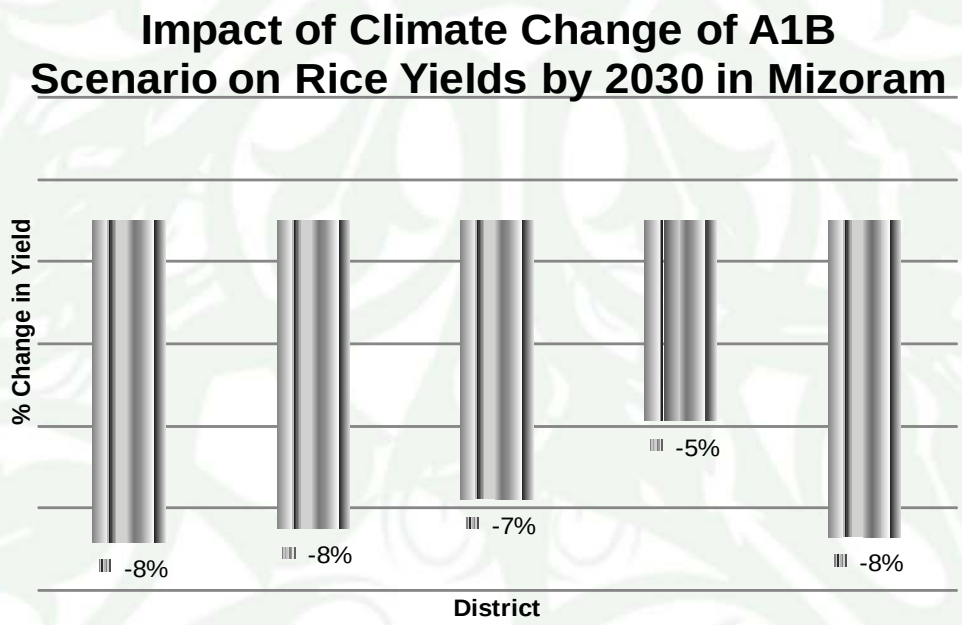


FIGURE 7IMPACT OF CLIMATE CHANGE OF A1B SCENARIO ON RICE YIELDS BY 2030S (% CHANGE IN PROJECTED RICE YIELD OVER CURRENT YIELD)

2.3.1.2 Agricultural vulnerability profile

Agricultural vulnerability assessment is an important pre-requisite for undertaking any planning work or developmental projects 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 rainfed 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 future 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 8 shows the district-wise agricultural vulnerability profile of Mizoram for baseline as well as A1B scenario.

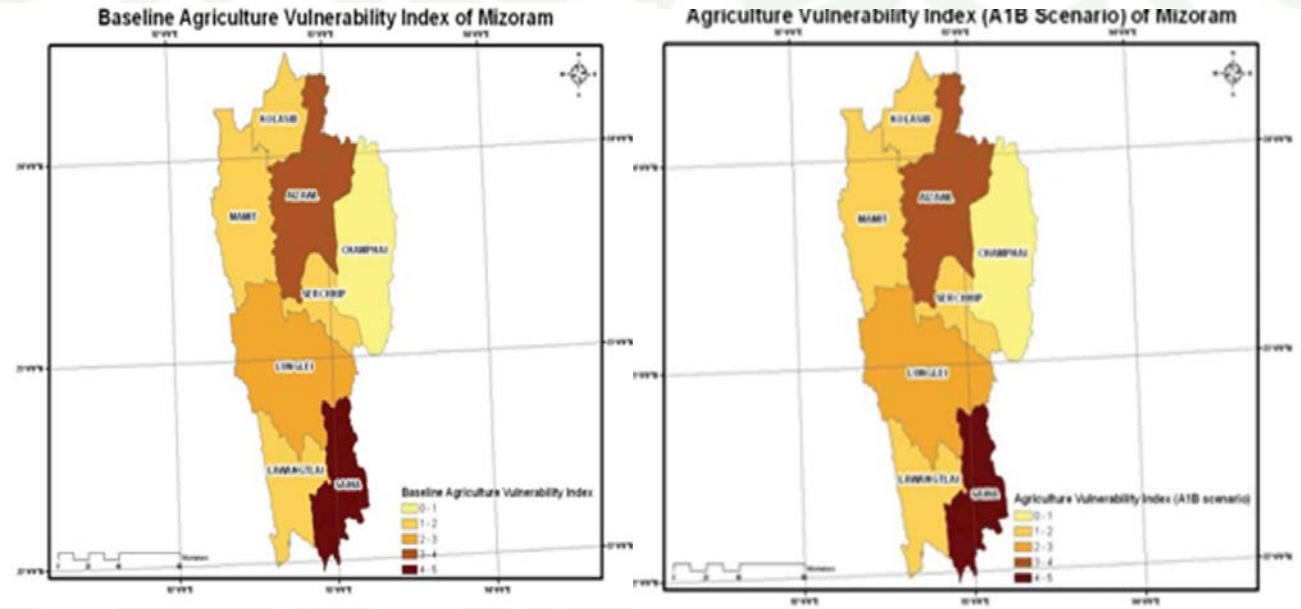


FIGURE No: 8

FIGURE 8 DISTRICT WISE AGRICULTURAL VULNERABILITY PROFILE OF MIZORAM FOR BASELINE AND A1B SCENARIO (WHERE 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)

2.3.2 Sectoral Vulnerability: Forest

2.3.2.1 Impact of climate change on forests of Mizoram

Methods and models: An assessment of the impact of projected climate change on forest ecosystems in Mizoram 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) period.

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.

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 50kmx50km). In Mizoram no change in the forest types is projected for the short term period of 2030s. Thus the forest types in Mizoram are not projected to be impacted by climate change in the short term.

2.3.2.2 Forest vulnerability profile of Mizoram

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. Figure 10 shows the forest vulnerability profile of Mizoram for future climate scenario.

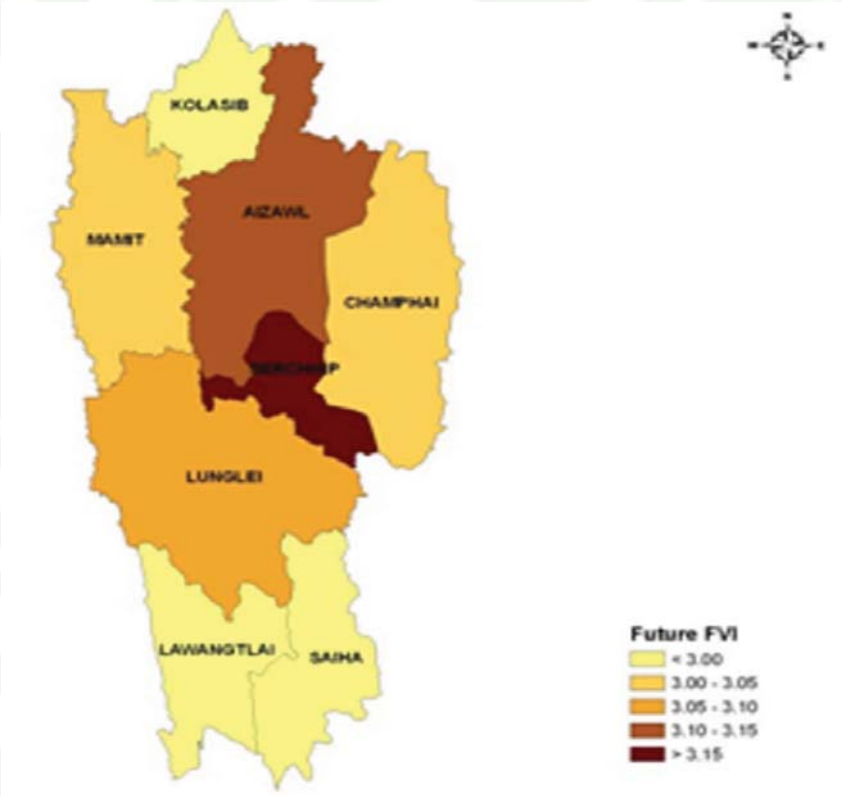


FIGURE 9: DISTRICT-WISE REPRESENTATION OF THE AREA THAT IS PROJECTED TO UNDERGO CHANGE IN VEGETATION TYPE BY 2021-2050 IN MIZORAM

Based on the CFVI, it was found that the forests of the following districts of Mizoram have high CFVI (have high to moderate vulnerability): Serchhip, Aizawland Lunglei.

2.3.3 Sectoral Vulnerability: Health

According to World Health Organisation (WHO) estimates, by 2020 we are likely to loose about 3,00,000 lives and 11 million years of healthy life due to global warming. Changes in temperature patterns will disturb many natural ecosystems. Frequent floods and droughts will cause shortage of food in many developing countries causing several million deaths due to malnutrition and starvation. Weather disasters end up in causing overcrowding in resettlement areas, which are poorly planned with poor sanitation.

The second IPCC report mentioned that the impacts of climate change will fall disproportionally upon developing countries and the poor thereby exacerbating inequities in health status and access to adequate food, sanitation and clean water. World Health Report 2002 estimated that 2.4% of world wide diarrhoea and 6% of malaria in 2000 was because of climate change.

Higher/erratic precipitation leads to water logging, especially with highways and urban expansion blocking natural drainage systems causing breakdown of sanitation systems and displacement will also trigger risk of various infections. Changes in the water cycle may cause an increase in water borne diseases such as cholera, hepatitis, plague (Yersenia Pestsis), leptospirosis, Hanta virus pulmonary syndrome, tick borne encephalitis, plague.

Sumana Bhattacharya et al., concludes that malaria is likely to persist in Orissa, West Bengal and southern parts of Assam, bordering north of West Bengal. However, it may shift from the central Indian region to the south western coastal states of Maharashtra, Karnataka and Kerala. Also the northern states, including Himachal Pradesh and Arunachal Pradesh, Nagaland, Manipur and Mizoram in the northeast may become malaria prone.

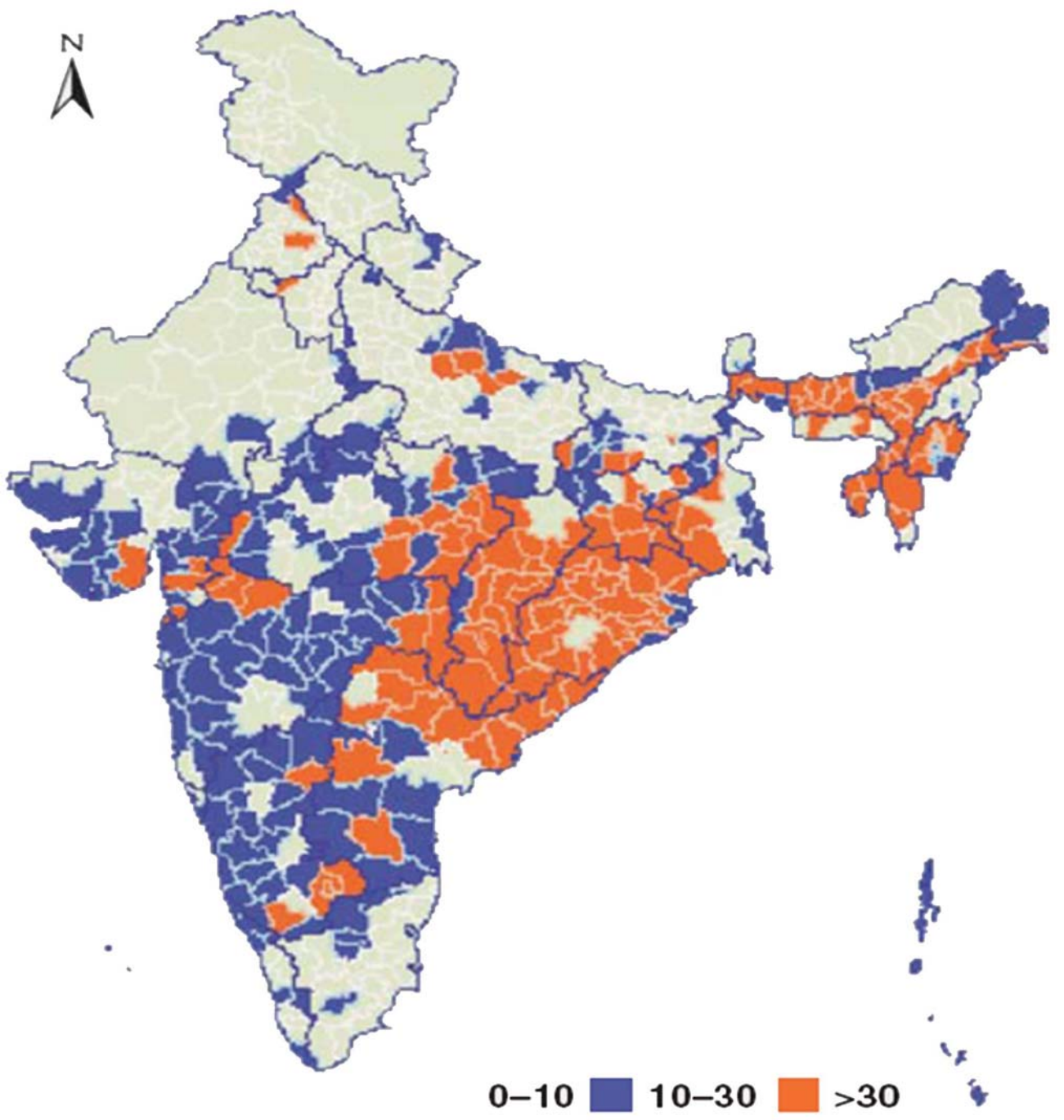


FIGURE 10: PLASMODIUM FALCIPARUM PROPORTION DISTRIBUTION IN INDIA. HIGH PROPORTION OF P. FALCIPARUM UP TO 90% IS SEEN IN ZONES INHABITED BY ETHNIC TRIBES IN FOREST ECOSYSTEMS WHERE STABLE MALARIA CONDITIONS OCCUR

The Mizoram state health department has said that some 199 people succumbed to malaria in the state in 2009. This figure has jumped up from 91 deaths in 2008. The report also said that 9,399 blood samples were found to be positive out of the 1,71,793 people, who had their blood samples tested during last year[4].

In 1974, chloroquinine resistant species of parasite was detected in Mizoram.

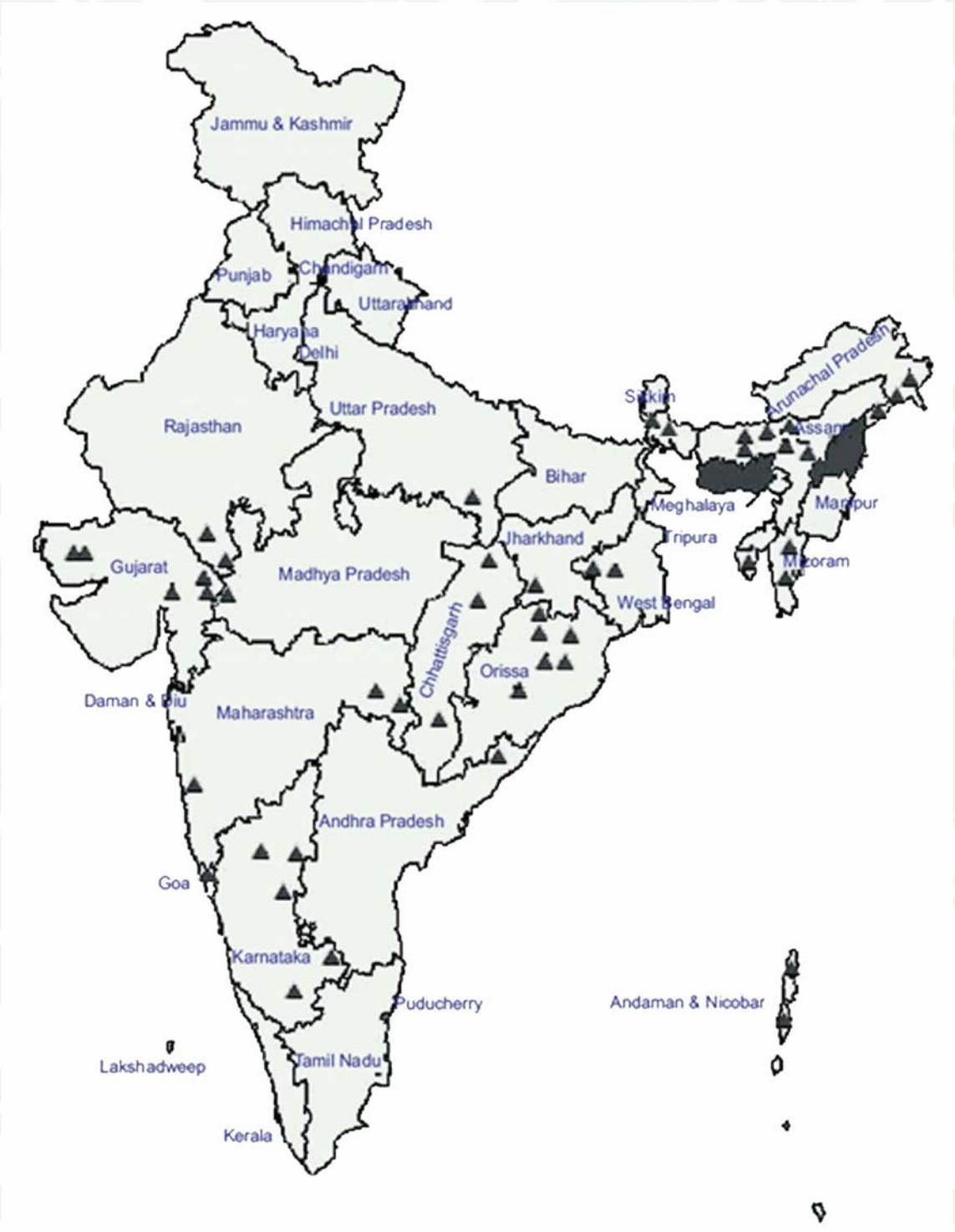


FIGURE 11: AREAS SHOWN IN GREY (TRIANGLES AND PATCHES) WHERE CHLOROQUINE RESISTANCE IN P. FALCIPARUM HAS BEEN CONFIRMED QUALIFYING FOR USE OF SECOND LINE DRUG SP

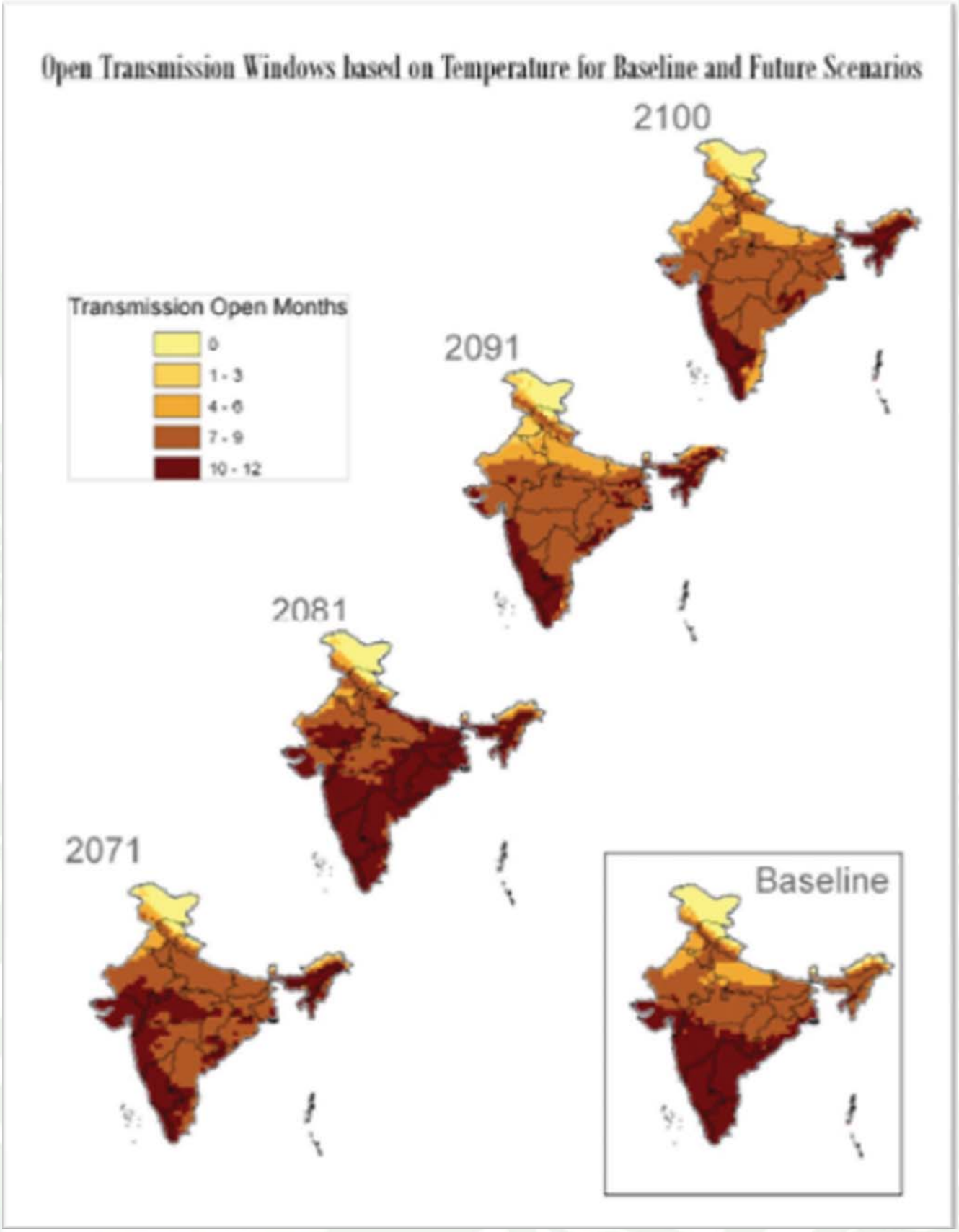


FIGURE 12PROJECTION OF MALARIA FROM BASELINE (DHIMAN ET.AL)

In 3-9 months Transmission Window (TW) open categories, appreciable increase in months of TWs is expected leading towards stable malaria. In baseline 128 pixels show NO transmission which may reduce to 90 pixels by 2091 Baseline TWs in 10-12 months(546) are likely to be reduced to 322 by the year 2091.

However, apart from Malaria there is reported deterioration of water quality in the state which is likely to increase water-borne diseases.

2.3.4 Sectoral Vulnerability: Habitat

Cities disproportionately contribute to climate change – e.g. although 50% of the global population resides in cities, they contribute 80% of global greenhouse gas emissions – and also have the most at stake in terms of people and assets at risk from climate impacts. Climate Change (CC) exacerbates the frequency and intensity of hydro-meteorological disasters and CC can add new disaster risks. The cities having significant concentration of human resources due to in-migration enhance the exposure and also the vulnerability.

Urban India is the major driving force of the country's economic growth contributing to more than 60% of the GDP. It is estimated that by 2030, urban India could generate 70% of net new jobs and contribute to more than 70% of the Indian GDP. India has experienced rapid increase in urban population in the past few decades. According to Census of India, the urban population of India has increased from 25 million in 1901 to 286 million in 2001. This growth has been more pronounced after the 80's and it is estimated that by 2050 half the Indian population will live in cities.

One of the key challenges in urban India is to cater to the infrastructure needs such as solid waste management, transportation, water supply and sewerage of the ever-increasing population which calls for huge investments in this sector. The XI Five Year Plan of India (2007-2012), foresees that the total fund requirements for implementation of the Plan target in respect to transportation, urban water supply, sewerage and sanitation, drainage and solid waste management is about 2.6 Trillion INR (~ 43 Billion Euro). On the other hand till

today Urban Local Bodies (ULBs) in India usually do not have financial and technical abilities to plan for, implement, operate and maintain improved infrastructure facilities, inspite of the fact that according to 74th amendment to the constitution all these responsibilities should rest with the ULBs.

In North Eastern region DRM includes seismic activity while CC also addresses gradual average changes in Climate both pre and post seismic activity. DRM and CC adaptation greatly overlap and can strategically reinforce each other.

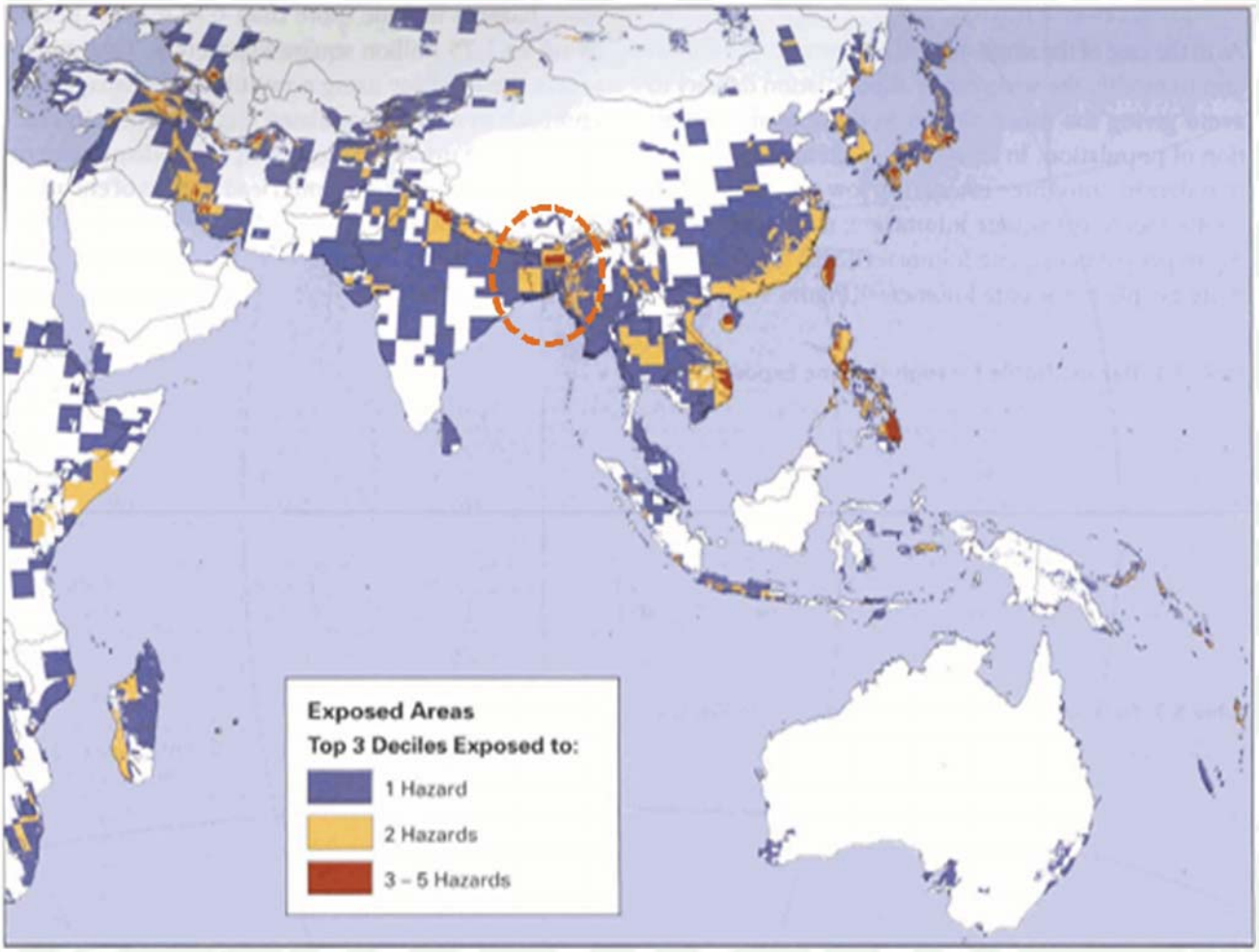


FIGURE 13 : MULTI-HAZARD ZONES

Many of the cities in Mizoram where the urban-rural divide is largely reducing are facing resource constraint or congestion due to migration.

2.3.5 Sectoral Vulnerability: Water

2.3.5.1 Impacts of climate change on water sector

The SWAT model for Barak basin has been run using PRECIS GHG climate scenarios for near and long term (2021–2050, 2071-2098, 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 7.

TABLE 7 TREND IN WATER BALANCE FOR BASELINE, NEAR TERM AND LONG TERM CLIMATE SCENARIOS (IPCC SRES A1B) FOR BARAK BASIN

Scenario	Rainfall mm	Change over baseline %	Water yield mm	Changeover baseline %	Actual evapotranspiration mm	Change over baseline %
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

- The increase in precipitation is about 13.4 and 25.5% in near-term and long–term scenarios, respectively in the Barak basin.
- An increase in water yield by 16.4 and 29.8% in the near and long-term scenario.
- 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 is that crops may face water stress.

2.3.5.2 Water Vulnerability Profile

- Method: Index-based method, weighted aggregation of indicators
- Indicators Chosen: Water Availability, Evapotranspiration, Drought, Flood
- Vulnerability Profile Ranking: District-wise, results in Table 3 and Figure 8.
- Results: In the current condition, the districts of Aizawl, Kolasib, Lawngtlai and Mamit exhibit high vulnerabilities. The districts of north Mizoram such as Aizawl, Kolasib and Mamit exhibit high vulnerability, along with Lawngtlai which is in south Mizoram. The rest of the districts such as Champhai, Lunglei, Saiha and Serchip exhibit moderate vulnerability in the current scenario. There are no districts that exhibit low vulnerability in Mizoram.

In the short-term A1B scenario, 2020-2050, the water vulnerability is reduced in all the districts (Figure 8). The districts of Aizawl and Lawngtlai experience a reduction in water vulnerability from high to low. The Kolasib and Mamit districts experience a reduction in water vulnerability from high to moderate. The districts of Champhai and Lunglei experience a water vulnerability reduction from moderate to low. The districts of Saiha and Serchip experience a reduction in water vulnerability from moderate to very low.

TABLE 8 : WATER VULNERABILITY PROFILES OF MIZORAM – CURRENT AND 2050 PROJECTIONS

District	*Water*	*Vulnerability Index*
	Baseline	Near-term (Mid-century)
Aizawl	4	2
Champhai	3	2
Kolasib	4	3
Lawngtlai	4	2
Lunglei	3	2
Mamit	4	3
Saiha	3	1
Serchip	3	1

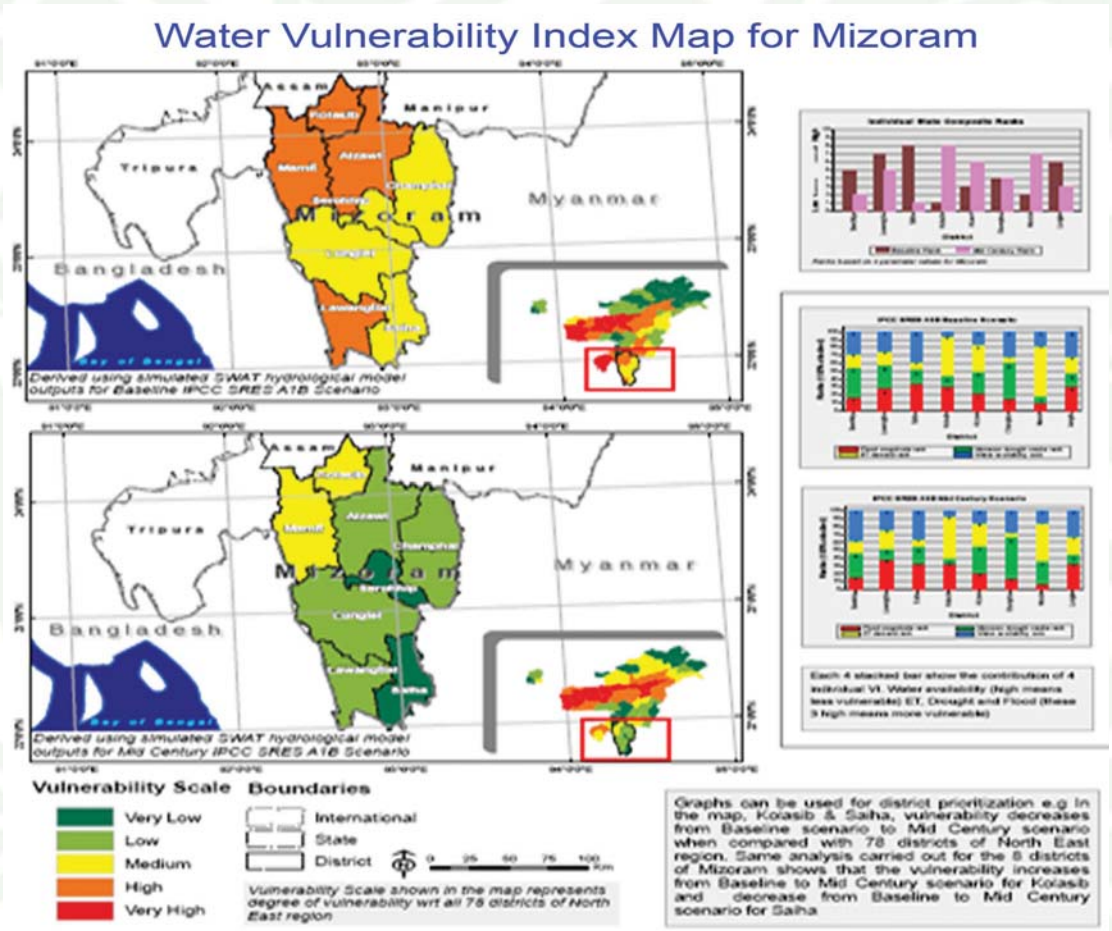


FIGURE 14: SPATIAL DISTRIBUTION OF DISTRICTS OF MIZORAM ACCORDING TO VULNERABILITY INDEX UNDER MODEL (A1B SCENARIO) DERIVED CURRENT CLIMATE (BASELINE) AND CLIMATE CHANGE (A1B SCENARIO) FOR MID CENTURY

2.4 Assessment of impact of and vulnerability to climate change on vulnerable groups

2.4.1 Demographic factors

Mizoram is rich in natural resources, yet it lacks in socio-economic development. As per the Census 2011 has recorded as 1091014 consisting of 552339 males and 538675 female. With this population Mizoram contributes 0.09 percent to the total population of the country and in terms of population its rank is 29th among all states and union territories of the nation According to Government of Mizoram figure, number of families who are lying Below Poverty Line/Level (BPL) who are in object poverty = 56.07 per cent. According to Government of India figure BPL in Mizoram = 25.66 per cent. While it is not important to go into merits of these figures the gap between rich and poor is very high. The population density of Mizoram at 2011 Census is 52 persons per sq. km against 42 persons per sq km recorded during 2001. It reveals that, in this hilly state, the population pressure on one square km of area has increased by 10 persons during last 10 years. Among all 8 districts, Aizawl district occupied highest density of population with 113 persons per sq km which is 22 persons more than the figure recorded during 2001 (i.e. 91 persons per sq km). Low population density makes difficult for the government machinery to reach the vulnerable population.

As per provisional figures, the state has recorded its overall literacy as 91.58 percent which is 2.78 percent point higher than that of recorded during 2001.As per provisional figures, the state has recorded its overall literacy as91.58 percent which is 2.78 percent point higher than that of recorded during2001. This is a positive sign and reduces the vulnerability as the awareness generation would be relatively easy.

2.4.2 Social Structure

Vast majority of the population are scheduled tribe – the percentage being 94.50. More than 50% of the total population live in over 700 villages. They have high level of dependency on the natural resources and hence are vulnerable to climate change.

2.4.3 SectoralWok-force

The State's economy is pre-dominantly agricultural with more than 60% of the total work force engaged either directly or indirectly in agriculture. However, agriculture still remains under-developed and the primitive method of jhum (shifting cultivation) predominates. Both production and productivity are relatively low. Jhum burning accounts for a very high percentage of green house gas emissions when every year almost 2 lakh acres of land in rain forest are cut down and burnt.There are still about 1 lakh jhumia families in the state. Considering the sensitivity of the sector to climate change, vast majority are vulnerable as the scope of diversification is currently limited.

The state Government has planned a New Land Use Policy through which the families will be given inputs on sustainable livelihood diversification opportunity. Under the NLUP family oriented programmes will be prepared for every jhumia family in a wide range of sectors. On an average 7 acres of land will be allotted to one family for agriculture, horticulture and allied activities. Thus only about 12 % of the tatal land area in Mizoram will be required/utilized.All the workforce hitherto engaged in jhuming will henceforth be employed in sustainable economic venture to create productive assets for each family. Projects will be prepared for each family to enable him to increase productivity at least 5 times from the level under the jhum system.

2.4.4 Human Development in Mizoram

The figure below gives a comparative picture of human development in the North East Region. It also shows that Mizoarm is not doing badly in this front and thus the people in the state are relatively better equipped to understand the adverse effect of climate change and can even cope with it.

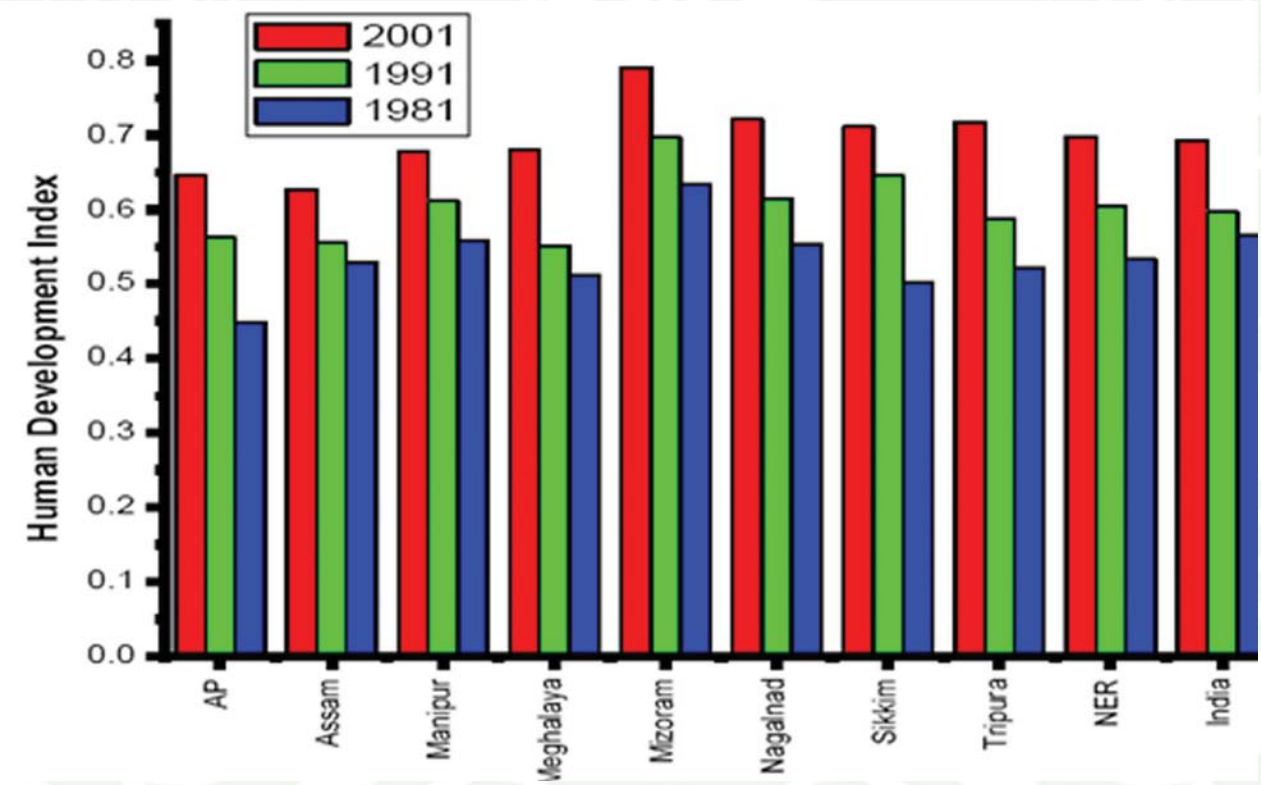


FIGURE 15 : THE EXTENT OF HUMAN DEVELOPMENT IN NORTH EASTERN REGION (PRADHAN ET.AL, 2011)

Mizoram state is vulnerable to impact of tropical cyclone which develops in North Indian Ocean (Bay of Bengal) and the cyclones of the post monsoon season (October to December) are more intense than those of pre monsoon season (April & May).Cyclone are associated with strong winds, torrential rains and storms. The impact of cyclone/windstorm and hailstorm has often led to damages to houses, power line cut-off, blockage of road, damage to crops and plantation, loss of live stocks, etc. Therefore, the poor suffers the most. Further damage to the infrastructure, creates pressure on the state economy and workforce.

Part B :

Climate Change Strategy

3 Formulation of SAPCC

3.1 Objective of SAPCC

The main objective of Climate Change Action Plan is to strategize adaptation and mitigation initiative towards emission stabilization and enhance the resilience of the ecosystem.

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 climates resilient.

3.2 Methodology

Government of Mizoram has taken the climate change issue very seriously. A detailed roadmap has been chalked out to develop the climate change action plan for the state.

3.2.1 Institutional Framework

Climate Change Council of Mizoram will coordinate state action plan for assessment, adaptation and mitigation of climate change. The composition of the Council on Climate Change is as follows:

S l No	Designation	Position in Council
1	Hon'ble Chief Minister, Chairman	Chairman
2	Hon'ble Minister, Rural Development	Member
3	Hon'ble Minister, Agriculture, etc.	Member
4	Hon'ble Minister, PHE, Tourism, etc.	Member
5	Hon'ble Minister, Transport, etc.	Member
6	Hon'ble Minister, Revenue	Member
7	Hon'ble Minister, Forests	Member
8	Vice Chairman, State Planning Board	Member
9	Chief Secretary, Govt, of Mizoram	Member
10	Principal Secy, PHE, Agri, etc.	Member
11	Secretary, Environment & Forests	Member
12	Secretary, Tourism	Member
13	Secretary, R.D.	Member
14	Secretary, Horticulture	Member
15	Principal Secy, Planning &Prog. Implemtn.	M e m b e r Secretary

Objective:The overall objective of the Council would be to monitor the targets, objectives an.-' achievements of the national missions specified by National Action Plan on Climate Change (NAPCC). The respective missions shall be taken care of and attended to by the individual departments who shall strive to attain the listed objectives within stipulated time frames and ensure their vertical integration with the National Mission.

The operating arm of the climate change council shall be the executive council. The composition of the council shall be as follows:

S l No	Designation	Position in the Council
1	Chief Secretary, Govt, of Mizoram	Chairman
2	Principal Secy, Planning &Prog. Implmtn.	Member
3	Principal" Secretary, PHE, Agri, etc	Member
4	Principal Chief Conservator of Forests	Member
5	Secretary, Rural Development	Member
6	Secretary, Horticulture	Member
7	Secretary, Tourism	Member
8	Principal Adviser Planning	Member
9	Principal Scientific Officer, Sc& Tech. Wing, Pig	M e m b e r secretary

Objective:The objective of the executive Council will be to monitor the directions and other related matters of the Climate Change Council.

3.2.2 Roadmap for the development of the climate change action plan

Required institutional arrangement has been put in place for the co-ordination of the preparation of the climate change action plan with the support from GiZ and CTRAN consulting acting as the knowledge partner.

The following process will be followed:

FIGURE 16 WAY FORWARD FOR THE PREPARATION OF THE CLIMATE CHANGE ACTION PLAN

3.2.3 Process of Prioritisation of the options

Adaptation and mitigation options will be generated within the working groups and prioritised. This will be based on the state specific barriers. The prioritisation framework has been given below:

3.2.3.1 Generating the options

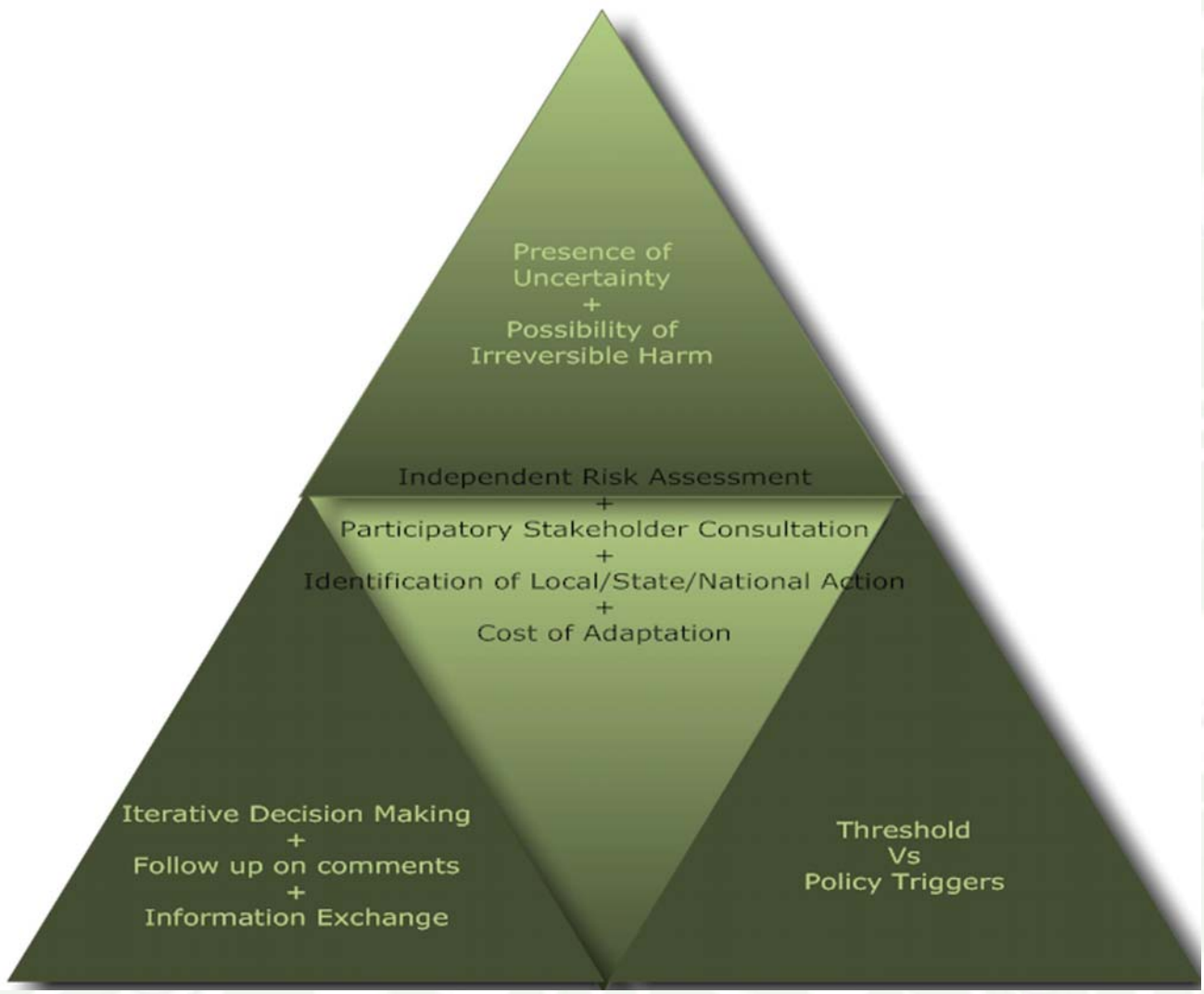


FIGURE 17 GENERATION OF OPTIONS

While generating the options it will be seen that, there is no strategic disconnect with the national policy with respect to stated positions, no further need to reinvent the wheel and also proposing workable approaches without having extra-emphasis on theoretical issues. The process will be participative and inclusive.

3.2.3.2 Prioritisation Framework

The process of prioritisation shall be as below:

Prioritisation of Sectoral Issues

This will give basket of options sectorally and also can later be linked to budgetary and extra-budgetary resources.

3.2.3.3 Enabling framework

A low carbon development requires an enabling policy and institutional framework. This has been given below.

Incentives	Rationalize energy, water and agricultural policies to Create incentives
Regulations	Efficiency Standards, codes, zoning; climate screening/ proofing of investments
Institutions	Capacity of public, private and financial sector institutions to assess and act on climate risks
Markets	Improve investment climate; deepen financial and capital markets; new markets (cap & trade, CDM)
Public Outreach	Education, raising awareness and promoting change in Behavior of the community and preferences

FIGURE 19 TOOLS TO DEVELOP AN ENABLING FRAMEWORK FOR CCAP

This tool will be used to analyse and develop a plan for carbon conscious development strategy for the state.

Sectoral Overview

4.1 Agriculture

The State's economy is predominantly agricultural, with more than 60% of the total work force engaged either directly or indirectly in agriculture, only 5% of the total area is under cultivation and about 11% of the total cultivated area is under irrigation. However, agriculture still remains under-developed and the primitive method of jhum (shifting cultivation) predominates. Both production and productivity are relatively low. As per the Agriculture Census (1995-96-the latest census), there were 65,919 operational holdings with a total operated area of 85,000 hectares. Out of 13 the total number of holdings 42.04% is marginal 39.0% small, 17.83% semi medium 1 .11% medium and 0.01% large holdings. Small holdings make adaptation planning far more complicated as compared to the larger ones.

Mizoram enjoys wonderful blend of climatic conditions of tropical, sub-tropical and temperate zone climates and the hill ranges run in North – south direction with varying altitude with an average height of 920m above sea level, coupled with high mean annual rainfall of 2500 mm and high relative humidity upto 90%. The soils are loamy to clay, rich in organic carbon and moderately rich in available potash. The temperature during summer season varies from 200C to 340C and during the winter season varies from 80C to 170C. Due to high rainfall during May to September the soil is Acidic ranging from 4.5-5.6 pH.In Mizoram, due to limited availability of irrigation, agriculture is entirely dependent on the rainwater from the driving monsoon downpours. The unfavorable physical conditions do not facilitate irrigation. The uneven terrains in Mizoram are not encouraging to the cultivation of crops, the distribution of rainfall that varies between 1900 mm and 3000 mm and the fertile temperate soil smooth the progress of extensive jhum cultivation. This primeval practice of Jhum cultivation is carried out by a large number of people living in rural areas of Mizoram.A number of crops like paddy, beans, cucumber, maize, arum, sesame, mustard and cotton are grown by practicing jhum or shifting cultivation.

4.1.1 Key Facts about agriculture in Mizoram

In Mizoram, Paddy is one of the most important crops, and after the completion of the of paddyharvesting, the seeds of the other crops are sown. Paddy occupies almost 50% of the total cropped area and more than 88% of the total area under food grains. The sowing commences from the end of April, close to the occurrence of the full moon. In Mizoram, two types of paddy are sown: 1) early paddy (short duration) and 2) principal paddy (long duration). The two crops are grown side by side in the same field. Although, the initial production of early paddy is poor, it ripens quickly and is a means of subsistence till

the verdant golden crop of principal paddy is collected. Besides agriculture, the cultivation of crops like sugarcane, cotton, tapioca, oilseeds, mustard, sesame, soybean and pulses like cowpea, French and rice beans also contribute towards the economy of Mizoram. Horticulture also adds substantially to the state's economy.

TABLE 9 AREA AND PRODUCTION OF IMPORTANT CROPS OF MIZORAM

Name of crop	2003-04		2004-05		2005-06		2006-07		2007-08	
	Area (ha)	Production (MT)	Area (ha)	Production (MT)	Area (ha)	Production (MT)	Area (ha)	Production (MT)	Area (ha)	Production (MT)
Paddy	59196	114630	57085	107661	55754	99021	52847	42091	54541	15688
Maize	10481	20282	10505	19788	11742	22703	10775	20969	7328	729
Pulses	4892	4313	6741	7971	2972	2737	5054	5833	5048	2632
Oil seeds	7532	5478	5817	5321	4816	5429	4075	3755	3755	748
Sugarcane	1393	36174	1357	13565	1383	45953	1340	12187	12187	826

Source: Statistical handbook, Mizoram 2008

Since the use of fertilizer and pesticides in agriculture and horticulture fields is almost non-existing in Mizoram, so the agricultural and horticultural products are mostly organic, and the products have very high value in the national and international product market.To motivate and encourage the organicfarmers, and also to arouse awareness, 2 Nos. of Market Outlet have been established atAizawl and Dartlang.

Agro-climatic conditions in Mizoram are found to be very much suitable for growing a wide range of horticulture crops covering fruits, vegetables, ornamental crops, plantation and spice cropsAbout 1600 Hectare has been covered for fruit plantation with the total yield of about 75,000 MT. The major fruit crops are, Orange, Pineapple, Passion Fruit, Banana, Mango, Papaya, Guava, jack fruit, Grapes, Pear, Litchi and Apple. The major vegetables grown in Mizoram are tomato, brinjal, beans, peas, squash, mustard, cabbage, etc. Among tuber crops, potato, sweet potato and colacasia are major ones grown. The climate in the State is suitable for the cultivation of spices. Ginger, turmeric, chilly, pepper, cinnamon and large cardamom grow very well in the State. At present ginger, turmeric and chillies are commonly cultivated.

The population of cross bred cattle have increased by 16.60% while the population of indigenous cattle also increased by 3.88% during the interval between the 16th and the 17th Census. The buffalo and goat population have increased by 6.84 % and 5.88 % respectively, showing that growth in this type of livestock is very small. Mithun population has increased by 33.00 % and pig population by 33.09 %. Pig is by far the most populous and popular livestock in Mizoram and shows the highest percentage of growth in its population, and while the cross bred population make up for 90 % of the total population, the indigenous pig accounts for only 10 % of the total population. It can be further seen that compared to the last census, there is a 44.00 % decrease in the indigenous population of pigs.

The Mizo tribes of north east India developed and practiced different types of fishing methods since time immemorial. The people of Mizoram used locally available materials and apply indigenous ideas and skills (indigenous technical knowledge, ITK) for fishing. Various fishing techniques depend

on various behavioural pattern and microhabitat type of fishes. 13 species of plants and plant products are used for fishing.

4.1.2 Key Issues

In the last two decades significant changes in the climatic variables have been seen due to increasing nature of anthropogenic activities in Mizoram. It is estimated that an average area of 2.00 lakh acres of forest cover are annually destroyed by slashing and burning of trees for Jhum land in Mizoram. 3.50 lakhs hectares are still utilized for the devastating and unproductive jhumming (Shifting) cultivation of Paddy. This deforestation is due mainly to the change in land use in which shifting cultivation or jhum cultivation is at the centre. Mizoram has experienced land degradation at an alarming rate owing to the destructive slash-and-burn system of cultivation. Mizoram Remote Sensing Application Centre (MRSAC) has identified a total of 20.64 % of Mizoram as degraded land, which scientists said is alarming.

Like all other North Eastern states of India as well as other country, Mizoram also facing the prediction and consequences of global climate change. Temperature is generally the first variable considered for assessments of climate change, it is also important to consider other climate parameters like rainfall and humidity. Agriculture is also highly dependent on these three parameters and the production and yield of Agriculture will change due to changes of any of these parameters. Failure of rains and occurrence of natural disasters such as floods and droughts could lead to crop failures, food insecurity, famine, loss of property and life, mass migration, and negative national economic growth within the state.

As per the present status, the total annual requirement of rice for Mizoram is 19,22,030 Quintals/year but Mizoram produces only 462924 quintals/ year (24% of the total requirement) so the deficiency is 76%. The rainfall pattern in Mizoram during 1986 to 2005 shows that, maximum downpour occurred during the monsoon seasons and declines during the rest of the seasons. But as per yearly basis analysis the trend shows that a gradual decline and then a sudden increase from 1990 to 1995.

4.1.3 Climate Change Adaptation in Agriculture and allied sectors of Mizoram

Adaptation measured can offset the negative impacts of climate change on irrigated rice but in the case of rain-fed rice, growing of tolerant and high input efficiency 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.

According to the Meteorological department, Guwahati (2009) it is seen that deficiency in rainfall is increasing in every year (in 2005 deficiency is 22% and in 2006 deficiency is 25%). Due to this low rain fall Mizoram is facing drought situation and which affecting fish, agriculture and livestock.

In the year 2005, extended dry periods have been seen in Mizoram and many springs and streams dried up accompanied by large scale landslides (ICIMOD, 2008). Improper rainfall (earlier or later) adversely affected sowing and harvesting of crops, and due to this reason harvestable grains have been damaged. Moreover, it is also seen that natural wetlands are dwindling in many parts of Mizoram. Some of the ecologists have argued that more number of invasive species have appeared and distribution pattern has changed in Mizoram. Some researchers have reported that more number of diseases and

pests occurred in citrus species. One significant impact which many plant scientists agree to is the change taking place in the phenological phases in plants (ICIMOD, 2008).

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.

4.1.4 Adaptation Pathways in Agriculture

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 and land degradation, livelihoods affected	Jhum optimisation through catchment area protection, plantation crops, soil conservation
Use of fertilisers	Reduction in carbon sink	Organic farming, Using sustainable fertilizer and tillage practices (improving soil drainage, no-till, etc)
Increase in vector-borne diseases	High mortality of farm animals	Vaccination, breeding of climate resilient breeds

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.

The following are the overview of the sectors and how they are likely to be impacted due to climate change. The sheaf of options for adaptations now being mulled over by the working groups and is not yet final. A snapshot of discussions has been presented in the following table.

Sectors	Possible adaptive options
Agriculture	**Develop new crop varieties including hybrids to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions**
	Diversify crop types and varieties, including crop substitution, to address the environmental variations and economic risks associated with climate change
	Soil and moisture conservation practices through activities like: contour ploughing, check dams and bunding, organic manuring, mulching etc.
	Develop water management and conservation innovations, including irrigation, to address the risk of moisture deficiencies and increasing frequency of droughts

	Develop early warning systems that provide daily weather predictions and seasonal forecasts
	Change timing of farm operations like sowing and harvesting to address the changing duration of growing seasons and associated changes in temperature and moisture
	Encourage organic farming practices
	Conservation of agrobiodiversity to provide specific gene pools for crop and livestock adaptation to climate change.
	Selection of crops and cultivars with tolerance to pests and diseases to generate greater genetic variability (FAO)
	Developing resilient rice crops to heat stress
	Use of genetic markers for speeding up breeding process
	Geographical analysis of vulnerable regions
	Site-specific adjustment in crop management (e.g. shifting planting dates and improved water management)
	Regional climate modeling to identify future "tilting points" of rice production (e.g. the temperature level or CO2 levels above which major yield losses are experienced)
	Developing newer crop management trends (e.g. diversification from rice-rice to rice-maize systems) to alter crops' budgets of carbon and nitrogen and thus significantly attempt to reduce greenhouse gas emissions
	Breeding livestock for greater tolerance and productivity. Changes in livestock practices may influence future spread/distribution of vector borne diseases
	Breeding livestock for greater tolerance and productivity
	Improving pastures and grazing lands management
	Preservation and conservation (in-situ and ex-situ) of existing animal genetic diversity
	Technological developments, such as the development and promotion of new crop varieties, improvements in water and soil management, and improved animal health
	Planting species with higher tolerance to changing climate

4.1.5 Key Priorities

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

Key priorities: Agriculture	
1.	Development of Land (Levelling, bundling, etc) for Wetland Rice
2.	Cultivation (WRC) on available lands having 0-10% slope and Improvement of Existing Wetland Rice Cultivation (WRC)
3.	Developing data base on genotypes of local crop varieties (mainly rice varieties) and identification of suitable varieties for different agro-climatic zones.

4.	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.
5.	Assessment study and demonstration of Systematic Rice Intensification (SRI) cultivation and Capacity building to train farmers in latest rice cropping techniques specially evolved to counter adverse effects of climate change
6.	Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops and Alternative jhum Control to Livelihood
7.	Construction of Hill Slope terraces for conservation of moisture and cultivation of foodgrain, vegetable, pulses and oilseed crops
8.	Increasing the area under perennial fruit plantation crops and low value high volume crops to help cope with uncertain weather patterns.
9.	Management of climate change impact on horticulture and Climate risk management studies
10.	Improving post harvest management such as cold chain for perishable crops and winter cultivation practices
11.	Promotion of organic farming through usage of compost and vermicompost
12.	Adoption of Integrated Pest Management for improved crop yield, Preparedness to tackle emerging scenarios of pests and capacity building for stakeholders
13.	Research study on livestock disease and establishment of early warning system and Capacity building to Stakeholders
14.	Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters
15.	Water storage and providing proper diversion channels to the existing ponds for drainage of catchment runoff during sudden heavy rains

16.	Providing extensive support and services to fishermen through establishment of district level training centres
17.	Water bodies conservation for fishery sector and establishment of fishery units in reservoirs and riverine area

- **Development of Land (Levelling, bundling, etc) for Wetland Rice Cultivation (WRC) on available lands having 0-10% slope and Improvement of Existing Wetland Rice Cultivation (WRC)**

In Mizoram, The cultivation method has remained primitive (jhum). The main reasons are 1) lack of suitable land for Wetland Rice Cultivation (WRC)and 2) lack of adequate resources. According to Department of Agriculture, Government of Mizoram (2007-08) about 9560 families are having WRC with an area of 11,000 hectares. It is seen that more than 90% of them have no irrigation facilities. In the context of environment, household food security and eco-regional imbalances, new directions are required in planning and transfer of technology to meet future challenges of growing demand of food. Shifting Cultivation is destructive for environment,

back breaking and less remunerative for the cultivators. Government of Mizoram has taken an initiative to increase and improvement of existing WRC as an alternative farming system. Improvement of WRC will decrease emission of CO2 from forest fire (Process of Jhum).

- **Developing data base on genotypes of local crop varieties (mainly rice varieties) and identification of suitable varieties for different agro-climatic zones.**

Government of Mizoram has taken initiatives to establish and maintain genetic resource collections of the state's major crop species and their close relatives. These collections are the repository of millions of years of natural selection and contain the genetic diversity necessary for plant breeding efforts to cope with the recurring pressure of pathogen evolution and global changes in climate and soil. Such collections typically contain plant samples per species, usually termed accessions, and in some cases contain some distinct lines or accessions. The collection depends partly on the species of the sample and the collection in which it is maintained. Extensive documentation systems will be put in place to maintain and allow the use of these collections efficiently in plant breeding programs state-wide. These are currently evolving to incorporate developments in information management, such as the use of formal ontology. Government of Mizoram will use of global positioning satellite systems by plant collectors has made available precise geographic location information for new collections, which in turn means that climatic and edaphic information can be more precisely associated with genotypic and phenotypic information for a given plant line.

This systematic approach of documentation includes the development of concepts and procedures for efficient Gene Bank management, such as reducing the number of duplicate accessions and establishing representative ''core collections'' The goal of these efforts is the efficient management and utilization of the resources by plant breeding programs

- **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.**

About 21% of the total agricultural area is put on the paddy/seasonal crop cultivation within the state. Overall 63% of the total crop area is under jhum cultivation. According to the departmental figure of 2007- 2008 total production of paddy stood at 15688 lakhs MT. Settled agriculture on terraces and valley lands is dominated by rice cultivation. Paddy cultivation is 30 % declining during 2008-09. Due to uneven distribution of rainfall over different seasons, irrigation facility is required by most of the crops viz. field crops like Rice, Maize, fodders etc., plantation crops like orange, Assam lemon, mulberries, etc. and other cash crops like tea, coffee, red Oil palms, etc. Along with Minor Irrigation facilities there is an urgent need of water harvesting system to support NLUP.

Check Dams/Earthen Dam can be suitably constructed to collect and store surface water from small streams and rivulets. A water body of a reasonable size will augment moisture retention and strengthen the water recharging system at the sub soil level. In spite of plenty of rains, at present, due to hilly terrain rivers and other water sources are usually dry, in winter leaving no scope for irrigation.

A better water management system needs to

be introduced to harvest rain water. In Mizoram there are numerous positive benefits for harvesting rainwater. The technology is low cost, highly decentralized, empowering individuals and communities to manage their water. It has been used to improve access to water and sanitation at the local level. In agriculture rainwater harvesting has demonstrated the potential of doubling food production by 100% compared to the 10% increase from irrigation. Therefore Mizoram Government has proposed to put up water harvesting system in each of 750 villages.

- **Assessment study and demonstration of System of Rice Intensification (SRI) cultivation and Capacity building to train farmers in latest rice cropping techniques specially evolved to counter adverse effects of climate change**

Use of quality seeds and adoption of System of Rice Intensification are the promising and one of the best practices for raising production and productivity of crops in the State.Rice cultivation is concentrated in 5 districts of Mizoram. Out of which one district falls under medium productivity group, 3 districts are under medium-low productivity group and one district comes under low productivity group. Triennium average area of medium productivity group (yield 2,000-2,500 kg/ha) in one district was 0.173 lakh hectares, which was 32.3% of triennium average area (0.536 lakh hectares) under rice in the State. Triennium average production was 0.349 lakh tonnes, which was 37.4% of triennium average production (0.933 lakh tonnes) of rice in the State. Triennium average productivity of medium productivity group in one district was 2,017 kg/ha as against 1,741 kg/ha triennium average productivity of the State.Low productivity is attributed due to adoption of old traditional varieties and lack of irrigation facilities.

SRI is a simple but every effective approach to the current food crisis. System of Rice Intensification (SRI) cultivationhas just been introduced in the state and can contribute to significant reduction of green house gases emission from rice cultivation.

- **Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative crops and Alternative jhum Control to Livelihood**

Jhum cultivation is the predominant land use system in the upland areas of Mizoram where 19 to 45 % of the forest area is under jhum cultivation. In the hills of Mizoram, agricultural operations are carried out up to a maximum elevation of 5000 m with 'slash and burn' method. More recently, attempts have been made to optimize the productivity of jhum fields. There is a gradual shift in focus from earlier campaigns to eliminate the practice of jhum to increasing its productivity and livelihood potential. But these efforts have not yet been systematic. 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. Proper capacity building and training will be provided to the farmers of Mizoram for optimizing the produce from their jhum fields by cultivating alder trees, which regenerate the soil and check erosion. The root nodules of these trees improve fertility by fixing atmospheric nitrogen in the soil.

- **Construction of Hill Slope terraces for conservation of moisture and cultivation of foodgrain, vegetable, pulses and oilseed crops**

With a combination of the desired altitude (above 1000m) in Mizoram, climate and rainfall, the tree flourishes in this area growing fast and yielding huge quantities of firewood. The ashes of burnt alder twigs are mixed with the soil to increase its fertility. No part of the tree is wasted. The wood is used for firewood, building houses, making furniture and carving. The leaves have medicinal properties and are used to stop blood flow. Alder trees are also used in terraces at bench level to prevent run-off of topsoil. Tribals of Mizoram are expert in cutting beautiful terraces along mountain slopes. This system of cropping is beneficial in retaining fertility of soil; preventing landslides and checking soil erosion. Secondly, it is helpful in retaining the moisture of soil and conserving water, also. The Mizoram Government understands the benefits of these farming methods and proposed to implement a programme that will lead to permanent cultivation of the land by a transition to terrace farming by construction of terraces on the moderate slopes.

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

The agro-climatic attributes of the state have since been found highly congenial for growing variety of horticultural crops particularly on gentle slopes are not only highly remunerative land use option but also for preventing soil erosion, improving soil fertility and thereby maintaining ecological balance. The State Govt. has also laid emphasis on the development and expansion of a high market potential fruits like passion fruit, orange, grape, papaya, chow chow (Sechiumedulis), Arecanut (Areca catechu), Hatkora, banana, etc. Passion fruit has been cultivated in Mizoram by almost every household as a garden fruit in the villages.

In the context of climate change, there will be a need to increase the area of plantation for perennial fruit and low value high volume 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 by 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 and Climate risk management studies**

The state of Mizoram is gifted with natural growing conditions for several economically important horticulture produce like Pineapple, Oranges, Banana, Ginger, Cashew Nut, etc. Climate change will impact on the agronomy, economics, and environmental aspects of horticultural production under conditions of changing water availability, growers need to consider both short-term and long-term coping strategies. Mizoram's increasingly variable climate poses challenges for horticulture, given the sector's dependency on natural resources, especially water for irrigation. The horticulture sector in Mizoram 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**

Market infrastructures have not been well organized or built up in the state so far. Storage facilities need to be created as well as transportation facilities for agricultural commodities need to be improved. The district also offers scope for development of post harvest management for many economically viable agricultural and horticultural commodities. Training for different technologies on post harvest may be organized in selected areas. Lack of storage facilities, transportation bottleneck, inadequate grading, packing & drying are the main constraints. Cold storage facilites is available in fisheries sector. Rural godown and market sheds in potential areas may be created.

Processing and preservation of value added products are required as part of the climate change adaptation strategy. 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 on the research and development of post harvest protection method on economically less demanding and consumer friendly alternatives for ensuring food security to people of Mizoram. State planned training of growers on post harvest crop management, establishment of good godowns and cold storage centres with grading facilities, market linkages, etc.

- **Promotion of organic farming through usage of compost and vermicompost**

Mizoram being declared an Organic State is all ready to follow a well guided systematic approach towards a uniform development in Organic Farming. Organic farming is a production system that avoid of largely excludes the use of chemical fertilizers, pesticides and growth regulators. As large scale use of fertilizers and pesticides pose a number of environmental hazards and imbalances in soil nutrient level, organic farming has been highly encouraged. The uses of Farmyard manure, compost, bio-fertilizer, bio pesticides, etc. are used instead of synthetic fertilizers and chemical pesticides etc. Crop rotation, growing of green manureing crops viz. Dhaincha, Sunhemp, etc. and different cultural practices are followed.

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. The Department has established 35 Nos. of vermiculture unit and large number of Organic farmers were assisted by distributing Vermi-Mother Culture and Vermicompost harvested from these Vermiculture pits. Promotion of compost / vermicompost requires mass awareness among farmers and growers which is also economically viable and has greater opportunity all over the state. Small Vermiculture Units have been set up at Farmers field in each District. In all 666 Units have been established by giving assistance @ Rs. 15,000/- per unit to each individual farmer in the previous year and another 120 units already distributed to the Farmers during 2010-11 under various District.

- **Adoption of Integrated Pest Management for improved crop yield, Preparedness to tackle emerging scenarios of pests and capacity building for stakeholders**

Integrated pest management is a broad ecological pest control aiming at best mix of all known pest control measures to keep the pest population

below the economic threshold level. The major pest found in the state are Leaf folder, Stem borer, Caseworm, Rice gundhi bugs, Leaf hoppers, Rodents, Pink borer, Striped borer, White grub, Heliothis, Maize Aphid etc. The multiple impacts of climate change could significantly reduce the effectiveness of current IPM strategies leading to higher crop losses.

It is economically justified and sustainable system of crop protection that leads to maximum productivity with the least possible adverse impact on the total environment. In crop production technology integrated pest management is a schedule of practices which starts from field selection till harvest of crop. The major components in this approach are to advocate cultural, mechanical, biological and chemical methods of insect pests, diseases, weeds and rodent control compatibly. Government of Mizoram is taking steps in motivating farmers to minimize the use of pesticides and to control the environmental population with the adoption of Integrated Pest Management. An area of 1567 ha will be taken up for adoption of Integrated Pest Management.

- **Research study on livestock disease and establishment of early warning system and Capacity building to Stakeholders**

Mizoram an agrarian economy still imports a large quantity livestock like pig, cattle, goat, poultry essentially required for the overall food supply of the people. Pork consumption in particular is very high. The traders who organize import sell the same in the local market. Particular policy attention should be paid to the health risks posed by the rapid worldwide growth in meat consumption, both by exacerbating climate change and by directly contributing to certain diseases.

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.

- **Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters**

Aquatic ecosystems are one of the critical components of environment. It is essential contributors to biodiversity and ecological productivity; they also provide a variety of services for human populations, including water for drinking and irrigation, recreational opportunities, and habitat for economically important fisheries. However, aquatic systems have been increasingly threatened, directly and indirectly, by human activities. In addition to the challenges posed by land-use change, environmental pollution, and water diversion, aquatic systems are expected to soon begin experiencing the added stress of climate change. The effect of climate change on fisheries which will increase temperature and may lead to early maturity and breeding of fishes this required for further analysis. Climate change is stress sensitive to freshwater of Mizoram, which are already adversely affected by a variety of other human impacts, such as altered flow regimes and deterioration of water quality. In Mizoram 14 major rivers and 6 lakes are the major water sources. Wetlands are a critical habitat for many species that are poorly adapted for other environmental conditions and serve as important components fisheries. Aquatic ecosystems have

a limited ability to adapt to climate change. Government of Mizoram has taken an initiative to do a research work on climate change impact on aquatic ecosystem.

- **Water storage and providing proper diversion channels to the existing ponds for drainage of catchment runoff during sudden heavy rains**

Mizoram has 24,000 hectares of potential area available for fish farming. Due to poor economic condition of the rural people and financial constraints of the State Government, it has not been possible to exploit the potential. So far only 2,640 hectares of water area has been brought under pond fish culture. There are another 400 hectares under paddy-cum-fish culture integrated farming with wetrice cultivation. Besides the area, 6,000 hectares of water area are also available in the riverine sector in the form of rivers and streams. This demand will further increase with the increase of state population and earning capacity of the people. This in itself justifies a major investment for the required development of fisheries in the state to bridge the gap between the demand and supply, besides generating self and regular employment.

According to 2007-08 State report, Mizoram gets an average annual rainfall of more than 2445mm and that too in a concentrated period of 6 months resulting in the working season in a year greatly restricted. During the heavy rain or uneven rainfall, government wants to develop proper diversion channels to get rid of from flash floods. At the same time, surface sub-soil being highly absorbent, its retention capacity of water is low. Consequently, Mizoram faces the unique paradoxical problem of scarcity of water in the midst of plenty. To increase the storage of water, government of Mizoram wants to promote water resource conservation and enhance water-use efficiency for irrigation; on the other hand governments also wants to create and development of new water bodies for fish farming and integration of Giant freshwater prawn in feasible areas.

- **Providing extensive support and services to fishermen through establishment of district level training centres**

Mizoram has about 2,000 hectare of water area under fish culture. About 7,000 families are engaged in fish farming while another 2,000 are involved in riverine (capture) fishery. An age old method of fishing followed in Mizoram is to put a barrier in the flow of a river or stream by putting stones, felled trees, bamboos etc. and catch fish through cages put in the openings. The existing demand, and anticipated challenges in the state, will require better multi-scale understanding of the impacts of climate change and of the interacting contribution of fisheries and aquaculture to food and livelihoods security. Climate change will increase uncertainties in the supply of fish from capture and culture. Such uncertainty will impose new challenges for risk assessment, which is commonly based on knowledge of probabilities from past events. Data for determining effects of past climate change at best cover no more than a few decades, and may no longer be an adequate guide to future expectations.

A serious need is felt for developing seed farms along with the capacity building of fishermen communities in the private sector to meet the present and future fishseed requirement from the state itself. Department is planning to establish district level training centres which can provide technical support for water and soil analysis along with identifying training needs, providing training and capacity building of the fishermen communities and fish farmers for adoption of advance and sustainable pisciculture

techniques. The existing fishing methods mostly adopted by some Mizo sub types can be modified and improved with enhancement of the capacity building and training procedures along with support services through the district level training centres.

- **Water bodies conservation for fishery sector and establishment of fishery units in reservoirs and riverine area**

It is estimated that Mizoram has a potential area of 24,000 hectares available for fish farming, out of which only about 10.5 percent has been exploited so far. As against this the demand of fish for the State's population of 9.45 lakh in 2004-05 was 10,395 M.T, calculated at per capita consumption of 11kg by the Fisheries Department of the state. Due to change in temperature and uneven rainfall fish breading is hampered and earning capacity of fish farmers is reduced. The demand for fish will further increase the earning capacity of the people. This in itself justifies a major investment for the required development of fisheries in the state to bridge the gap between the demand and supply, besides generating self and regular employment. Government of Mizoram has identified some water bodies for fishery sector. As per the Government report 2007-08, the existing water bodies under fish farming in the state is 2840 hectares. Government has taken initiatives for water body conservation and to setup new fisheries unit in reservoirs and riverine area for fishery sector development.

4.1.6 Summary Table : Agriculture

Sl. No.	Key Priorities	Departments/Organisation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
1	Development of Land (Levelling, bundling, etc) for Wetland Rice Cultivation (WRC) on available lands having 0-10% slope and Improvement of Existing Wetland Rice Cultivation (WRC)	Dept. Of Agricu lture		42.0	42.0	Govt. Of India, External Agencies
2	Developing data base on genotypes of local crop varieties (mainly rice varieties) and identification of suitable varieties for different agro-climatic zones.	Dept. Of Agriculture		0.25	0.25	Govt. Of India, Govt. Of Mizoram
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		7.5	7.5	Govt. Of India, Govt. Of Mizoram, External Agencies

4	Assessment study and demonstration of Systematic Rice Intensification (SRI) cultivation and Capacity building to train farmers in latest rice cropping techniques specially evolved to counter adverse effects of climate change	Dept. Of Agriculture		0.5	0.5	Govt. Of India, Govt. Of Mizoram
5	Optimization of jhum cultivation through conservation of arable land, water utilization management, parallel cultivation of alternative cropsand Alternative jhum Control to Livelihood	Dept. Of Agriculture, Dept. Of Animal Husbandry		4.93	4.93	Govt. Of India, External Agencies
6	Construction of Hill Slope terraces for conservation of moisture and cultivation of foodgrain, vegetable, pulses and oilseed crops	Dept. Of Agriculture		31.75	31.75	Govt. Of India, Govt. Of Mizoram
7.	Increasing the area under perennial fruit plantation crops and low value high volume crops to help cope with uncertain weather patterns.	Dept. Of Horticulture, Dept. Of Agriculture		72.40	72.40	Govt. Of India, Govt. Of Mizoram
8.	Management of climate change impact on horticultureand Climate risk management studies	Dept. Of Horticulture		148.40	148.40	Govt. Of India, Govt. Of Mizoram
9.	Improving post harvest management such as cold chain for perishable crops and winter cultivation practices	Dept. Of Horticulture, Dept. Of Agriculture		85.92	85.92	Govt. Of India, Govt. Of Mizoram
10.	Promotion of organic farming through usage of compost and vermicompost	Dept. Of Horticulture, Dept. Of Agriculture		3.0	3.0	Govt. Of India, Govt. Of Mizoram
11.	Adoption of Integrated Pest Management for improved crop yield, Preparedness to tackle emerging scenarios of pests and capacity building for stakeholders	Dept. Of Horticulture, Dept. Of Agriculture		6.925	6.925	Govt. Of India, Govt. Of Mizoram, external agencies
12.	Research study on livestock disease and establishment of early warning system and Capacity building to Stakeholders	Dept. Of Animal Husbandry		7.597	7.597	Govt. Of India, Govt. Of Mizoram

13.	Study of impact of Climate Change on the indigenous fauna of aquatic ecosystem and open waters	Dept. Of Fisheries		0.05	0.05	Govt. Of India, Govt. Of Mizoram
14.	Water storage and providing proper diversion channels to the existing ponds for drainage of catchment runoff during sudden heavy rains	Dept. Of Fisheries	1.5	3.75	5.25	Govt. Of India, Govt. Of Mizoram
15.	Providing extensive support and services to fishermen through establishment of district level training centres	Dept. Of Fisheries	0.06	0.45	0.51	Govt. Of India, Govt. Of Mizoram
16.	Water bodies conservation for fishery sector and establishment of fishery units in reservoirs and riverine area	Dept. Of Fisheries	1.65	0.875	2.525	Govt. Of India, Govt. Of Mizoram
	Total		**3.21**	**416.297**	**419.507**	

4.2 Sustainable Forestry

4.2.1 Introduction

Mizoram has the highest forest cover spread over 87.42% of its geographical area in India (Forest Survey Report, 2009). Forests and forestry constitute dominant feature of the state's landscapes, economy and environment. The State enjoys different types of evergreen forests and waterfalls as well as areas of unique floral and faunal varieties. Based on the distribution of rare endemic and threatened species, several localities have been identified as important areas for plant conservation. The majority of the forested land lies in notified forest and also significant forest cover lies under the management of communities and individuals. Mizoram has the most variegated hilly terrain in the eastern part of India. The hills are steep and are separated by rivers which flow either to the north or the south creating deep gorges between the hill ranges. There are 21 major hill ranges with average height of 2000 m to 1000 m spreading across the state. The average height of the hills is about 900 metres with highest forest cover in the eastern region. Tropical Wet Evergreen Forests found in Southern & Western parts of Mizoram. Under this group, sub-group-IB Northern Tropical wet evergreen forests are mostly found in Mizoram. Tropical Semi-Evergreen Forests cover the central biographic zone and the coverage is approximately 50% of the total geographical area and Sub-Tropical Hill Forests come in the Eastern fringes bordering Myanmar and approximately extending from 1500-2158 m MSL. The area constitutes about 24% of the total geographical area.

However, the major constraints for the state are higher deforestation rates due to jhum cultivation and forest degradation caused by anthropogenic pressure. Due to this the majority of the forests classified under the open and medium dense forest category and only 1% of forest cover classified under the high dense forest with the canopy cover more than 40%. Lack of infrastructure, Market Linkages and sustainable forest policies making under utilization of potential for development of forest based enterprises within the state. Almost 2/3rd of the area has already been degraded. These depleted and degraded forests could not meet the growing demands of timber and other forest products in the state and cannot provide a safeguard to the ecological functions like soil conservation, protection of land degradation, maintenance of agricultural productivity and protection of catchment area.

National Mission for Green India under the National Action Plan for Climate Change recognized the forestry sector as one of the most effective carbon sinks to mitigate and adapt to the Climate Change and its indispensible role in the conservation of ecological balance and biodiversity restoration. Mizoram Climate Change Forestry Action Plan is prepared as per the guidelines of National Climate Change Action Plan.

4.2.2 Key Facts about urban areas in Mizoram

The recorded forest area of the state is 16,717 sq km out of this reserved forest constitutes 47.31%, protected forest constitutes 21.34% and Un-classified Forests constitutes 31.35% of the total forest area. About 80% of the state geographical area is under recorded forests. The state has 2 National Parks and 7 wildlife sanctuaries covering an area of 990.75 sq km which constitutes 4.69% of the state's geographical area.

The state has different forest types belonging to 4 groups Tropical Semi Ever Green, Tropical Moist Deciduous, Subtropical Broadleaved Hill and Subtropical Pine Forests according to Champion & Seth's Classification System (1968). Around 70.43 % of Forest belongs to Tropical Evergreen forest and 28.91% belong to Tropical Moist deciduous Forest. The state of Mizoram is a part of Indo-Myanmar bio geographic region, which is one of the rich biodiversity regions of the world. Wildlife Sanctuaries and a large number of sacred groves are found in the different parts of the state, these are the main preserves of biodiversity. The floral diversity of Mizoram is quite rich and also harbours about 35 species of Bamboo belonging to 8 genera. Besides, a wide variety of wild cultivable plants, edible fruits, leafy vegetables and orchids are found in the natural forests of Mizoram.

TABLE 10 FOREST TYPE

Altitude zone	VDF	MDF	OF	Total
0-500 m	1	1,813	6,791	8605
500-1000 m	34	2,921	4520	7475
1000-2000 m	98	1,516	1544	3158
2000-3000m	1	1	0	2
Total	134	6251	12855	19240

(Based on SRTM Digital Elevation Model)

Primarily Very Dense forest found in 1000-2000 m altitude range and also partly in 500-1000 m altitude range. Moderately dense and open forests are present mainly in low altitude area of 0-500 m and 500mt to 1000 m (State Forest Report 2009).

TABLE 11 DISTRICT WISE FOREST COVER IN 2005 (AREA IN KM2)

District	Geographical Area	Very Dense Forest	Mod dense Forest	Open Forest	Total	% of G.A	Change*	Scrub
Aizawl	3575	32	1013	2278	3323	92.95	196	0
Champhal	3185	58	1180	1519	2757	86.56	175	0
Kolasib	1,382	0	210	1090	1300	94.07	32	0
Lawngtlai	2557	0	699	1681	2380	93.08	53	0
Lunglei	453	0	1586	2698	4284	94.44	38	
Mamit	3025	41	568	2137	2746	90.78	105	0
Saiha	1400	0	629	703	1332	95.14	-4	0
Serchhip	1421	3	366	749	118	78.68	45	0
Total	21081	134	6251	12855	19240	91.27	640	1
*Change compared to 2005 assessment (revised) : Forest Survey of India, 2009 Report								

The state has about 134 sq. Km of very dense forest Area, which is present mainly in Aizwal, Mamit and Champal districts, while Serchip having the lowest amount of very dense forest cover and other districts doesn't have any very dense forest cover. More than half of the moderately dense forest can be found in Aizawal, Champhal and Lundleit Districts. Open forest constitutes 66% of total forest cover spreading across the Mizoram State.

Mizoram has adopted the Joint Forest Management in the year 1998, which envisaged involvement of the local communities and voluntary agencies in planning, protection, regeneration and development of forests. Already there are 593 JFM committees been formed and managing more than 26000 ha of forest area till date. Traditional Community Forest Management has adopted long way back by the local communities in Mizoram by forming village safety and village supply reserve for their daily use of Forest Resources.

4.2.3 Key Issues

Agriculture and allied sectors is the mainstay for 70% of the total population in the Mizoram but most of the geographic terrain of the Mizoram is not conducive to the sustainable agriculture practices due to the slope of the terrain which made them to opt for Jhum cultivation. Jhum cultivation on forest lands has been responsible for habitat fragmentation, destruction and degradation of the forests in the state. Almost the entire state is influenced by age-old practice of Jhum Cultivation, except some pockets of valley bottomlands. Forest Fires, High rainfall and hilly terrain have further accentuated the impact of human activities on the forest.

TABLE 12 LAND USE PATTERN IN MIZORAM

Category	Area(ha)	Percentage (%)
Forest	1,593700	75.5
Not Available for Cultivation	1,34050	6.2
OtherUncultivated Land	7,209	3.4
Fallow Land	2,10,928	10
Cropped Area	1,02,903	4.9

Source: Forest Statistical Handbook 2009

Limited cultivable land availability for the rural population, land tenures and soil erosion are promoting the age old tradition of the Jhum Cultivation. Around 1,20,000 families are dependant on the Jhum Cultivation. Annually about 50000 hectors of forest land have been diverted for the Jhum cultivation. This practice destroys the protective and productive vegetation in preference over a very brief period of immediate crop production. In order to earn their livelihood people are practicing shifting cultivation and over-exploiting forest resources, which is leading to the serious damage to the forest and biodiversity. However Mizoram State Government has initiated New Land Use Policy (NLUP) from 2008 to divert Jhum cultivators towards other income generation activities.

Second most important reason for the forest degradation is from the Forest fires. NLUP estimated around 50% of the forests estimated to be highly vulnerable to the both manmade and natural forest fires. This threat further intensifies in the case of Bamboo forests in Mizoram, which constitutes around the 32% of the total forest area and close to the human habitats.

Some of the emerging problems for Mizoram Forestry sector are increasing number of landslides due to loss of forest cover and soil erosion, reserved forests are constantly over-

exploited in unsustainable way, laws applicable to these forests are too weakly enforced, overexploitation of ornamental and medicinal plants, animal products, conversion of forests areas into agricultural lands and habitat destruction. Even the sacred forests maintained as community forests, are rapidly vanishing.

4.2.4 Climate Change Adaptation in forestry sector of Mizoram

Mizoram has 92% forest cover of the total land surface. Hence forestry sector plays key role in climate change adaptation by helping human societies.

The life cycles of forests range from decades to centuries. Adaptation to climate changes refers to adjustments in ecological, social, and economic systems in response to the effects of changes in climate. Adaptive management of forests will contribute to sustaining the livelihood of forest dependent communities in Mizoram. Many existing forests within the state and most newly established stands will experience climatic conditions that deviate from conditions today. In Mizoram 67.7% of reserved forests are intensely managed by state department. The other proportion managed by different district councils which fulfils multiple functions at lower management intensity; the remainder is managed at low intensity or for protection, conservation or social services.

4.2.5 Adaptation Pathways in Forestry sector

Issues	Impact	Pathways
Warmer and drier summer conditions	Reduced growth rates, Increased disturbance through fire and insects, Changes in wood quality and quantity, Reduced regeneration success, Increased competition from exotics (vegetation, insects, and diseases)	Identification of suitable genotypes through provenance trials, Development of technology to use altered wood quality and size, Inclusion of climate variables in growth and yield models, Development of "fire-smart" landscapes
Higher precipitation long dry spell and more extreme weathers	Landslide, Forest fire and flood	Disaster risk reduction, Socio-economic adjustment (water allocation management)
Rainfall inhibition	Draught like situation and loss of vegetation, impact on food security and community livelihood	Conservation measures and policy formulation for forestry
Jhum Cultivation/ Slash and burn technique for agriculture	Increased degradation/ GHG Emissions	Better dialogue and diver sification of agro-forestry and agri-sylvicultural system
Outbreak of forest fires	Loss of Forest Cover/ GHG Emissions	Awareness Generation, Alternative Income Generation, Fire management Strategies

Adaptive management of forests will contribute to sustaining the livelihood of forest dependent communities in Mizoram. 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.

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 measure 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. Mizoram formulated the key priorities in line with National mission. The following section will focus on the key priorities.

4.2.6 Key Priorities

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

Key priorities: Sustainable Forestry	
1.	Improvement of forest quality and density in degraded lands and abandoned jhum lands
2.	Improvement the productivity of Bamboo and promotion of local value addition through establishment of market linkages
3.	Assessment of climate vulnerability and climate change impacts on state biodiversity and forest resources
4.	Undertaking studies on climate change impacts on NTFP productivity, investment promotion and indigenous harvesting practices for adaptation of climate change
5.	Undertaking study on valuation of forest resources (Non traded) and climate change impacts on the vulnerable ecosystems
6.	Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions
7.	Capacity building of communities/community forest management institutions for climate change adaptation
8.	Work to establish new systems to support for public awareness building through Establishment of Envis Centre
9.	Prevention and control mechanism for forest invasive species and its utilisation strategies
10.	Promotion of forest based industries based on various forest based products
11.	Formulation of conservation strategies for Orchids and establishment of market linkages for value addition

12.	Restructuring land use policy for jhum cultivation and habitation on notified forest lands
13.	Policy formulation on transportation subsidy or development of low cost transportation for primary Forest products of the state

- **Improvement of forest quality and density in degraded lands and abandoned jhum lands**

Mizoram Forest sector has highest Forest cover in India though it facing challenges in terms of forest crown density. Forest survey of India Report, 2009 reported 92 % total forest cover of its Geographical area but the very dense forest is less than 1% of total forest area. This is clearly indicating the need for the increasing the afforestation activities to promote the forest density. Ecological restoration in terms of reforestation and afforestation of degraded lands will 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.

Innerline Reserved Forest Notification 17th October 1878 and Riverine Reserved Forests Gazatte Notification of ADC on 19 May 1965 notified the majority of the catchment area of the Rivers as Reserved Forest in Mizoram also known as Riverine Reserve Forest. Over the years most of the riverine forests have been encroached or under jhum cultivation's due to this soil erosion and the environmental pollution like acidification of water bodies and drinking water contamination increased many folds. Jhum cultivation has been responsible for fragmentation, destruction and degradation of the forests in the Mizoram state. Annually about 50000 hectors forest land been diverted for the Jhum cultivation. This practice destroys the protective and productive vegetation in preference to a very brief period of immediate crop production. After the crop production the Jhum cultivation areas abandoned. Large tract of lands have become the home for less productive alien and invasive species in the process of natural regeneration. Assisted natural regeneration or artificial regeneration required for the abandoned Jhum land restoration otherwise these abandoned land will be further degraded by soil erosion and forest fires leading towards permanent fallows. Climate Change Action Plan working group for Mizoram recognised the importance of restoration of these abandoned Jhum areas as one of the key priority.

- **Improvement the productivity of Bamboo and promotion of local value addition through establishment of market linkages**

Bamboo forests cover an area of 21,090 sq. km with an abundant reserve of bamboo forest covering 1,254,400 ha, contributing to 14% of all India bamboo distribution. Most of the Bamboo occurring are found between 400m to 1500m altitude. Bamboo also grows under storey plants tropical ever green forests in pure stands along the river side. The clear felling of Jhum cultivation has also helped the Bamboo to become the dominant species. The bamboo represent vast untapped major resource of Mizoram whose full ecological and economic potential remaind underutilized .The eco-friendly Bamboo crop has immense potential in improving rural economy, industrial development and sound economic base for the state on the sustained basis. The latest growth stock of Bamboo is estimated to be 24 Million MT. This implies the need to encourage enterprises that will add value to its forest products like Bamboo to generate more

income and employment for its generally poor population. Mizoram 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 under climate change action plan.

A series of massive forest fires break out every year across Mizoram throughout the pre monsoon season. The primary reason of forest fires in Mizoram can be attributed to the Jhum cultivation and the magnitude of the devastation on the ecosystem is very high. Annually 50,000 ha of forest patch brunt due to the forest fires by Jhum cultivators. Jhum burning not only resulted in destruction of forests and also increases in pollution. This threat further intensifies in the case of Bamboo forests due to their occurrence at lower altitudes. Large areas of Bamboo forests are wasted annually by the way of cutting and burning of Jhum cultivation.The uncontrolled fires by Jhum Cultivators burns large tracks of forests and also do fatal damages to humans. New strategies will be developed for reducing Bamboo Fires through capacity building & involvement of JFM committees using new technologies and trainings in containing forest fires. Climate change Action Plan working group recognised the need for Fire management strategies in the context of Mizoram.

Bamboo based industries in cottage, small and medium sectors will be established within the state. An investment friendly framework will be designed for the implementation of financing mechanisms to support the Bamboo industries in terms of associated incentives and subsidy. To improve the quality of the bamboo products, new technologies will be adopted to enhance the market outreach & Linkages. Proper rotation will also ensure sustainable harvest.

- **Assessment of climate vulnerability and climate change impacts on state biodiversity and forest resources**

Forests in Mizoram state like in many parts of India are among the most important natural resources, which have played a fundamental role in supporting the livelihood of the people. Due to its sheer importance Working Group decided to have a comprehensive study on Climate change Impacts on the Biodiversity and Forest Resources to mitigate and adapt to the changing climatic conditions. In Mizoram, human activities are triggering the biodiversity loss at alarming rates through land use change, forest cover loss, soil and water pollution, and degradation due to forest fires, habitat fragmentation and selective exploitation of species. In the context of climate change these vulnerable eco systems will be further stressed.The impacts of climate change will be varied with respect to populations and composition of species. Species with limited climatic ranges and restricted habitat requirement or small population are typically the most vulnerable to extinction such as endemic mountain species and biota. Infra-specific variation in select species will also be taken up.

This study will act as a precursor for the future planning of Mizoram forest sector for conservation of forest resources. This study will be focusing on the climate Change impacts on Biodiversity, Forest Resources and adaptation measures to be taken in the Planning for Climate Change Impacts minimization.

- **Undertaking studies on climate change impacts on NTFP productivity, investment promotion and indigenous harvesting practices for adaptation of climate change**

In Mizoram 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.). It is important to understand the various indigenous practices; some of them even climate resilient while some are regressive.

- **Undertaking study on valuation of forest resources (Non traded) and climate change impacts on the vulnerable ecosystems**

Mizoram forests provide some tangible benefits in the form of food, fuel, fiber, timber and other forest products and also some intangible benefits like soil conservation, watershed management, ground water recharge, etc. 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.)

Till date the total forest valuation has not been conducted in Mizoram. Considering the natural forest in Mizoram, 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. 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. Climate Change Action Plan working group recognised the importance of the total valuation forest resources.

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

Mizoram has the wide varieties of hilly terrains, luxuriant valleys, rivers, lakes and rich flora & fauna in the eastern part of India and also shares international borders with Bangladesh and Myanmar. The mild climate conditions in Mizoram throughout the year and types of the forests ranging from the moist tropical and moist sub-tropical have great eco-tourism potentials nationally and internationally. Eco-tourism can provide sustainable livelihood to the rural tribal communities whose primary dependency is primarily on Jhum cultivation. For promotion and development of eco-tourism in forest areas requires small degraded or barren land may be put to use along with the landscaping, plantation, regeneration and protection components which would be jointly managed by the Department of Tourism and Department of Forest with the help of local community for which no specific diversion may be required. Sacred Grooves in Mizoram has vast amount of tourist potential to be realized. Sacred Grooves are the loose ends of relict virgin forests which are quite different from the surrounding degraded forests. Thus these can serve as micro-level biodiversity hotspots.

To secure the necessary funding for the Forestry Administration and to manage the protected area in future, the development of ecotourism as a financing mechanism can be one of the best options for Mizoram. Mizoram 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 Jhum cultivation and commercial logging that threaten the forest.

- **Capacity building of communities/ community forest management institutions for climate change adaptation**

Mizoram started the practice of JFM from 1998-99 onwards and is an essential part of all plantation programmes. A total number of 116 VFDC has raised plantation area of 12740 ha under JFM up to 2000-2001 and process of registration of these VFDCs is in progress. Such plantations are raised through these VFDCs within notified forest and also in community lands after obtaining consent of the local village Community council. The impact of JFM on protection, conservation and regeneration of forests cannot be quantified now as the scheme is initiated only a few years back Like-wise, distribution of usufruct and quantum of benefits accrued to VFDC members cannot be highlighted at this stage. However, the recent survey exercise undertaken by this Department shows that JFM has been showing its impact but it is still in incipient stages. Moreover, the concept itself is to be made clearer by the members as well as the Dept. Staff. Most of these VFDCs are living in and around the forest deriving their livelihood and essential needs from the forest. JFM has brought in appreciable change in outlook among villagers, forest department and its officials as it provide ample employment opportunities in the form of wages through creation and maintenance of plantation. In short, the concept of JFM in Mizoram is at its infant stage and a lot more needs to be done in the years to come. However, the State Government is happy to get an overwhelming response from the members of the VFDC and anticipates a high degree of involvement and achievement in the years to come provided that the constraints presently faced mitigated.

The Forest & Environment Department registered 593 JFMCs, 19 FDAs constituted in Forestry Divisions covering all the districts of the State. JFMC Members support to protect about 26000 Hectares of forest. This programme objective is to building adaptive capacity among Panchayat Raj Members Community Forest Management Institutions and communities towards Climate Change Adaptation for increasing the forest cover, protection and reduce the climate change impact .This can be planned and proceeded as component under JFM for better capacity building and training of the stakeholders and JFMCs.

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

The present thrust of forest department of Mizoram is all round restoration of forest ecosystems. Both the Focal Point as well as the ENVIS Centres has been assigned various responsibilities to achieve the Long-term & Short-term objectives. For this purpose, various services have been introduced by the Focal Point. ENVIS due to its comprehensive network has been designated as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the United Nations Environment Programme (UNEP). In order to strengthen the information activities of the NFP, ENVIS was designated as the Regional Service Centre (RSC) of INFOTERRA of UNEP in 1985 for the South Asia Sub-Region countries. 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 through this centre. Periodic thematic workshops will be organised to sensitize the public and generate awareness in the line of conservation and effect of climate change on local ecosystems.

- **Prevention and control mechanism for forest invasive species and its utilisation strategies**

Some of the factors threatening the existence of biodiversity of the Mizoram are habitat fragmentation and destruction due to deforestation, developmental activity, shifting cultivation, poaching, trade in wild flora and fauna, introduction of exotic and containing rapid wild spread of invasive species. The greatest impact that invasive species have on biodiversity is obviously in the protected areas that are relatively undisturbed. Though significant forest cover still exists outside the lake area,the forests around it continue to deteriorate. The actual reserveforest around PalakDil is very small (about 10.5 sq. km). Theinter-village trail that surrounds it makes it vulnerable todisturbance. There are three main villages in the vicinity of thelake. Of these, Phura with 150 houses is the largest village. The main invasive species considered in the forestry area of Mizoram are Mikaniamicrantha, Eupatorium serotinumm,Musa sp. (wild banana), Ageratum conyzoides etc. Wild banana is predominant in the hilly slopes of Mizoram and hindered the natural biodiversity of the area. This wild banana can be utilised as fodder for the livestock and the fibre also can be utilised for local dress materials. State forest dept. is planning to formulate a control mechanism for these invasive species in the forest lands and also formulate and utilisation plan of these invasive species especially the wild banana.

- **Promotion of forest based industries based on various forest based products**

The bamboo forest in the state contributes to 14% of all India bamboo area of 8.96 million ha. A total of 23 species of bamboo have been identified in the forest of Mizoram. At present, only a small percentage of bamboo resource, 28,315 MT/Year are harvested for the purpose of local construction, tiny handloom and handicraft production. Though the geographical location and hilly terrain does not permit to set up large industry yet there is an ample scope to setup mini paper plant and other bamboo based industries to manufacture products such as bamboo panel, bamboo ply, particle board, mat ply etc. in the state. There is also a huge potential for production of bamboo shoots, charcoal and activated carbon from bamboo cultivation. Large area of forest and huge amount of bamboo is wasted annually by ways of cutting and burning for jhum (slash and burnt) cultivation and forest fire. Thus there occurs a huge loss of resource to the State. Forest Dept. is planning for protection, tending and fertilizer application: It is necessary to prevent newly planted bamboo against displacement by wind and disturbance by animals or man and also promotion of Bamboo based industries within the state which will also contribute to the livelihood enhancement of the local people.

Mizoram is well known for its timber production. Most of the timber demands in the state are being met from the natural forests and only small fraction of the demands is met from government as well as private plantations. It is used mainly for traditional house construction and furniture. No wood based industry has been established so far in the state except some petty saw mills. Small timbers are consumed for fire wood in most of the rural area. Mizoram has the natural advantage in setting up plywood industry, other timber-based units, plantain fibre and hill broom units. Forest dept. will give special efforts for promotion of wood based industries in the region by plantation in abandoned jhum land.

- **Formulation of conservation strategies for Orchids and establishment of market linkages for value addition**

Within the hills of Mizoram about 246 orchid taxa in 74 genera were recorded. Out of these, 67 taxa (including saprophytes) are terrestrial and 179 are epiphytic. Bulbophyllumparryae, Erialacei and Sterogynelushaiensis are endemic. Dendrobium, with 41 species and one variety, is the largest genus. Forty genera, 3 being monotypic, are represented by a single species. About 55% of the total taxa appear to be endangered. The habit, phenology, distribution frequency and conservation status, and phytogeographical affinities are discussed for all taxa. Apart from these the commonly found species are Vanda coerules (Blue Vanda), Renantheraimschootiana (Red vanda), Paphiopedilumhirsutissimum, P. Villosum which are prohibited from export. Conservation measures for those endangered are also suggested. Local people of the state are well acquainted about the medicinal properties of Orchids growing in their surroundings. The knowledge gained through their experience and on from generation as a guarded secret. Mizoram is a small state but quite rich in orchid diversity.

However these orchids are not properly conserved and developed to a sustainable utilisation level due to lack of eco-scientific management. These orchids have domestic and international potential in cut-flower and medicinal markets. There is great export potential for exotic orchid species found in Mizoram. Till date there are no such marketing potential explored in Mizoram. The markets are mostly operated by village councils though constructed by Department of Trade and Commerce. Forest dept. is planning to establish a sustainable cultivation and establishment of market linkages of local orchid species which have high demand outside the state.

- **Restructuring land use policy for jhum cultivation and habitation on notified forest lands**

Jhum or Shifting Cultivation, a traditional means of agriculture based on indigenous knowledge system as the major form of livelihood for Mizoram farming community was a viable proposition in the past. About 80 per cent of farmers in Mizoram still depend on jhum cultivation that involves clearing forests and burning trees, weeds and bamboos and is believed to have caused considerable loss of forest cover in the species-rich tropical rainforests of the region. Jhum burning accounts for a very high percentage of gas emission when every year almost 2 lakh acres of land in rain forest are cut down and burnt.

New Land Use Policy focused on eco-friendly activities, preserving green forest and through species programme of bamboo plantation would aim at increasing forest cover from the present 49% to 60% of the total land area. The area between Tuilut to Dampa-Rengpui is dominated and extensively used for jhuming. Small forest patches are seen but no gibbons are reported from these patches. Restructuring of the present land use policy is required for control of jhumming in notified forest area. Programmes will be eco-friendly and attuned to soil and water conservation and would encourage the forestation on a large scale with the benefit of environmental protection and over a period time opening up scope for carbon economy.

- **Policy formulation on transportation subsidy or development of low cost transportation for primary Forest products of the state**

Unfortunately, the infrastructure facilities in Mizoram are very poor and the industrial sector has equally been the victim of infrastructural bottlenecks especially in transportation. The high transportation cost of Bamboo from Mizoram to consumer market makes it uneconomical. Subsidy and alternative trade route development for Bamboo is very important aspect of bamboo

market development. The state has transport subsidy on plant & machinery, announced to attract perspective entrepreneurs in to this sector. The main objectives of both the policies were; the enrichment of industrial growth potentials lying in the sectors like agriculture, horticulture, forest and establishment of proper linkage amongst the industries based on resources available in these sectors. Mizoram Government will restructure the existing transport policy to introduce subsidy for transportation of forest based products.

4.2.7 Summary Table: Sustainable Forestry

Sl. No.	Key Priorities	Departments / Organisation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
1	Improvement of forest quality and density in degraded lands and abandoned jhum lands	Department of Forest, Dept. Of agriculture		200.0	200.0	Govt. Of India, External Agencies
2	Improvement the productivity of Bamboo and promotion of local value addition through establishment of market linkages	Department of Forest		2.5	2.5	Govt. Of India, Govt. Of Mizoram
3	Assessment of climate vulnerability and climate change impacts on state biodiversity and forest resources	Department of Forest		2.1	2.1	Govt. Of India, Govt. Of Mizoram, External Agencies
4	Undertaking studies on climate change impacts on NTFP productivity, investment promotion and indigenous harvesting practices for adaptation of climate change	Department of Forest		8.0	8.0	Govt. Of India, Govt. Of Mizoram
5	Undertaking study on valuation of forest resources (Non traded) and climate change impacts on the vulnerable ecosystems	Department of Forest		0.8	0.8	Govt. Of India, External Agencies
6	Ecotourism promotion for biodiversity protection and sustainable livelihood through Pre-investment feasibility study, DPR preparation, pilot implementation in 2 regions	Department of Forest, Dept. Of Tourism		10.0	10.0	Govt. Of India, Govt. Of Mizoram

7.	Capacity building of communities/ community forest management institutions for climate change adaptation	Department of Forest		0.7	0.7	Govt. Of India, Govt. Of Mizoram
8.	Work to establish new systems to support for public awareness building through Establishment of Envis Centre	Department of Forest, SPCB		1.0	1.0	Govt. Of India, Govt. Of Mizoram
9.	Prevention and control mechanism for forest invasive species and its utilisation strategies	Department of Forest		0.65	0.65	Govt. Of India, Govt. Mizoram
10.	Promotion of forest based industries based on various forest based products	Department of Forest, Dept. Of Industries		0.75	0.75	Govt. Of India, Govt. Of Mizoram
11.	Formulation of conservation strategies for Orchids and establishment of market linkages for value addition	Department of Forest		2.0	2.0	Govt. Of India, Govt. Of Mizoram, external agencies
12.	Restructuring land use policy for jhum cultivation and habitation on notified forest lands	Department of Forest, Dept. Of agriculture		0.5	0.5	Govt. Of India, Govt. Of Mizoram
13.	Policy formulation on transportation subsidy or development of low cost transportation for primary Forest products of the state	Department of Forest, Dept. Of Transport		0.5	0.5	Govt. Of India, Govt. Of Mizoram
	Total			**229.5**	**229.5**	

4.3 Sustainable Habitat

4.3.1 Introduction

The climate of Mizoram is neither very hot nor very cold, but moderate throughout the year. The whole state falls under the direct influence of south-west monsoon and receives an adequate amount of rainfall. The climate of the state is humid-tropical, characterized by short winter, long summer with heavy rainfall.

Urbanisation is a process, rather than a product by which a group of people start living in towns and cities dominated by industrial and service functions. It is a process by which population migrates from rural areas to towns and cities which are major commercial and industrial centres in the economy. Mizoram became a state in 1987 and Aizawl became the state capital has been experiencing rapid socio-economic growth. With an 11% growth at two urban centres of Aizawl and Lunglei in 1971 the state claimed to have the higher urban population growth in the country (over 36%) with 22 towns according to 2011 census. The population density of Mizoram at 2011 Census is 52 persons per sq km against 42 persons per sq km recorded during 2001. Among all 8 districts, Aizawl district occupied highest density of population with 113 persons per sq km which is 22 persons more than the figure recorded during 2001 (i.e. 91 persons per sq km). Aizawl town alone accommodates 56.26% of the total state urban population followed by Lunglei with 31.11%, whereas Mamit shows the lowest Urban Population of 16.96%.

4.3.2 Key Facts about urban areas in Mizoram

The population of Mizoram is 10,91,014. It shows that the state's total population has increased by 201,441 persons during last 10 years (Census 2011). The state has experienced relatively slower economic growth in comparison with rest of India. The state of Mizoram, the smallest state in terms of size, is the fifth most urbanized state in India with 49% of its population residing in urban areas. The level of urbanization in Mizoram is likely to be 99% in 2016. As a result of rapid increase of population within the state spilling of population outside the city limits has taken place.

It highlighted the fact that the towns in Mizoram are overgrown villages, trading centres with some rural development administrative office outfits, which become urban settlements. These outgrowth areas are generally devoid of basic urban services and are administered through rural growth mechanism.

There are increasing urban problems of overcrowding and growth of slums, scarcity of water supply, inadequacies of public health and sanitation system, mismanagement of waste materials. The existing urban infrastructure for service delivery is increasingly insufficient, even for provision of core urban public services such as water supply, sanitation and sewerage, urban roads and solid waste management.

Sanitation possesses 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.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 Mizoram 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. Integrated Solid waste Management facility is being implemented in the capital city of Aizawlwith the support from Asian Development Bank (ADB).

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 topographicand concentric development. Often there are days when some areas remain inaccessible due to blockage of roads by landslides or other damages caused by heavy rains. Public transport is limited due to inadequate road network, poor infrastructure and scattered demand. Except for the National Highways and a few leading roads, much of the road length in Mizoram is unusable for load bearing heavy vehicles.

Integrated sewerage and drainage system is not available in all cities of Mizoram. City development plans are underway for construction of the same in the major cities and district headquarters of Mizoram. Under the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) and Integrated Housing and Slum Development Programme (IHSDP) major initiatives taken for six district headquarters. The Housing and Urban Development Corporation Limited has been appointed as consultant to prepare Detailed Project Report (DPR) to provide services to the poor in Aizawl under the Integrated Housing and Slum Development Programme (IHSDP) programme.

4.3.3 Key Issues

The state of Mizoram is located in a highly seismic zone (Zone V) as per the seismic zoning atlas of India and is prone to frequent earthquake shocks and subsequent hazards. The state also lies in the ecologically sensitive region of the northeast India. Although temperature is usually the first variable considered in assessments of climate change, it is important to consider other data that integrate the state of the climate system over space and time. These include such climate parameters like rainfall and humidity.

As per the present status, there has been a prediction in the change occurring which has been experienced even by the common man either in the form of rise in temperature or increase or decrease in rainfall. Also frequent rainfall makes urban living highly vulnerable to climatic impacts such as floods and landslides. However, when analyzed on a yearly basis the trend shows a gradual decline and then a sudden increase from 1990 to 1995 (Fig 1). Infact, during the span of the 20 years study period, 1995 recorded the highest rainfall of 3185.98 mm where as 1994 had the lowest rainfall with a measure of 2278.29 mm only. Thus, it can be interpreted that there is change in the rainfall trend when analyzed and compared between the two decades, but not on an extremely large scale which again shows that this trend can further change the pattern for the consecutive 10 years rainfall data. If this usual small scale change in trend continues, then Mizoram is not expected to experience a sharp decrease in rainfall unless

there are other climatic elements that unexpectedly alter the usual trend, which is mostly above the 2000 mm mark.

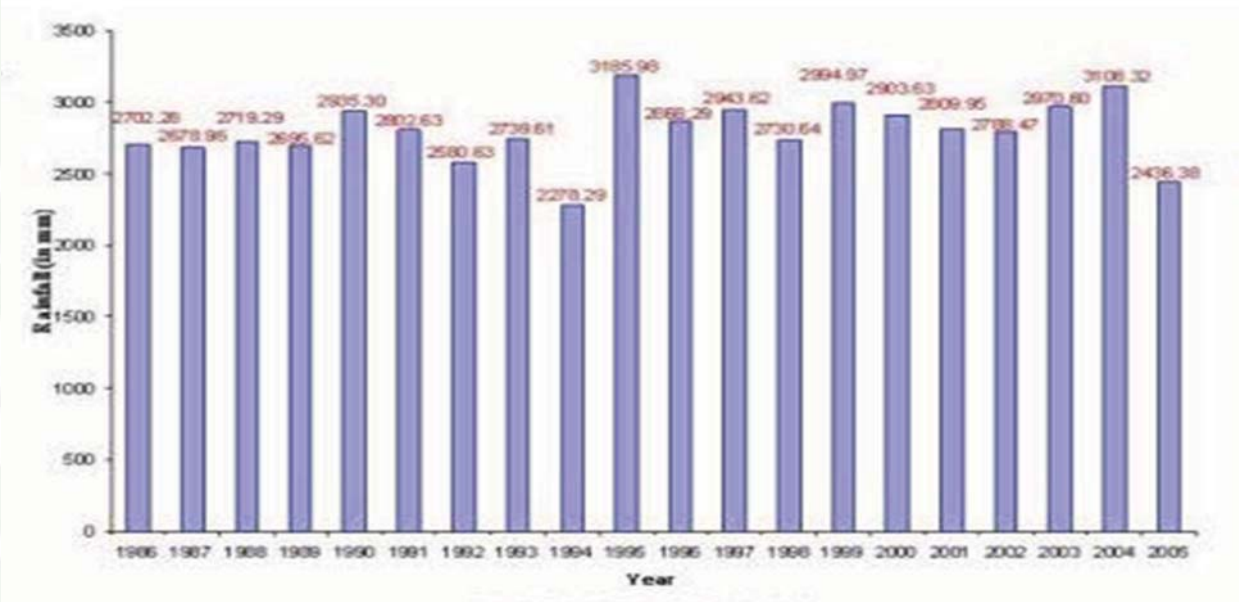


FIGURE 20 RAINFALL VARIATION OF AIZAWL CITY

There has been an increase in the average maximum temperature during 1996-2005 by +0.28°C over the decade of 1986-1995, which denotes a trend in increase in temperature during the last decade. The same increase is also reflected in the average minimum temperature recorded for the decade of 1996-2005 which is +0.30°C, much higher than that recorded for the previous decade of 1986-1995. The rate of increase is clearly reflected when the overall monthly average temperature recorded for both decades shows an increase of +0.29°C. The overall trend in temperature also shows a gradual increase during the 1996-2005 decade. In fact, the global temperature increase for 50 years (1951-2000) was 0.5°C (source: NASA GISS) whereas Aizawl is warming at the rate of 1.22°C in 20 years only. It may be noted that the 20 years data may be too little to base upon.

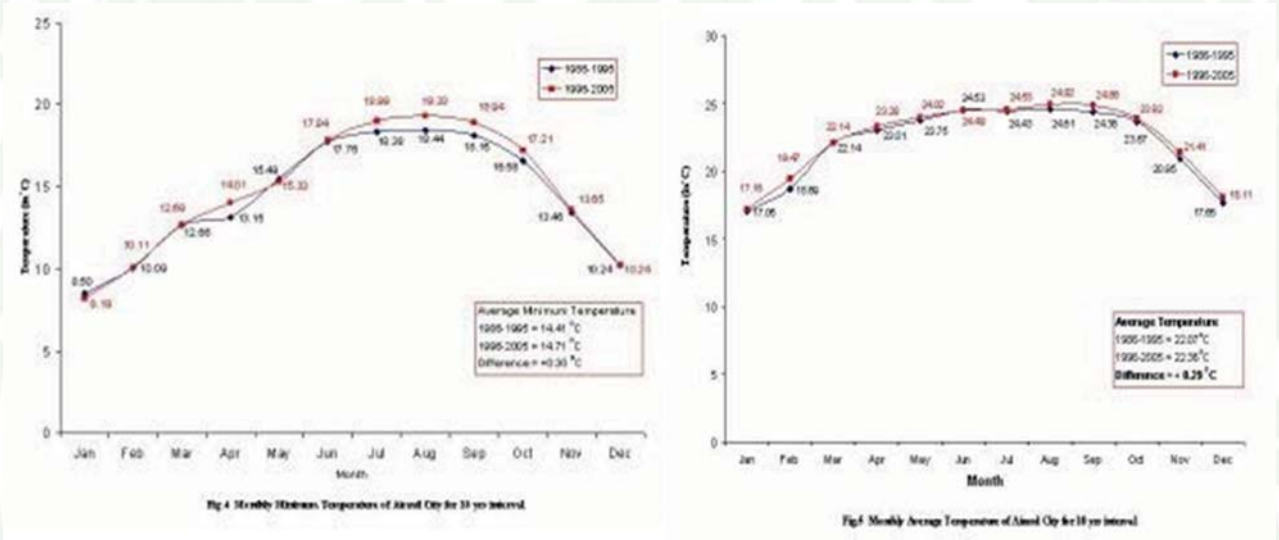


FIGURE 21TEMPERATURE VARIATION

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.

In addition, the large-scale structure of precipitation (rainfall) and heat flux (temperature variations) also closely resembles the observed estimates on a global scale (which was +0.3 and +0.6° C during the last 150 years).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.

4.3.4 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 aberrant 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 urban agglomeration by population influx	Health hazards, soil contamination through leaching, odour pollution	Awareness for waste segregation and policies for landfilling of waste
Transport system congestion and ageing	Congestion and higher GHG 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
Decline in the forest cover	Decrease inbiosequestration of atmospheric carbon dioxide, incur significant adverse soil erosion and frequently degrade into wasteland.	Planting heat tolerant trees, city wide programmes for tree watering and maintenance, roadside plantation programme, development of parks

4.3.5 Key Priorities

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

Key Priorities: Sustainable Habitat

1. Capacity Building and research initiatives on Climate Change Impacts and Preparedness
2. Improvement in water usage management for urban drainage to reduce climate change impacts
3. Development of climate friendly Waste management systems and improvement of aesthetics
4. Reduction of disaster risk through climate change adaptation
5. Energy efficiency improvement and promotion of renewable energy usage in urban sector
6. Improvement of vehicular pollution control mechanism for reduction of GHG emissions
7. Assessment and inventorisation of climate change impact on urban sector

• Capacity Building and research initiatives 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 solid waste management, water management and efficient distribution of supply and delivery and urban management would be conducted and training imparted. Capacity building would also be extended to awareness generation of residents on good practices such as source segregation of waste and energy efficiency.

• Improvement in water usage management for urban drainage to reduce climate change impacts

The water supply in urban areas of Mizoram is inadequate. In order to provide for unforeseen climatic extremes such as floods in urban design, build provisions for storm water flow, and prevent contamination of water streams due to flooding, these aspects would be incorporated into the urban design. The local spring like sources is considered to be converging to the drainage system while its utility to drinking water system remains beyond the normal scope of consideration.

It would include installation of liquid waste treatment facilities, provision of new sewerage system, including the sewage treatment plant, collection network, outfalls and sewer cleaning equipment, both rehabilitation of the existing water supply and distribution systems and construction of new systems, constitution of water use societies for regular monitoring of services, leak detection and water quality monitoring. 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. Activities will include bulk and household water metering and capacity building exercises.

• Development of climate friendly Waste management systems and improvement of aesthetics

Solid waste management subprojects include

construction and upgrading of landfill sites, transfer station, storage and parking facilities for the collection vehicles and procurement of collection and disposal equipment, as eligible under the subproject selection criteria for the Investment Program. 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.

As high priority, the Aizawl city solid waste management project will be initiated and subsequently Lunglei town solid waste management will be developed. It will consist of construction of composting plant, procurement of household bins and provision of door-to-door waste collection for the same, construction of sanitary landfill and transfer station, purchase of collection vehicles and equipment and construction of parking facility for collection vehicles, survey in context of urban development.

- **Reduction of disaster risk through climate change adaptation**

Climate change and urban disaster risk are the two biggest challenges to Mizoram today, as it faces the consequences of unprecedented rates of population growth, urbanisation, economic development and GHG emissions. Most of the towns and the capital city lies in a mountainous high terrain region where natural hazards strike so all the towns will be considered for appropriate measures to reduce its vulnerability. Due to the lack of preparedness, emergency response and post-disaster recovery plans, natural disasters destroyed schools, housing and cultural environment of urban areas, which consequently have serious impacts on efforts towards the sustainable development.

Urban Department will formulate building guidelines with provision for disaster resistance construction, design and materials and will promote traditional environment-friendly & energy-efficient and disaster resistant housing and buildings in urban and rural areas for different agro-climatic zones, flood plains and consideration of seismic vulnerability of the state. Climate responsible master plans for selected cities/towns will be developed considering the disaster risk of the zones. Understanding the function of the land management and revenue department to protect land from encroachment; land revenue code, ownership titles as provided in the present Land Law of Mizoram and reformulation of land tenure policy to enable sustainable urban development is necessary.

- **Energy efficiency improvement and promotion of renewable energy usage in urban sector**

Urbanization and economic development in Mizoram are leading to a rapid rise inenergy demand in urban areas in our country leading to enhanced GreenHouse Gas (GHG) emissions. The capital city of Aizawl and other towns are experiencing rapid growth in thepeak electricity demand. The local governments and the electricity utilities are finding it difficult to cope with this rapid rise in demand and as a result most of the cities/towns are facing electricity shortages. In the state a policy mechanism will be formulated for promotion of solar water heating and lighting system for reduction of energy usage and mitigating GHG emissions. This can be promoted as a Public-Private-Partnership (PPP) basis on selected urban areas. Once established and proven a state-wide programme will be launched. Master plan will be prepared for increasing renewable energy supply and energy efficiency measures in the selected city

and towns along with awareness generation and capacity building activities will be conducted.

- **Improvement of vehicular pollution control mechanism for reduction of GHG emissions**

Aizawl is linked by the National Highway No. 54 which runs from west to east from Sairang to Zemabawk and passes through the city at Bawngkawn saddle the goose neck point of Aizawl. At present Mizoram is solely dependent on its road network to meet its transportation needs. Most of the prime areas are in the top ridges and saddle areas. It leads to the increase in vehicular movement within the state and the connecting cities and towns.

Vehicular emission is one major source of pollution as there is no significant industrialization. The steady increase in number of vehicles in the state is contributing to the deterioration of ambient air quality. The records by the Motor vehicle Inspection Wing, Transport Department, Govt of Mizoram, for the past 11 years show continual trend of increase in vehicular population. This steady increase of number of vehicles year after year shows that vehicles shall continue to be one of the main sources of air pollution in the state especially in the city. Mizoram Government plans to improve the enforcement to control the vehicular pollution which leads to air pollution and GHGs with the help of State Pollution Control Board (SPCB).

- **Assessment and inventorisation of climate change impact on urban sector**

Estimation of emissions load is an essential step in order to quantify the share of Urban Sector in the pollutant levels in the city/towns. The sources of emissions include vehicles, domestic fuel burning, DG sets, solid waste dumping, liquid waste discharge, energy consumption etc. Accurate and comprehensive emission inventories are needed as a foundation for determining the geographic distribution of pollutants, the evolution of their chemical and physical properties and their impact on human health and ecosystems. Similarly, accurate estimates of emission rates and patterns of pollutants are necessary to support effective air quality management strategies. Emission inventories are typically constructed through a data aggregation process that accounts for emission rates, activity levels, and source distributions. Emission rates are often derived from laboratory measurements (e.g. vehicle dynamometer studies), activity levels can be obtained from traffic counts or surveys of sources and source distributions may come from roadway maps, aerial photographs or estimated from population density. However, the propagation of errors associated with this data process can result in large uncertainties that reduce the utility of emission inventories and consequently impede the air quality management process.

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.

4.3.6 Summary Table: Sustainable Habitat

Sl. No.	Key Priorities	Departments /Organisation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
1	Capacity Building and research initiatives on Climate Change Impacts and Preparedness 1. Awareness generation and capacity building in climate change impacts and preparedness 2. Capacity building for departments on advance solid waste management. 3. Capacity building on Water management and efficient distribution of supply and delivery. 4. Capacity building on Urban Management	Dept. of Urban & PA, Power, Transport Dept., PHE		1.3	1.3	Govt. Of India, External Agencies
2	Improvement in water usage management for urban drainage to reduce climate change impacts 1. Liquid waste management through improved sewage design for addressing climate change impacts 2. Developing models of urban storm water flows and capacities of existing drainage system	PHE, Dept. of Urban & PA		600.0	600.0	Govt. Of India, Govt. Of Mizoram, External Agencies
3	Development of climate friendly Waste management systems and improvement of aesthetics 1. Developing a climate friendly waste management system 2. Landfill gas recovery from closure landfills 3. Reduction of vector borne diseases from unmanaged dumping grounds 4. Improvement of collection efficiency and resource recovery	Dept. of Urban & PA, Municipal council		701.0	701.0	Govt. Of India, Govt. Of Mizoram, External Agencies

4	Reduction of disaster risk through climate change adaptation 1. Formulation of building guidelines with provision of promoting traditional houses for different agro-climatic zone, flood plains and in consideration of the seismic vulnerability of the state 2. Developing climate- responsible master plans for selected city/ towns (CDP) 3. Reformulation land tenure policy to enable sustainable urban development	Dept. of Urban & PA		5.8	5.8	Govt. Of India, Govt. Of Mizoram
5	Energy efficiency improvement and promotion of renewable energy usage in urban sector 1. Promotion of solar water heating and lighting in buildings through policy mechanisms	Dept. of Urban & PA		0.15	0.15	Govt. Of India, BEE/ MNRE, External Agencies
6	Improvement of vehicular pollution control mechanism for reduction of GHG emissions 1. Improve enforcement to control vehicular pollution	Transport Dept., Dept. of Urban & PA		6.0	6.0	Govt. Of India
7.	Assessment and inventorisation of climate change impact on urban sector 1. Quantitative assessment of the impact of climate change	Dept. of Urban & PA		0.35	0.35	Govt. Of India
	Total			**1314.6**	**1314.6**	

4.4 Health

4.4.1 Introduction

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-being as 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 the 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. Increased 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 sections 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 may be in form of heat strokes which 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.

One of the youngest states of the union, Mizoram 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 region that 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. The socio economic scenario of 1.09 million Mizo population distributed across 719 villages and 23 towns in 8 districts is represented in terms of socio-economic indicator like literacy rate (Mizoram's has one of the highest literacy rate in the country 2 ER of 91.58%[i]), lower population density of 52 persons per sq km, economic status (12.6% percent of total population lying below poverty line[ii]) and employment(total employment of 0.41 lakhs[iii]).

Though National Action Plan on Climate change does not identify human health as a separate National Mission, Govt of Mizoram is focused 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 diseasesand 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.

4.4.2 Key Facts about the Sector

The section intends to present and overview of the health status of the state that has formed an integral part of strategy development. The parameters include overall health scenario, diseases outburst (incidence and prevalence of both communicable and non communicable diseases), morbidity and associated mortality, health risk and available infrastructure. Although the fact remains that trends of diseases over years are not exclusively driven by the impact of climate change but the issue persists that the existing health scenario might deteriorate under weather variability and overall human health impact may escalate with respect to their virulence and spread to hitherto diseases free area.

Demographic Characteristics

TABLE 13BIRTH RATE

Category	India		Mizoram	
	2008	2009	2008	2009
Combined birth Rate (Birth rate Per 1000 population)	22.8	22.5	17.8	17.6

TABLE 14DEATH RATE

Category	India			Mizoram		
	Male	Female	Total	Male	Female	Total
Death Rate (death rate Per 1000 population) in 2009	8.0	6.8	7.4	6.3	3.9	5.1

TABLE 15INFANT MORTALITY RATE

Category	India			Mizoram		
	Male	Female	Total	Male	Female	Total
Infant Mortality Rate (death rate Per 1000 population) in 2009	49	52	50	33	38	36

Table 16Health Status : Communicable Diseases

Malaria Cases

Category	India		Mizoram	
	Cases	Death	Cases	Death
Malaria Cases (Reference period Dec 2006)	1785129	1707	10650	120
Malaria Cases (Reference period Dec 2007)	1508927	1311	6563	75
Malaria Cases(Reference period Dec 2008)	1526210	1055	7361	91
Malaria Cases(Reference period Dec 2009)	1563574	1144	9399	119
Malaria Cases(Reference period Dec 2010)	1373317	678	15626	71

Diarrhoeal Diseases

Category	India		Mizoram	
	Cases	Death	Cases	Death
Diarrhoeal Diseases (Reference period Dec 2009)	11984490	1818	21841	17
Diarrhoeal Diseases (Reference period Dec 2010)	10112845	1388	16142	12

Enteric Fever

Category	India		Mizoram	
	Cases	Death	Cases	Death
Enteric Fever (Reference period Dec 2009)	1099331	436	1163	4
Enteric Fever(Reference period Dec 2010)	1034642	379	1115	0

Acute Respiratory Infection

Category	India		Mizoram	
	Cases	Death	Cases	Death
Acute Respiratory Infection (Reference period Dec 2009)	28240346	3043	41078	16
Acute Respiratory Infection(Reference period Dec 2010)	24720144	2612	25665	18

Viral Hepatitis

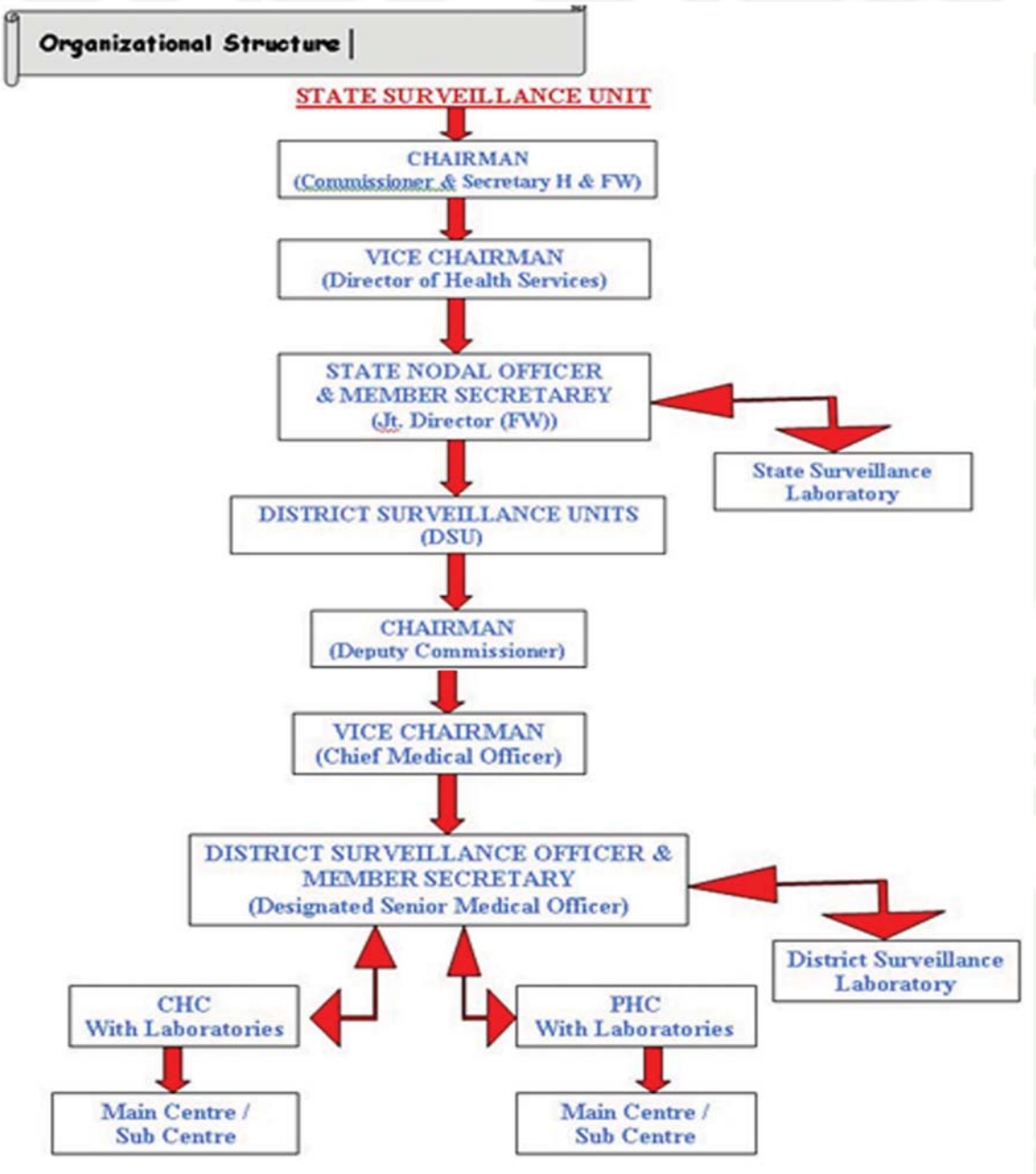
Category	India		Mizoram	
	Cases	Death	Cases	Death
Viral Hepatitis	124085	600	476	7

Infrastructure

Health is a state subject in India where the policies and infrastructure are planned and developed by the state government. The health care infrastructure of the state comprises of network of hospitals, Community health Centre (12 CHCs – Community Health Centres are designed to provide all assured services which includes routine and emergency care in addition to all national Health Programme and all support and service to fulfil national programmes), Primary Health Centre (57 PHCs – Public Health is the first port of call for routine, preventive, promotive, curative and emergency care in addition to all national health programme) and sub-centres (370 sub-centre and 60 sub centres clinic –Sub centres is the most peripheral and the first contact point between the primary health care system and community care system). Despite of the expansion of health care facilities in the state till the last plan period the health care facilities and access to quality health services need improvement in the state especially in the rural areas where there is no public health providers. Rural health care services in the state lacks the adequate infrastructure including shortage of medical and Paramedical staff's absence of medicines and supplies due to limited financial resources.

Apart from the health care facilities rendered in the state, the department has also provisioned to improve the general health of school going children under School health programme through all PHC and CHC. The program is conducted with an objective of promotion of positive health, of school children, prevention of diseases, early diagnosis and treatment along with awakening of health consciousness and improving hygiene and environment.

The health department in the state is bifurcated into two directorates viz, Directorate of health service and Directorate of hospital and medical education. The organogram for the health and family welfare department is presented below:



4.4.3 Key Issues

Increase in morbidity/mortality due to increased incidence of Vector Borne diseases

Transmission dynamics of malaria is highly climate sensitive and is severely impacted by the climatic conditions. Epidemiological study substantiated the impact of climate change on malaria. The study revealed decrease in the duration of sporogony in anopheles mosquito with increase in temperature from 20 to 250C.

Since the anopheline mosquito are cold blooded the development of parasite in their body are effected by climatic condition like temperature, rainfall, relative humidity, frost and wind velocity. At increased temperatures the rate of digestion of blood meal in mosquito increases which in turn accelerates the ovarian development, egg laying, reduction in duration of gonotrophic cycle and higher frequency of feeding on hosts thereby enhancing the probability of transmission as reduction in the duration of gonotrophic cycle and sporogony are related

with increased rate of transmission . A relation between the temperature and duration required for the completion of sporogony of the parasite in anopheles mosquito is presented in the table below[vi] :

TABLE 17 MALARIAL INCIDENCE

Parasite Species	No. of Days required for sporogony at different temperature	
	200C	250C
P.falciparum	22-23	12-14
P.vivax	16-17	9-10
P.malarie	30-35	23-24
P.ovale	Not known	15-16

Weather Variability[vii]

Temperature

The temperature condition of Mizoram can be described in terms of not so warm summer (20-300C) and not very cold rain free winter (11-210C). However temperature analysed using 20 years temperature data from 1986-1995 and 1996-2005 revealed an increase of average temperature in course of last decade in comparison to earlier. There has been observed increase in average maximum temperature by 0.28^0C, average maximum temperature by 0.30^0C in 1996-2005 over 1986-1995 periods. The trends of increase in average temperature across the years revealed a probability of gradual increase in temperature.

Humidity

A study of 20 years humidity data revealed and average increase of humidity from 73.14% during 1986-1990 to 81.42% in 2001-2005.

TABLE 18 DEATH DUE TO MALARIA

Year	Population	BSC/BSE	ABER	Total Malaria Cases	SPR	SFR	Death due to Malaria
2006	905689	218072	24.07	10650	4.88	3.18	120
2007	980366	154045	15.71	6563	4.26	2.69	75
2008	980366	165441	16.87	7361	4.4	3.73	91
2009	980366	171793	17.52	9399	5.47	4.29	119
2010	1001289	322929	32.25	15626	4.68	4.39	71

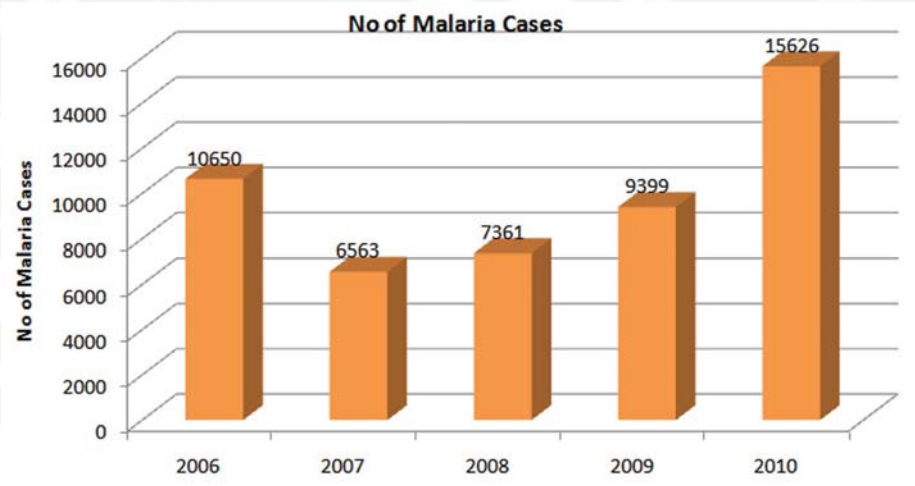


FIGURE 22CASES OF MALARIA IN THE STATE

TABLE 19 GENDER WISE INCIDENCE

Age wise	Male	Female	Pregnant woman
0-4	940	892	Among 15626 malarial cases 23 are pregnant woman
5-15	2036	1949	
15 years and above	5553	3831	

FIGURE 23 PARASITE INCIDENCE

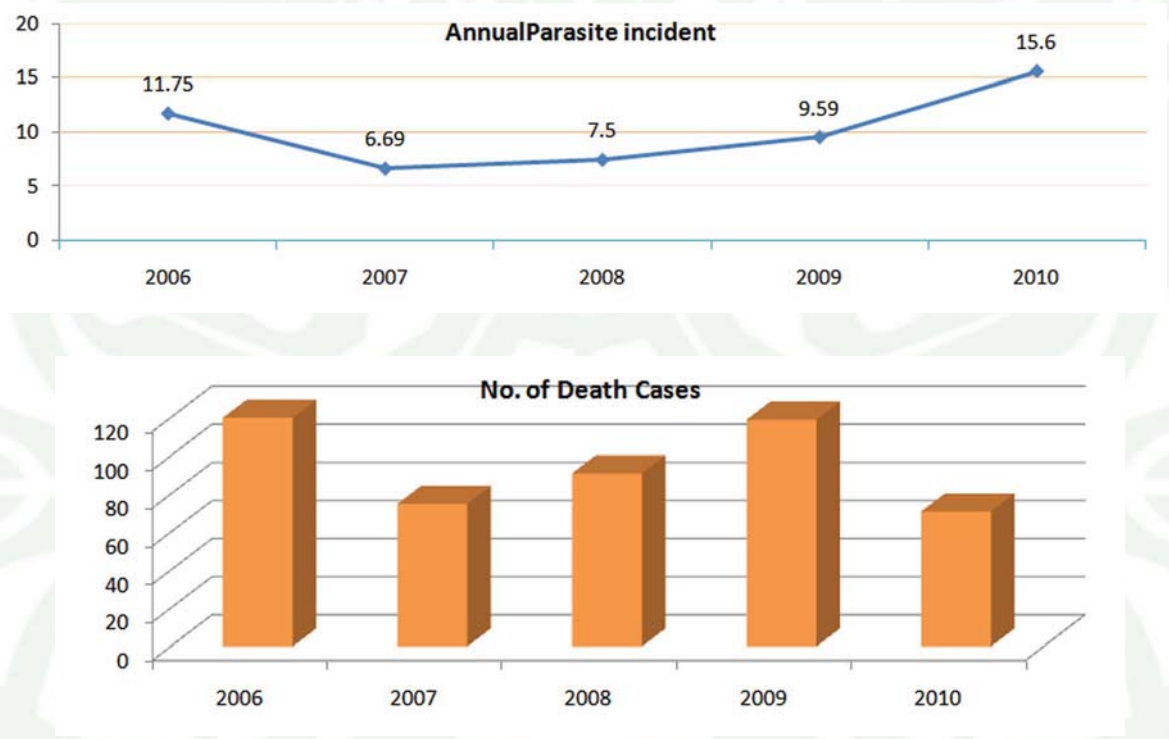


FIGURE 24 PARASITIC DEATH

From the above figure it is well evident that although the number of malarial death has decreased across the year the number of malarial incidence and annual parasite incidence has enhanced across the year substantiating the increase in the morbidity due to malaria.

Projection of Malarial Transmission

Based on the minimum required temperature for ensuring transmission of malaria and projected climatic condition a projection is provided for transmission in the year 2030 as against the baseline (1960-1990).

Transmission Window's of Malaria in North-Eastern region based on temperature and RH (Baseline (1960-1990) and projected scenario by 2030)

TABLE 20 MALARIAL TRANSMISSION

State	No. Of District	No. of months open for Malaria Transmission			
			7-9	10-12	Data not Available
Mizoram	8	Baseline	6	1	1
		Projection	3	4	1

Activity Undertaken

1. Distribution of Long Lasting insecticidal Nets in villages where malarial incidence is high (in year 2009 and 2010 around 70,000 and 80,000 numbers of Long Lasting insecticidal Nets were distributed in the villages of Mizoram)

2. Indoor Residual spray

3. Increase awareness to the population regarding the curative and preventive measures under NVBDCP

4. Training, orientation, reorientation and refreshers course is conducted from FTD/ASHA, NGO, Medical officer and specialists.

5. Surveillance within the state boundary to take blood smear of any fever cases suspected for presumptive dose.

Gaps

a. Requirement of man join power and decentralisation of funds and material for malaria control in far off and inaccessible area.

b. Funds for vehicle hiring and treatment of people living under below poverty line and inaccessible areas.

c. Infrastructure for transfer of slides from sub-centres to PPP microscopy centre or Government microscopy centre.

d. Lack of adequate facility for identifying extrinsic and intrinsic drivers towards devising

Enhanced exposure to Water Borne Diseases

Water borne diseases are classified as water borne (ingested) and water washed (caused by lack of hygiene). Several factor like water availability, household access to safe water and impact of temperature plays vital role in incidence of water borne diseases.

The State of Mizoram is characterised with poor and unsafe drinking water and sanitation facilities (9.99% of the rural household and 1% of the urban household in the state lacks toilet-2001 census). The unavailability of safe drinking water and improper sanitation facilities in far off and inaccessible area enhances the chances of incidence of water borne diseases.

TABLE 21 ACCESS TO DRINKING WATER

Category	India		Mizoram	
	1991	2001	1991	2001
Household having Safe Drinking water Facilities (in %)	62.30%	77.90%	16.21%	36.00%

The situation of quality water availability is further worsen during the dry season due to increase of the pathogen loading of the water as well as during the over precipitation(water contamination via flooding) period due to increase in microbial loading.

Of the Water borne diseases the incidence of Diarrhoea and enteric fever are quite noticeable in the state. Although the rate of the both the diseases has decreased in 2010 in compared to 2009 the total number of cases seems to provide additional diseases burden.

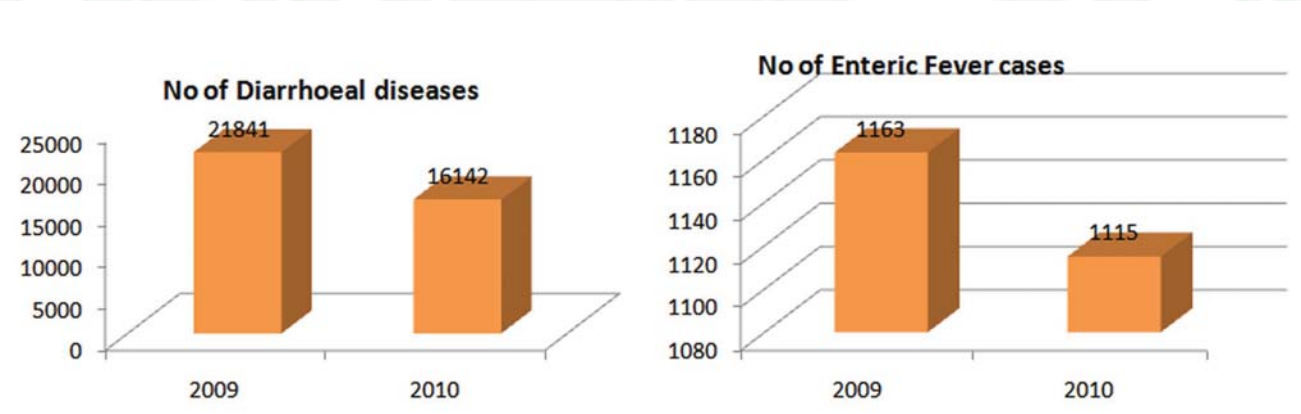


FIGURE 25 INCIDENCE OF WATERBORNE DISEASES

Enhanced exposure to Cardio –Respiratory Problem

Assuming current emission level continue their is high chances for deterioration of air quality in urban region as well increased exposure to ozone and other air pollutant including particulate matter projecting an increase in cardio-respiratory morbidity and mortality. Certain weather patterns enhances the development of urban heat island, the intensity of which is important for secondary chemical reaction within the urban atmosphere leading to elevated level of some pollutants.

The climate change may also alter the seasonal distribution of some allergenic pollen species leading to physiological problem.

Enhanced chances of Malnutrition and Food Insecurity:

The lowering of yield of food crops due to climatic variability might diminishes dietary diversity and reduces overall food consumption and may therefore lead to micronutrient deficiencies posing impact including death, malnutrition and/or micronutrient deficiencies specially among the vulnerable section of the population with lower economic stability. Food insecurity issue may also lead to urban migration.

4.4.4 Adaptation Pathway

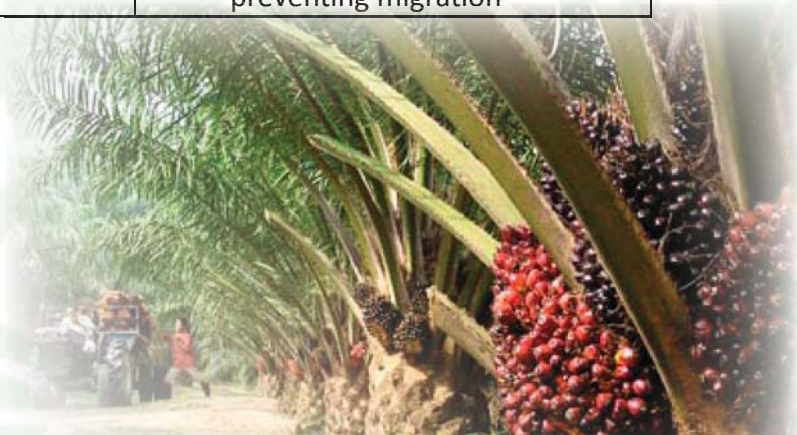
Adaptation measures are strategized in order to offset and reduce the negative impact of climate change and utilising the positive impacts towards enhancement of overall sustainable development.

For working out the comprehensive strategy the socio economic driving forces are also linked those are indirectly impacted by the climate change but influence the overall health scenario which forms the fundamental and integral part of socio economic development.

Climate change Issues	Impact	Pathway
Surface temperature is projected to increase between 0.8-2.10C	Expected to face an increase incidence of malaria due to increase in temperature	Development of adaptation frame work towards reducing the incidence of malaria and enhancing the infrastructural facilities towards facilitating prompt and complete treatment of vector borne diseases
Decrease in winter Precipitation Increase in intensity of summer precipitation Increase in night time temperature	1. Lower crop yield in winter 2. Damage of crop due to higher precipitation 3. Increased pest incidence 4. Increase runoff and landslide during summer precipitation 5. High night temperature reducing cereal yield	1. Management of Malnutrition and addressing food security issues 2. Loss of employment and adverse effect on health
Climatechange Extremes like flood, landslide	1. Damage to agriculture leading to Increased Poverty and malnutrition, population displacement 2. Population displacement adversely impacting social cohesion and health	1. Planning effective disaster management programme 2. Increased surveillance for evidence malnutrition including micronutrient deficiencies 3. Addressing the specific needs of the community thereby preventing migration

4.4.5 Key Priorities

The following are the key priorities identified in the health sector:



Key priorities: Health Sector

1. Identify extrinsic and intrinsic drivers of malaria and identifying immunity intervention measures towards control of incidence of malaria.
2. Assessment of impact of heat stress on human health and framing adaptation strategy, identification, documentation and awareness creation on temperature related morbidity
3. Evidence based assessment of biophysical determinants of malaria and development of framework for adaptation measures for malaria control.
4. Carrying out of Adaptation study
5. Research initiatives to identify change in pattern of diseases by region due to climate change/ weather variation
6. Study and documentation of diseases caused by water (water borne) and development of institutional mechanism to reduce the incidence/outbreaks of such diseases along with awareness generation
7. Development of institutional framework and infrastructural facilities for early detection of vector borne diseases, including managing outbreaks
8. Establishment of pathological laboratory with state of art technology for diseases identification
9. Public health system infrastructure development for extreme climate risk management and managing outbreaks of major diseases
10. Capacity building and training for health workers for sensitisation of climate variation and health impacts
11. Research study on malnutrition of vulnerable group due to food security caused mainly due to climatic variation

- **Identify extrinsic and intrinsic drivers of malaria and identifying immunity intervention measures towards control of incidence of malaria.**

Mizoram is a malaria prone area with around 7-9 months of open transmission window. The weather condition (hot and humid for around 9 months) in the region is conducive for both mosquito proliferation and active malaria transmission. Mostly pockets in forest, forest-fringe and foothill villages located along inter country/interstate border are vulnerable to occasional outbreaks. Many of the intervention like indoor residual spray is not operationally feasible as the human settlements are scattered in hilly terrain and are also not accepted among the community.

The quantum of transmission in the region is governed by two entomological indices i.e. vectoral capacity and Entomological Inoculation Rates (EIR) per person/night. These indices are directly affected by the density of vectors in relation to number of humans in a given local situation, daily survival rate, feeding rate of vector

mosquitoes and the duration of the sporogonic cycle which are sensitive to environmental conditions.

Although the environmental and eco-climatic factors are assisting in enhancing the breeding of mosquitoes but such parameters cannot be varied. It is therefore highly essential to identify the other extrinsic and intrinsic factor based on the local conditions through detailed entomological investigation in malaria endemic pocket.

The studies can include identification of vectors and parasite prevalence region wise, their breeding time and places, bionomics concerning their breeding, in addition to other parameters like geographic distribution, seasonal prevalence and host feeding preference and other related issues.

Based on the identified extrinsic and intrinsic factor the immunity intervention measures towards control of incidence of malaria will be strengthened including variety of options like distribution of LILN, Insecticide treated bed nets, antimalarial drug, introduction of larvivorous fishes in stagnant water, introduction of residual spray, clinical cure and awareness creation through training programme.

- **Assessment of impact of heat stress on human health and framing adaptation strategy, identification, documentation and awareness creation on temperature related morbidity**

The rise in temperature due to climatic change is likely to intensify the summer conditions with heat waves poses risk of deaths from heat strokes, diseases (skin and eye diseases) and injury. The risk is higher among the vulnerable groups which include infants, elderly persons, pregnant woman, urban poor and labourers.

In order to reduce the impact of heat stress on human health it is essential to quantify the heat effect on human health including the identification of medical, social, environmental and other factors that modify the temperature–mortality relationship in line with the local factors like climate, topography, heat-island magnitude, income, and the proportion of elderly people. Based on the assessment the appropriate infrastructure can be developed which includes setting up of intensive therapy units in existing health care facilities for prompt treatment.

Since the climate change and its impact on the health related issues are expected to be widespread, strengthening awareness, knowledge and skills at all levels across the states is highly essential. Such initiatives includes advocacy and sensitization of policymakers, massive general awareness campaign, sensitization of the health service providers (ASHA, AYUSH, Doctors), health workers and paramedic staff, strengthening community resilience.

- **Evidence based assessment of biophysical determinants of malaria and development of framework for adaptation measures for malaria control.**

To frame up the adaptation measures it is essential to undertake multi-disciplinary, multi-institutional and multi- locational study to generate evidence for impact of climate change on malaria. Such study is essential for developing a framework for adaptation measures for addressing the adverse impacts of climate change on malaria. Such study should include field survey in vector and parasite prevalence pockets, surveillance of entomological indices and malaria.

The adaptation measures towards control and outbreak of vector borne diseases includes

both proactive initiatives towards reducing the incidence of diseases and reactive measures including preparedness for undertaking prompt and complete treatment.

Development of proactive framework includes:

- Enhanced surveillance of suspected fever cases which is the cardinal symptom of malaria
- Supply of LLIN to population at higher risk of malarial incidence
- Supply of Insecticide treated bed nets
- Residual spray
- Chemoprophylaxis - Chemoprophylaxis is recommended for travellers, migrant labourers and military personnel exposed to malaria in highly endemic areas. Use of personal protection measures like insecticide-treated bed nets should be encouraged for pregnant women and other vulnerable populations.
- Assessment of malaria related knowledge, practices and behaviour of the community in malaria endemic areas to develop behavioural change for developing strategy towards prevention and control of malaria
- Increased awareness level and enhancing community participation in control of malaria
- Monitoring and supervision of activities to ensure carrying out of Malaria Control Programme in effective and judicious manner which is most often jeopardized due to lack of funding and lack of adequate professional support.
- Development of reactive frame work includes
- Early diagnosis followed by Prompt, effectiveand complete treatment
- Development of adequate infrastructure towards diagnosis of severe malaria cases negative on microscopy
- Strengthening of present health care set-up
- Development of adequate infrastructure for management of complications for management of severe malaria

• Carrying out of Adaptation study

Adaptation activity is needed to be implemented in order to counter and reduce the vulnerability to climate change that has already occurred and health risk projected to occur over coming decades. Current levels of vulnerability are due to non-performance of traditional public-health activities, including providing access to safe water and improved sanitation to reduce water borne diseases, and implementing surveillance programmes to identify and respond to outbreaks of malaria and other infectious diseases.Weak public-health systems and limited access to primary health care contribute to high levels of vulnerability and low adaptive capacity amongst the people.

In order to reduce the burdens of climate-sensitive health, determinants and outcomes may need to be revised, reoriented and in some regions expanded to address the additional pressures of climate change. To this context an assessment is required to be carried out to determine the degree to which the existing health programmes need to be augmented depending on factors such as the current burden of climate-

sensitive health outcomes, the effectiveness of current interventions, projections of where, when and how the burden could change with changes in climate and climate variability, access to the human and financial resources needed to implement activities, stressors that could increase or decrease resilience to impacts, and the social, economic and political context within which interventions are implemented. Given the importance of these types of assessments, further research is proposed under the state climate change action plan. The assessment will also include the cost of adaptation.

- **Research initiatives to identify change in pattern of diseases by region due to climate change/ weather variation**

There is high probability that Climate change might enhance the chances of newly emerging infectious diseases, re-emergence of diseases previously under control and redistribution of diseases in new areas/diseases free area. Since the overall health condition is vital element in determining the adaptive capacity there is a high chance that the burden of disease and disability are likely to be more severe than otherwise in light of change in climatic conditions. The degree of emergence of diseases and climate change related vulnerability in the future will depend not only on the extent of socio-economic change, but also on how evenly the benefits and costs are distributed, and the manner in which change occurs (McKee and Suhrcke, 2005). Given the importance of these types of assessments, further research is proposed under the state climate change action plan.

- **Study and documentation of diseases caused by water (water borne) and development of institutional mechanism to reduce the incidence/outbreaks of such diseases along with awareness generation**

Climate-change-related alterations in rainfall (enhancement of precipitation- flood situation), surface water availability and water quality (increased contamination) could affect the burden of water related diseases. Extreme summer and lower rainfall is envisaged to enhance the pathogen loading whereas extreme rainfall and runoff events may increase the total microbial load in water courses and drinking water reservoirs. So it is vital that a research study being is carried out to find out the possibility of outbreak.

Institutional development involves strengthening the surveillance with an integrated approach for management of water borne diseases including water source contamination and determining possibility of outbreaks of water borne diseases including developing of infrastructure towards facilitating prompt treatment of the diseases.

- **Development of institutional framework and infrastructural facilities for early detection of vector borne diseases, including managing outbreaks**

Vector-borne diseases such as malaria enhance the morbidity and mortality leading to social disruptions within the community. Besides ecological parameters which influence the disease incidence other local factors such as socioeconomic, socio-cultural and behaviour patterns of the community play a major role in disease transmission. The objective of early detection and managing outbreaks can be accomplished by compilation of generated dataset and its integration within spatial infrastructure (SI) and introducing a geographical information system (GIS) for analysis and management of diseases outbreaks.

As a part of GIS infrastructure development thematic layers including PHC/CHC locations, geomorphological parameters, land use, soil type, water bodies, drainage network, forest cover and settlement is to be considered to form the basis of analysis towards describing the primary risk factor within the PHC/CHC's. Thematic maps of ecological parameter when overlaid on Malarial API map can guide towards information on malarial epidemiology including early detection and framing up strategy towards managing outbreaks.

- **Establishment of pathological laboratory with state of art technology for diseases identification**

Climate change is expected to enhance burden on the existing health care system and specifically the diseases detection centre in the far off, remote and inaccessible areas or even in malaria endemic pockets where microscopy cannot be conducted within 24 hrs of sample collection or does not have RDT facilities or facilities of storing of RDT under recommended conditions. Such areas call for increase in the test centre for early detection of malaria.

Moreover some patient may not respond to treatment due to drug resistance or treatment failure or happened to be the case of severe malaria where microscopic evidence may examined to be negative. In such cases there is a requirement of well-equipped lab.

Judging the necessity on the basis of above scenario well equipped labs are proposed in the state at malaria endemic pocket and also at remote areas that are not well connected to the main part of the sate having well equipped laboratory.

- **Public health system infrastructure development for extreme climate risk management and managing outbreaks of major diseases**

Climate changes poses high risk of extreme climatic events like enhanced precipitation leading to flooding, drought and landslide. A disaster management plan and emergency preparedness measures needs to be facilitated in order to reduce the impact of climate change extreme events. The infrastructural facilities need to be strengthened including strengthening of the current health care facilities to respond during natural disaster. Actions such as community resilience, disaster preparedness, extending psychological aid to victims, retrofitting of vulnerable infrastructure, strengthening surveillance including traditional knowledge and cultural plan is proposed under the initiatives.

- **Capacity building and training for health workers for sensitisation of climate variation and health impacts**

Since the degree, dynamics and intensity of the vector and water borne diseases are changing with changing of time it is highly essential that training should be imparted to the existing man power on the treatment procedures. The training is to be carried out among the different categories of health care service provider after understanding the training requirement, development of module in consultation with state health department, undertaking training of local trainers and imparting of training among the community through the identified and trained trainers.

- **Research study on malnutrition of vulnerable group due to food security caused mainly due to climatic variation**

Climate change variations are expected to lead to consequential decline in agriculture and increased malnutrition and food security. Given the importance of these types of assessments, further research is proposed under the state climate change action plan to assess the increased impact due to climate change and develop nutritional status of vulnerable population.

Monitoring and managing migration and psychological impacts of food security on the vulnerable rural poor is also planned as a part of the study.

4.4.6 Summary Table: Health

Sl. No.	Key Priorities	Departments/ Organisation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
1	Identify extrinsic and intrinsic drivers of malaria and identifying immunity intervention measures towards control of incidence of malaria.	Healthdept, Research institute		1.2	1.2	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
2	Assessment of impact of heat stress on human health and framing adaptation strategy, identification, documentation and awareness creation on temperature related morbidity	Healthdept, Research institute		2	2	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
3	Evidence based assessment of biophysical determinants of malaria and development of framework for adaptation measures for malaria control.	Healthdept, Research institute, Mizoram Remote sensing Application Centre		1.2	1.2	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
4	Carrying out of Adaptation study	Healthdept, Research institute		3	3	Govt of Mizoram, Govt of India
5	Research initiatives to identify change in pattern of diseases by region due to climate change/ weather variation	Healthdept, Research institute		5	5	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies

6	Study and documentation of diseases caused by water (water borne) and development of institutional mechanism to reduce the incidence/outbreaks of such diseases along with awareness generation	Health dept		35	35	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
7.	Development of institutional framework and infrastructural facilities for early detection of vector borne diseases, including managing outbreaks.	Health dept		10	10	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
8.	Establishment of pathological laboratory with state of art technology for diseases identification	Health dept		15	15	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
9.	Public health system infrastructure development for extreme climate risk management and managing outbreaks of major diseases	Health dept,		200	200	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
10.	Capacity building and training for health workers for sensitisation of climate variation and health impacts	Health dept, NGO		1	1	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
11.	Research study on malnutrition of vulnerable group due to food security caused mainly due to climatic variation	Health dept, Research institute		1	1	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
				274.4	**274.4**	

4.5 Energy Sector

4.5.1 Introduction

Energy is a key indicator and input to achieve the desired economic growth. The development of a country or state or a region is measured in terms of technological development, industrialization and socio- economic growth. The entire fabric of developmental goals is webbed around a successful energy strategy. Human's quest for leading a better and comfortable life and with the present era of massive growth in all the spheres of life, it has compelled him/her to use all available energy sources irrespective of the involved cost and environmental degradation.

Climate change is admittedly a serious issue and must be a key consideration in any energy policy, but ensuring diversity of energy supply and providing affordable energy options are also important issues. The action plan on energy is presented to enable communities to understand the uncertainty of future climatic conditions and engage effectively in a process of developing adaptation and mitigation programmes. The climate change action plan for energy sector is strategized in line with the National Climate Change Action Plan goal of promoting the country's development objectives while yielding co-benefits for addressing climate change effects. The energy action plan is developed by following the approach of adaptation measures which will help to cope-up with climate change effects and also the mitigation measures to portray the pathway of reducing the carbon emission intensity and achieving the sustainable development.

4.5.2 Key Facts about the Energy Sector

Mizoram is far behind in terms of the economic and infrastructural growth level of the nation since last three decades which can easily be depicted from the per capita energy consumption[5], a key indicator of human development and growth[6]. Availability and access to quality, reliable and affordable power is critical parameters for promoting economic and social development of the developing countries. The per capita energy consumption of the state in all demand segments – domestic consumers, industrial consumers, agriculture consumers, etc. is one of the lowest in the country. Mizoram which is a power deficit state owing to negligible in-house power generation capacity is facing a serious power shortage and financial constraints as the majority of power requirement is procured from other states at an average rate of Rs. 6.33 /unit including wheeling charges whereas the state government sold power to the public at an average subsidised rate of Rs. 1.75/ unit[7]. The change in climate condition and inconsistent rainfall pattern in the state is observed in last few years. Around 64% of total rainfall of Mizoram occurs in monsoon period of June to September of every year. Almost all the hydro power plants of Mizoram have seasonal operation due to non-availability of water in lean period.

[5]Per capita electricity consumption of Mizoram as 185 kWh is very low compared to the national average of 566 kWh (World Bank Data for 2008).
[6]According to Human Development Index (HDI), coined by UNDP.
[7]Source: Zoram Energy Development Agency, August 2009

TABLE 22 DEMAND MIX

Restricted Peak Demand[8]	100 MW
Restricted Off Peak Demand	50 MW
Electricity Consumption Pattern	
Domestic Consumers	68%
Commercial	13.65%
Public Lighting	4.95%
Agriculture	0.001%
Public Water Works	28.14%
LT Industrial	2.40%
Bulk Supply (HT)	12.02%

Till now Mizoram is not exposed to any large industrial activities as a result the HT industrial electricity consumption is observed as nil. Majority of electricity demand is of LT consumers as high as 94% of total electricity consumed out of which 68% is consumed by the domestic sector only.

The power demand of the state is met through own generation from small hydel, diesel and thermal power stations owned by the Power & Electricity Department and through import from other NE Grid. The installed capacity of 52.77 MW[9] of power generation in the state is primarily Hydro based which results in around 13.48 million units during 2009 -10 and remaining 3.3 million units from Heavy Fuel Oil based power plant in Bairabi. Owing to high generation cost, diesel, HFO and thermal power plants are kept as standby for emergency requirements. The state's own generation is insufficient to meet the peak demand. The hydro power potential of the state is estimated at 2425 MW, out of which only about 1.5% is presently harnessed.

TABLE 23 POWER SECTOR IN MIZORAM

Year	Energy Consumption (in Million Units)	Energy Generation (in Million Units)			
		Hydel	Thermal	Diesel	Total
2004-05	125.65	5.92	0.59	0.07	6.58
2005-06	134.51	8.66	2.43	0.38	11.47
2006-07	151.22	11.14	3.05	0.03	14.22
2007-08[10]	179.44	16.30	2.59	0.03	18.92
2008-09	169.86	8.2	-	2.6	10.8
2009-10[11]	190.70	13.48	-	4.0	17.48

[8]Source: Annual Report on Energy Conservation Measures in Mizoram for 2009-10 by State Designated Agency, Mizoram

[9]Ref: Tariff Order of 2010-11 by Joint Electricity Regulatory Commission for Manipur & Mizoram.

[10]Ref: Economic Survey of Mizoram -2008-09

[11]Ref: Annual Report of Energy Consumption Measures in Mizoram for 2009-10 by State Designated Agency, Mizoram.

At present only 8% of the total energy demand of the State is met through own generation and the remaining 92% is imported mainly from Central Sector (NEEPCO, NHPC) and TSECL. The daily peak shortage at normal condition accounts for about 34% to 40%. Around 20% of Mizo villages are still un-electrified and have no access to electricity as per the definition of Electrified Village from Government of India . Lower electrification in the village level is the result of difficult terrain, unevenly dispersed population and high incidence of rural poverty.

The conventional primary sources of energy in Mizoram are fuelwood and chips, petroleum products and electricity. Mizoram has been depending mainly on electricity imported from Central sector generation/other states through grid lines. Electricity is the predominant energy source for rural lighting reported by 86% of the households and remaining households are dependent on kerosene, gas and other sources as well as the urban lighting energy scenario is also almost same with 99.5% of the households using electricity and remaining 0.5% are using gas and other sources .

Firewood and chips is a predominant cooking fuel to rural Mizoram which is used by around 70% of total households whereas around 29% of them are using LPG and remaining 1% is consuming other sources of energy. But, the urban scenario is significantly different with LPG as main fuel for cooking at around 88% of households whereas 11% of households are using firewood and rest of them are using kerosene, dung cake, etc.

To cater to the ever increasing power demand due to various factors like population growth, urbanization and to kick start the industrial development and considering the present power crisis in the state, the state government has begun to explore the possibility of enhancing the power generation by focusing on installation of more number of hydro power plants as the state has huge hydro potential and the power generation will be less costly and also decided to encourage power generation from other non-conventional energy sources. In spite of the fact, that generation capacity addition is highly essential for the socio economic growth of the state, the point also crucial for addressing that increasing of large hydro or coal based power plant will contribute to GHG emission. Promotion and use of renewable based option will not only reduce the strain on the existing forest but will also promote low carbon growth.

An estimated 38.9% of the total power available for Mizoram is lost through Aggregated Technical and Commercial (AT&C) losses during 2008-09. The losses are extremely higher when compared with all India average and much higher than the average T & D losses of other developed nations. It is estimated that, loss may be in tune of 50% but due to inexistence of 100% metering facility, actual loss could not be estimated. The losses are due to factors like inadequate T&D facility, lack of proper distribution planning, defective metering, unmetered supply and pilferage.

Modernisation and renovation of exiting electricity network and addition of transmission and distribution network in the state to reduce the degree of losses and meet the demand-supply gap is an immediate action. The stability of power sector in the state is confronted by the factors like:

a. Lower installed capacity in respect of existing demand
b. Peak demand shortage and energy demand shortage

[12]Ref: NEDFI Databank
[13]Ref: National Sample Survey 61st Round, 2004-05 by National Sample Survey Organization, Govt. of India April 2007.
[14]Review of Greenhouse gas emission from creation of hydro power reservoirs in India, Background paper: Strategies for Low carbon growth, World Bank 2008
[15]Ref: Tariff Order for 2010-11 by JERC for Manipur and Mizoram

c. Lack of proper transmission and distribution infrastructure both for evacuation of power from upcoming power projects and also distributing power to all the villages.

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

e. High AT&C losses, lack of metering

f. Unscheduled and prolonged outages

TABLE 24 T&D LOSS

Year	T & D Losses in Million units[16]	Percentage Losses
2004-2005	79.4	39%
2005-2006	76.47	36%
2006-2007	82.32	35%
2007-2008	92.48	34%

Energy conservation can be a vital tool for reducing the current demand but it is still at infancy owing to lack of infrastructure. The sectors however has considerable scope of energy saving.

TABLE 25 ENERGY CONSERVATION POTENTIAL

Sector	Saving potential (MU)[17]
Agriculture	NA
Commercial sector	1.8
Municipalities	8.38
Domestic Sector	23.18
Industries	0.12
Total	33.5

4.5.3 Concerns Due to Climate Change

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 envisaged climate change could impact different components of the electricity sector as outlined below:

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 project 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.

[16]Source: Economic Survey of Mizoram, 2008-09

[17]Source: Annual Report of Energy Conservation Measures in Mizoram for 2009-10 by State Designated Agency, Mizoram

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 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. fire wood, dung, etc. are more vulnerable to adverse effects of water cycle changes on river catchment affecting the poorest segment of the society.

The envisaged climate change could impact different components of the electricity sector as outlined in below.

Possible Climate Change Impacts on the Energy Sector	
Climate Change Indicators	Impacts on Energy Sector
Hydrological Variability (Greater Seasonal and year to year variability in precipitation, more frequent and prolonged extreme events like drought or heavy rainfall)	• Variability in Hydropower generation • Variability in water availability for Thermal Generation • Biomass availability vulnerable to water cycle impacts affecting household energy security • Could impact renewable generation potential, especially solar thermal • Threat of damage to infrastructure from extreme events
Increased Temperature	• Impacts Hydropower generation in summer months • Increased requirements of water for cooling in Thermal generation • Increased need of energy in household sector for cooling • Could impact renewable generation potential, especially solar

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 coherence across different sectors and governance to reduce the sectors vulnerability to the impact of climate change.

4.5.4 Key Priorities to address climate change concerns

The key elements for the multi - pronged strategy of the sector for mitigation and adaptation measures were identified after detailed deliberation in the working groups. The priorities are in line with the concerns raised due to impact of the climate change and the states response.

- **Increase renewable energy generation share in the state**

Around 56% of the state power generation capacity is hydro based whereas remaining part is through fossil fuel based, a more carbon intensive power generation option. To the extent the use of stand-alone or grid interactive renewable based power generation option will be promoted and 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 state has initiated solar photo voltaic and micro hydro power project in a pilot mode with implementation of 37 number SPV pumps, 315 number of solar street lighting system, 3045 number of solar home lighting system, 5812 solar lanterns, 110 number of solar cookers, 109 kWp solar photovoltaic power plants[18]. Apart from these, the state has already installed pilot projects of 0.20 MW biomass gasifier, 3470 number biogas plants and 20 remote village electrification projects. The following steps will help in achieving the compliance:

- **Promoting Micro hydro power generation**

Grid interactive micro hydro projects in the catchment area of perennial streams (as the investment is low and easy construction). Implementation of pilot projects through state and central government funding which are-

i. Setting up of 100 kW micro hydel project in Tuinching river which is located in north of Champai District.

ii. Setting up of 100 kW micro hydel project in Tuiriza River which is located in Aizwal district.

iii. Detailed reconnaissance study and hydrology data evaluation and approval of micro hydro projects

- **Maximizing use of solar energy resources by Implementation of 1 MWp Grid interactive Solar PV**

For large scale power (as it works in low and diffused solar radiation cases) in the districts (where solar radiation throughout the year, required slope and land is available). The sub activities are-

i. Survey and investigation to identify appropriate sites

ii. Develop project proposal, DPR

iii. Infrastructure Creation for energy evacuation to the grid

iv. Facilitating implementation of pilot project of 1 MWp power plant by grid interactive solar PV applications at Lengpui, Aizwal.

- **Promoting off grid renewable energy applications**

The household energy requirement in the state is

[18]Source: MNRE as on 31st March 2007

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 activities proposed are:

- **Incorporation of 100 systems of both 100 LPD and 200 LPD solar water heating systems in the state**

in order to Increase the use of solar energy for certain end-uses like water heating through low temperature solar thermal applications.

- **Pilot project installation of 100 numbers of 250 Wp solar PV power pack systems**

To cater the power demand and maximize and judicious utilisation of renewable energy resources for meeting up household and dedicated consumer requirement, use of solar photovoltaic power packs will be promoted. The systems can be designed according to the power requirement variation throughout the day with alternative source of back up of solar photovoltaic to avoid power shortage during lean time.

- **Implementation of 100 KWp standalone solar photovoltaic power plants for village electrification and to substitute grid power usage:**

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:

i. Undertaking study for electrifying remote villages in decentralised mode

ii. Preparation of DPR

iii. Undertake implementation - Reduce the grid power dependency of villages located in remote areas and of the comparatively concentric population through standalone Solar Photovoltaic Power plants which can meet the power demand of the villagers and provide constant source of power. Promotion through installation of 100 kWp standalone solar photovoltaic power plants in 10 numbers of villages.

- **Reduce anticipated energy and peak demand in the Business As Usual scenario**

The objective of the pilot initiative in demand side management for energy efficiency is to demonstrate the possibility and benefit 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:

- **Penetration of energy efficient devices in domestic sector facilitated by financial, supply chain and market incentives**

Majority of the power consumption in the state

is consumed by domestic sector with 68% of total energy consumption and most of the energy consumed is for lighting requirement only. Therefore, implementation of energy efficiency measures in 1.5 Lakhs domestic households through replacement of incandescent lamps with CFLs will reduce anticipated energy and peak demand of the state and also the demonstration initiative will encourage the consumers to incorporate the similar activities in future.

- **Deployment of energy efficient lighting for public lighting facilitated by financing and supply chains.**

Around 5% of the energy consumed by the state is for public lighting though there are more than 137 villages is still un-electrified. According to the energy audit study carried out under the BEE program by State Designated agency, it is estimated that around 8.4 million units can be saved in municipality activities.

i. Undertaking IGEA

ii. Taking up pilot implementation of 90W energy efficient LED in 5500 electric poles will replaces 250 HPSV lamps.

- **Implementation of pilot energy efficient projects and IGEA**

The state designated agency as a part of National Energy Efficiency Agenda with support from BEE, has conducted energy audit to identify the energy efficiency improvement opportunities and thereby reducing energy consumption of major Government and public sector buildings in Mizoram. To reduce the energy consumption in such buildings, implementation of pilot Energy Efficiency Measures will be carried out in 7 buildings.

Key Priorities in the Energy Sector

1. Promoting Micro hydro power generation

1..1. Setting up of 100 kW micro hydel project in Tuinching river located in north of Champai District.

1..2. Setting up of 100 kW micro hydel project in Tuiriza River located in Aizwal district.

2. Maximizing use of solar energy resources by Implementation of 1 MWp Grid interactive Solar PVin Aizwal

3. Incorporation of 100 systems of both 100 LPD and 200 LPD solar water heating systems in the state

4. Pilot project installation of 100 numbers of 250 Wp solar PV power pack systems

5. Implementation of 100 KWp standalone solar photovoltaic power plants for village electrification and to substitute grid power usage

6. Penetration of energy efficient devices in domestic sector facilitated by providing CFLs to 1.5 lakhs consumers

7. Deployment of energy efficient lighting for public lighting facilitated by putting 90W LED lights to 5500 poles.

8. Implementation of pilot energy efficient projects and IGEA in 7 buildings.

9. Capacity building of the state designated agency, energy departments

10. Awareness creation of users and other citizens on energy efficiency measures and renewable energy application

- **Institutional development of State Energy Departments and Awareness Creation**

The State of Mizoram is facing a formidable challenge in reforming power sector in terms of functional reorganization and institutional

development of the departments to achieve efficient functioning and implementation of energy conservation, promotion of energy efficient systems, promotion of renewable energy applications, improved transmission and distribution network. The option includes –

- **Capacity building of the state designated agency, energy departments**

  i. Capacity building of the state designated agencies, existing staff of the energy departments to operationalize energy conservation act in the state and to enhance the knowledge about the policy and procedure to implement the policy.

  ii. 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.

- **Awareness creation of users and other citizens on energy efficiency measures and renewable energy application**

The objective of awareness creation amongst the sectors, present and future end users 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. Apart from that awareness creation among the citizens in the state on renewable energy applications, systems about the benefit of RE systems, durability, and also for diffusion of renewable energy in infrastructure projects Complying of the action plan is planned through following sub activities:

i. Identification of Agencies for taking up awareness generation activity.

ii. Undertaking Training Need Analysis Study for the department, preparation of manual and carrying out pilot workshop.

iii. Carrying out awareness campaign towards taking up energy efficiency measures, use of star rated devices and use of renewable energy applications.

iv. Preparation of study material on energy efficiency measures and renewable energy applications and incorporation of the material through mandatory course curriculum in school level.

4.5.5 Summary Table: Energy

Sl. No.	Key Priorities	Departments/ Organisation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
A	Increase renewable energy generation share in the state					
1.	Promoting Micro hydro power generation a) Setting up of 100 kW micro hydel project in Tuinching river which is located in north of Champai District. b) Setting up of 100 kW micro hydel project in Tuiriza River which is located in Aizwal district. c) Detailed reconnaissance study and hydrology data evaluation and approval of micro hydro projects	ZEDA, PHE Department, Department of Energy	0.882 1.399	0.511 1.437	0.556 1.910	Government of Mizoram & India, Central Finance Assistance, MNRE
2.	Maximizing use of solar energy resources by Implementation of 1 MWp Grid interactive Solar PV a) Survey and investigation to identify appropriate sites b) Develop project proposal, DPR c) Infrastructure Creation for energy evacuation to the grid d) Facilitating implementation of pilot project of 1 MWp power plant by grid interactive solar PV applications at Lengpui, Aizwal.	ZEDA, PHE, Department of Energy		27.00	27.00	Central Finance Assistance, Government of India
B	Promoting off grid renewable energy applications –					

3.	Incorporation of 100 systems of both 100 LPD and 200 LPD solar water heating systems in the state a) Study of existing policy and develop investment friendly policy to promote additional Solar thermal application and inclusion of it in existing renewable energy policy b) Developing project proposal and apply for financial assistance c) Inviting applications for pilot demonstration projects to promote SWH applications d) Developing SWH supply chain involving SWH manufacturers, distributors, installers, etc. e) Promoting SWH application by installing pilot projects of 100 systems of 100 LPD and 100 systems of 200 LPD capacity across various demand segments f) Raising awareness amongst the probable users of various demand segments g) Creating conducive scenario for investment h) Awareness and capacity building of the regional offices of ZEDA, Energy department	ZEDA, Department of Energy		0.80	0.80	Government of Mizoram, Central Finance Assistance, MNRE, IREDA, External Funding Agencies

4.	Pilot project installation of 100 numbers of 250 Wp solar PV power pack systems a) Increased use of Solar for the purpose of meeting energy requirement b) Replacing and reducing grid power consumption c) Awareness creation and capacity building for incremental usage d) Identification, evaluation and approval of 100 consumers for 250 Wp SPV power pack systems e) Design of Solar power pack systems according to the user need. f) Installation of 100 such systems in the approved sites. g) Identification of technology supporters and empanelment of them with ZEDA h) Training to users on operation and maintenance support.	ZEDA, Department of Energy		0.675	0.675	Government of Mizoram, MNRE, IREDA, External Funding Agencies (if any)

5.	Implementation of 100 KWp standalone solar photovoltaic power plants a) Undertaking study for electrifying remote villages in decentralized mode b) Develop project proposal, DPR c) Apply for Financial closure, land acquisition and transfer, d) Infrastructure Creation for energy distribution network e) Undertake implementation of 100 kWp solar standalone Solar Photovoltaic Power plants in 10 numbers of villages to meet the power demand of the villagers under the MNRE scheme of village electrification.	ZEDA, Dept. of Energy, Panchayati Raj Department		27.00	27.00	RGGVY, DDG, Central finance assistance, MNRE, IREDA, REC,
C.	Reduce anticipated energy and peak demand in the Business As Usual scenario					
6.	Penetration of energy efficient devices in domestic sector facilitated by financial, supply chain and market incentives a) Identification of domestic households for pilot demonstration project b) Strengthening of technology supplier and manufacturer database at SDA c) Implementation of pilot energy efficiency measures in 1.5 Lakhs domestic households through replacement of incandescent lamps with CFLs.	State Designated Agency, PHE, Department of Energy		10.8	10.8	Government of Mizoram, BEE, External Funding Agencies (if any)

7.	Deployment of energy efficient lighting for public lighting facilitated by financing and supply chains. a) Undertaking IGEA b) Identification of technology partners in the state c) Empanelment of technology partners for future similar projects and current project d) Taking up Pilot Implementation of energy efficient light installation by installing 90W LED street lights in 5500 no. of electric poles and replacing existing 250 HPSV lamps.	State Nodal Agency, Dept. of Energy, PHE,		13.75	13.75	Government of Mizoram, BEE
8.	Implementation of pilot energy efficient projects and IGEA a) Implementation of Energy Efficiency Measures in 7 Government building in Mizoram where energy audit is carried out by the Nodal Department. b) Identification of Pilot energy Efficiency project. c) Undertaking IGEA	State Nodal Agency, Dept. of Energy,		0.104	0.104	Government of Mizoram, BEE
D.	Institutional development of State Energy Departments and Awareness Creation					

9.	**Capacity building of the state designated agency, energy departments** Formulating reform agenda, implement critically needed investment,strengthenownershipand build wider public and departmental support for the program. a) Restructuring and functional reorganisation of the nodal department of energy sector including nodal department for improving energy efficiency, promotion of renewable energy (ZEDA), 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. b) Restructuring of the state department designated under BEE for undertaking the Energy Efficiency activity and Program i. 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.	State Designated Agency, Mizoram, Department of Energy, ZEDA,		0.20 per annum	0.20 per annum	Bureau of Energy Efficiency, Government of Mizoram, Government of India

	ii. Recruitment and retaining of Energy Auditor and Energy Manager to support the Nodal Officer (3 years period). iii. Recruitment of officials, engineers to support the nodal officer in undertaking the initiatives towards energy efficiency iv. Upgrading office Infrastructure.					
	c) Restructuring and capacity building of State Designated Agency, ZEDA including adding up human resource base and infrastructure d) Implantation of existing Generation policy needs to be facilitated on first track e) Develop operational plan for power trading. f) Promotion of renewable power project in PPP and IPP mode. g) Capacity building is required to enhance the knowledge about the policy and on procedure to implement the policy. h) Training of the member of the working group or their representative of different departments and organisations on sector specific climate change issue. i) Empanelment of Energy Auditors, Electricity Services Companies (ESCO) for taking up energy efficiency activities.					

10.	Awareness creation of users and other citizens on energy efficiency measures and renewable energy application a) Identification of Agencies for taking up awareness generation activity. b) Undertaking Training Need Analysis Study for the department, preparation of manual and carrying out pilot workshop. c) Supporting state level entrepreneurs to become ESCO. d) Carrying out awareness campaign on energy efficiency measures, use of star rated devices and use of renewable energy applications. e) Curriculum development on energy efficiency measures and renewable energy applications and incorporation by mandatory course in school level.	State Designated Agency, ZEDA, Energy Department, Directorate of School Education		0.50 0.10	0.60	Bureau of Energy Efficiency, Government of Mizoram, MNRE, Government of India
	Total		**1.393**	**82.884**	**84.276**	

4.6 Water

4.6.1 Introduction

Water is the prime natural resources and indispensible component for sustenance of all forms of life in the earth. Precipitation (including snowfall) is the source of all water on the earth. Part of this precipitation received in an area enhances the ground water storage, a part is lost as evapo-transpiration and the remaining portion appears as surface water. Not only the sustenance of life the availability of desired quality and quantity of water is the prime factor for economic prosperity, enhancing the quality of life and contributing to the food security of the nation. The assured supply of irrigation water (irrigation is the major consumer of water resources contributing to 83% of the total water consumption) is the primary function of food grain production and contributes towards national food security.

Although the total amount of fresh water available at present is enough to meet up the current requirement of the state but the availability of desired quality and quantity of water may get strained in some places under projected impact of climate changes, increase in population, lifestyle, economic stability, land use pattern, agricultural production, urbanisation and migration of population followed by uneven distribution of precipitation over space and time.

Climate change is likely to impart formidable challenge to the water sector and the adversity may increase due to the location of the state in a fragile ecosystem. The impact of climate change on water sector is likely to be due to erratic precipitation creating variability in river flow and increased frequency/ intensity of extremes events including flood. Increased frequency and severity of floods may affect groundwater quality in alluvial aquifers. Similarly increased rainfall intensity may lead to higher runoff and possibly reduced recharge.

The other consequence of climate change envisaged is increased evapo-transpiration influencing groundwater recharge and change in rainfall pattern resulting in lower agricultural productivity. Determining the degree of aforesaid impact will however require research at basin level but considering water as a finite source and current scenario of scarcity of water at national level (the per capita availability of water for the country as a whole has decreased from 5,177 cubic metres per year (m3/year) in 1951 to 1,654m3/year in 2007 to as low as about 1,140 m3/yr in 2050) it becomes essential to strategise for water conservation, adaptation of better management practices with emphasise on optimal utilisation and artificial recharging.

National Water mission established under National Action plan on Climate Change is designed to ensure conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within

States through integrated water resources management. Promotion of integrated basin level water resources management (Basin Level management strategies are planned to be reconsidered to deal with variability in rainfall and water flows), increasing water use efficiency by 20%, focussing attention to vulnerable areas including over exploited areas and water conservation are few designed initiative under the programme. The mission will also seek to optimise the efficiency of existing irrigation system including rehabilitation of system that has been run down and also to expand irrigation, where feasible with special effort to increase storage capacity. Initiatives to reduce fresh water use in urban areas are also planned under the mission. Since water is a state subject the plans and programmes under the mission to be executed falls under the preview of the state government. It is therefore important that the key priorities proposed under National Water mission are consistent with the state plan.

The key priorities are therefore strategized considering the national plan and state policies towards meeting up the overall objective of the Climate Change Action Plan.

4.6.2 Key Facts about the Sector

Mizoram unlike others areas of the country has experienced the weather variability. Although air temperature is usually felt as the first variable in assessment of climate change, it is important to consider other factors like rainfall and transpiration.

Rainfall

The pattern of Rainfall has shown a gradual decrease during 1986-1990, followed by gradual increase from 1990-1995.When analysed on an average monthly basis the trend of rainfall shows a gradual increase from January till it reaches the peak maximum during July – August and then continues to decrease sharply by the end of the year.

FIGURE 25 RAINFALL PATTERN

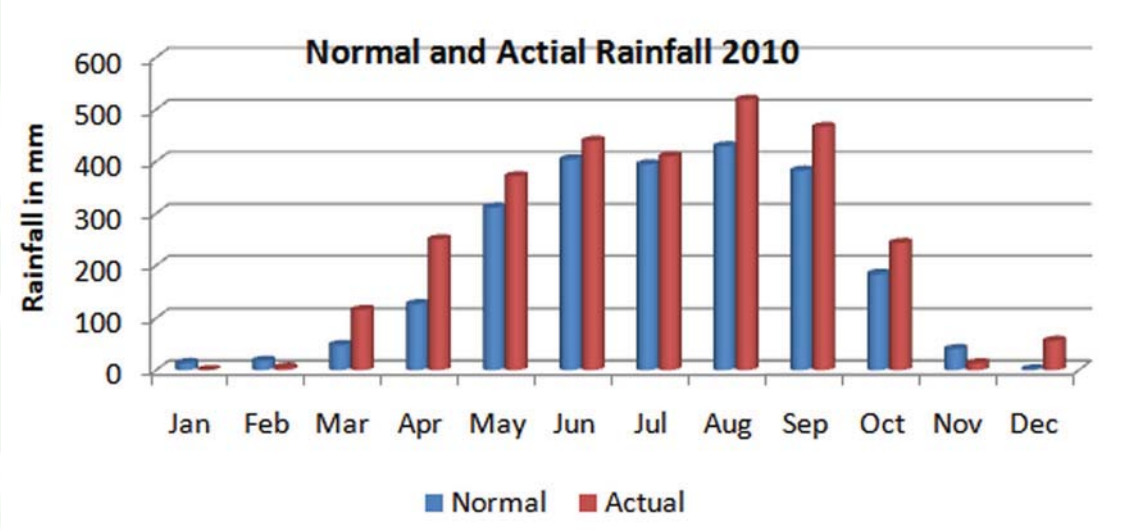
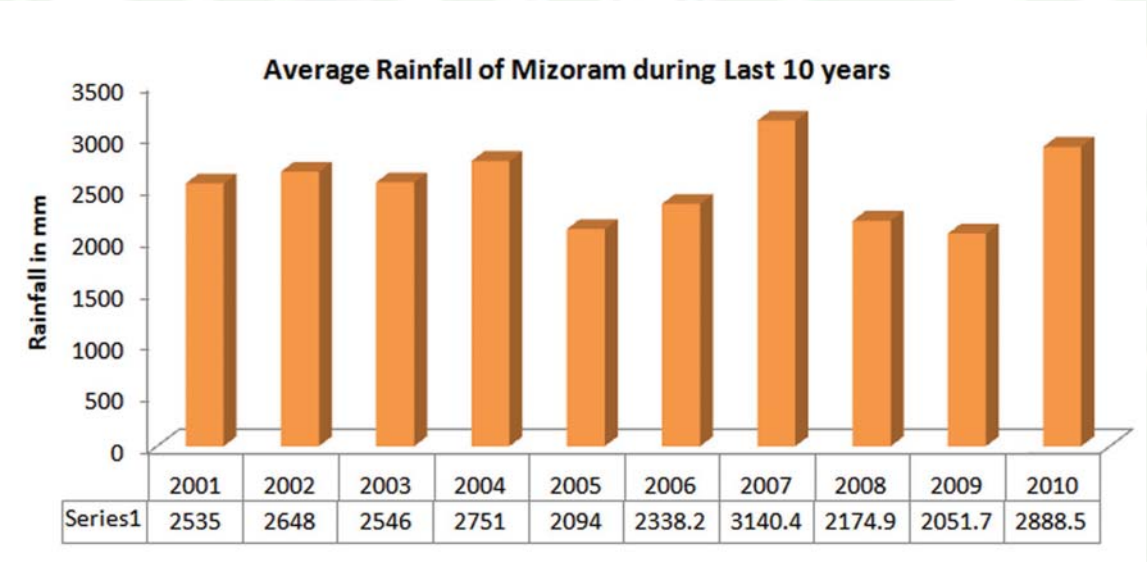


FIGURE 26 TRENDS OF AVERAGE RAINFALL



Ground Water

The ground water is the dynamic resource which is replenished each year. The Annual Replenishable Ground Water Resource is contributed by two major sources – rainfall and other sources that include canal seepage return flow from irrigation, seepage from water bodies and artificial recharge due to water conservation structures. Geologically, the state is underlain by sedimentary rocks of Tertiary age, which have been tightly folded in a series of anticlines and synclines. Ground water occurs under confined and unconfined conditions in sandstones, sandy shales, etc. In the northern and north western part of the State, the relief is much subdued. Mizoram is an abode of springs. These springs are widely utilized by people for domestic needs. Recent study suggests that there is good scope of tapping ground water in the riverbeds with sumps connected to infiltration galleries.

TABLE 27 GROUNDWATER POTENTIAL

Annual Replenishable Ground water Resource	0.04 BCM
Net Annual Ground Water Availability	0.04 BCM
Annual Ground Water Draft	0.0004 BCM
Stage of Ground Water Development	0.90%
Artificial Recharge to Ground Water (AR)	Feasible AR structures: 500 check dams, 1000 weirs, 1000 gabion structures, 300 roof top harvesting, 200 development of springs.

State	Annual Replenishable Ground water Resource					Natural Discharge during non-monsoon season	Net Annual Ground Water Availability
	Monsoon Season		Non-monsoon		Total		
	Recharge from rainfall	Recharge from othersource	Recharge from rainfall	Recharge from other sources			
Mizoram	0.03	0.00	0.02	0.00	0.04	0.004	0.04

	Annual Ground Water Draft			Projected Demand for Domestic and Industrial uses	Ground Water Availability for future irrigation	Stage of GroundWater Development (%)
	Irrigation	Domestic and industrial uses	Total			
Mizoram	0.00	0.0004	0.0004	0.0008	0.04	0.90

Surface Water

Surface water resources in the state comprises of the 1395 km of rivers and cannels (The most important and useful rivers in the state are the Tlawng (also known as Dhaleswari or Katakhal), Tut (Gutur), Tuirial (Sonai) and Tuivawl which flow through the northern territory and eventually join river Barak in Cachar. The Koldoyne (Chhimtuipui) which originates in Myanmar, is an important river in the south Mizoram. It has four tributaries and the river is in patches.) The Western part is drained by Karnaphuli (Khawthlangtuipui) and its tributaries. and 0.02 lakhs hectare of tanks lakes and ponds. The state lack reservoir, flood plain lakes &Derelict water and Barkish water reservoir.

4.6.3 Key Issues

4.6.3.1 Change in Precipitation

Studies revealed an annual increase in the level of precipitation (barring some small pocket). An increase in precipitation will result in increase in water yield. Increase in precipitation may also lead to climate extremes like flood leading to loss of agricultural crops and even lives.

4.6.3.2 Change in Evapo-transpiration

Studies revealed a projected increase in the level of evapo-transpiration in 2030 scenario. Increment of evapo-transpiration might lower water yield in the region. Enhanced level of evapo-transpiration might increases soil moisture stress or enhances the chances of drought conditions.

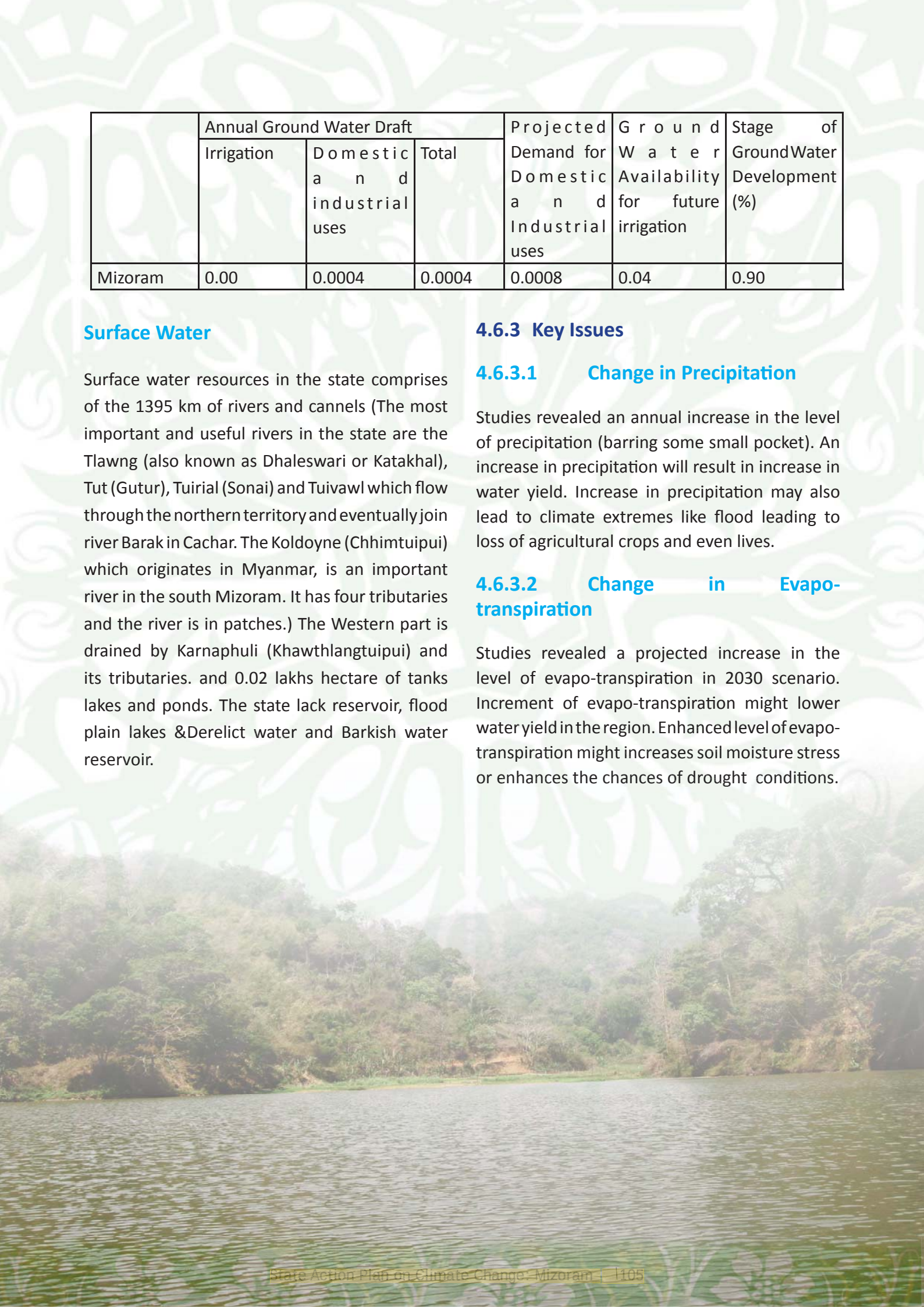
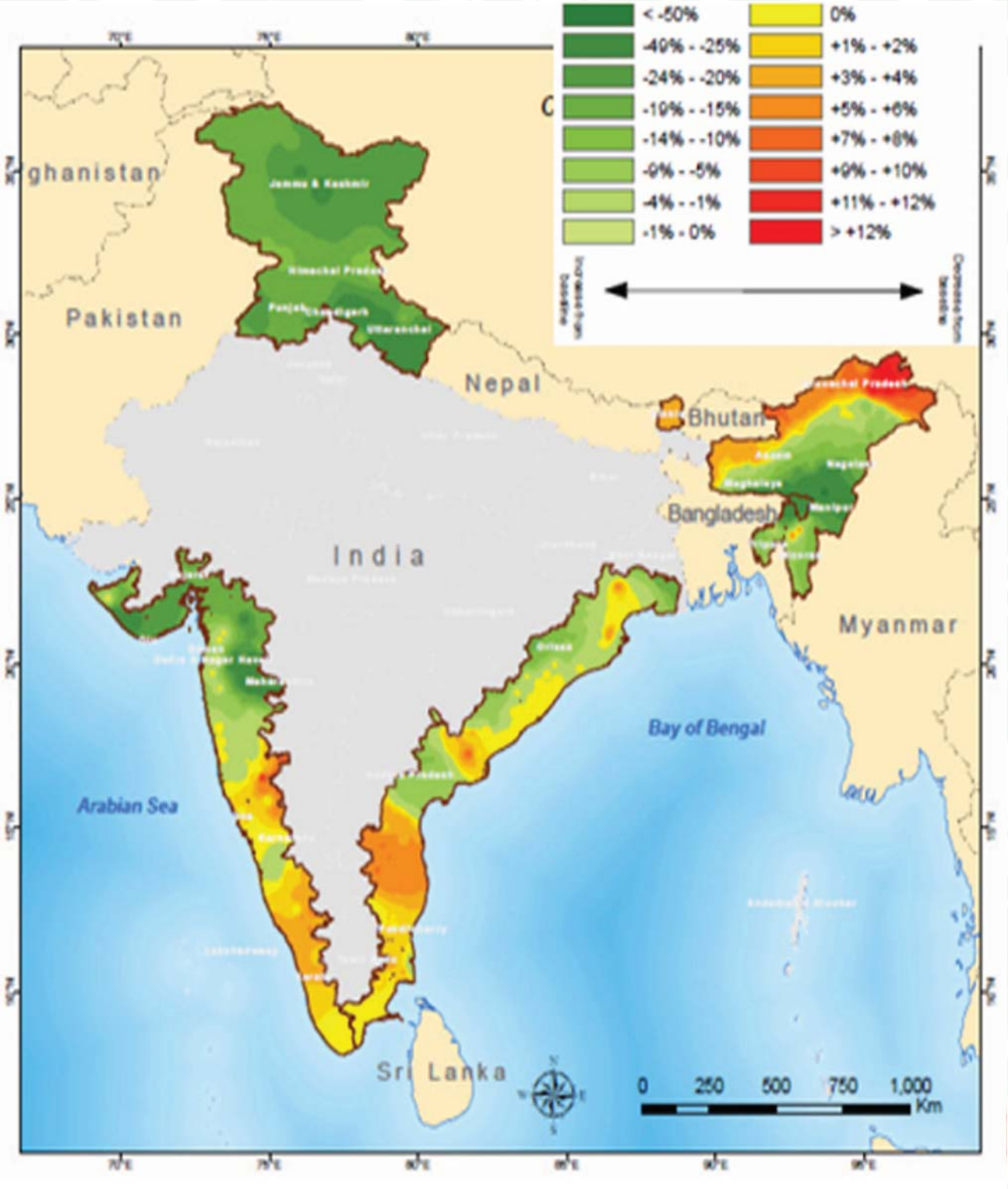


FIGURE 27PERCENTAGE CHANGE IN PRECIPITATION



4.6.4 Adaptation Pathways in Water Sector

The impact of climate change on the freshwater system and their management (management includes conservation and optimum utilisation) are mainly due to the projected rise in temperature, increased level of precipitation and evapotranspiration, lower water yield, land use pattern. Adequate availability of water is the prerequisite for sustainable socio economic development. There are perceived conflicts

towards availability, usage, distribution, allocation of water both sectorally and inter-sectorally. The anticipated impacts of climate change will exacerbate the challenges and further imperil poverty reduction efforts.

Issues	Impact	Pathways
Higher Precipitation and Evapo transpiration	Climate change extremes like flood, impact on agricultural production	Improvising Disaster management technique , capacity building of the communities
Higher variability in monsoon	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 water-resistant varieties and their
Reduction water quality due to heavy siltation downstream	Water-logging, uneven hydrology and diseases and pest incidence	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

4.6.5 Key Priorities

- **Climate change impact assessment of present status of water resources like river, wetland, streams and lakes**

The climate change projects possible impacts like flood, higher evapo- transpiration, lower water yield which may lead to severe consequence of climate extreme event like flood or even scarcity of fresh water. It is therefore essential to carry out assessment of current availability of water from ground and surface water bodies and asses the possible impact of climate change on the availability of water to suffice the demand in the projected scenario. The study is hereby proposed to establish gauging station in all the major river and tributaries for collection of hydrological data for water resource planning and management.

- **Finalisation of plan for conservation and preservation of water resources**

Considering water scarcity it is essential that appropriate water conservation technique be planned to provided adequate and equitable supply of water to the communities. The Plan proposes construction of check dams, counter trenches recharge pit and sub surface dykes for the purpose of conservation of water.

- **Formulation of State Water policy**

The state of Mizoram is not having water use policy. The water use policy is required to promote 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

- **Catchment and command area treatment through reverine afforestation**

Heavy precipitation may lead to flood situation with wash away of the top soil. It is therefore essential to undertake special programmes for planting forest trees to increase the run off infiltration ratio in identified regions.

As a part of the above plan a collaboration should be sought with the forest department for afforestation at source and in the catchment area of the plant.

- **Capacity building of Water Resources department/ Mizoram PHED for integrated water resources management**

As outlined in the National water mission promotion of integrated water resources management will get an additional focus as an effective response to climate change. Integrated water resource management leads to conservation of water, minimising waste and ensuring equitable distribution of water for various application.

Capacity building is proposed to make operational integrated water resources management practices across different river basins in the state.

- **Expansion of hydrometric network and establishment of micro weather station for regular monitoring**

Presently there is no such hydrometric station run by the state . However the hydrometric data pertaining to water resources becomes 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 planned weather station will be installed at all divisions and subdivisions of the state to obtain meteorological information. Under this initiative, selected locations will be identified and hydrometric 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.

- **Community tank management for combating water borne diseases**

In water scarce areas, there is a potential for climate change to make water availability even more acute. There is high possibility of pathogen loading in the water available during the water scare scenario leading to emergence of water borne diseases. In order to reduce the impact of water borne diseases it is highly essential that fresh water source be maintained properly. There should be proper identification of areas for new creation as well as renovation and protection of water bodies. Ground water recharge options to take care of both domestic and agriculture options in the region.

- **Promoting zero energy water purification for domestic water supply**

Access to safe drinking water is now regarded as

a universal right and millennium development goal. However few of the remote areas in the state faces lacks of supply of safe drinking water. Climate change might also bring about adverse impact on the availability of drinking water. In light of the above context it is proposed to set up zero energy water purification for domestic water supply to provide safe drinking water to the communities.

- **Renovation and development of traditional water harvesting system with scientific intervention in district level**

Groundwater is the major source of freshwater that caters to the demand of ever growing domestic, agricultural and industrial sectors of the country. Rapid urbanization and land use changes has resulted in reduced natural infiltration /recharge of aquifers. This has lead to various problems related to quantity and quality and issues like the decline in water levels, depletion of groundwater resource and quality deterioration. There is thus an imperative need for augmenting the valuable ground water resource. Artificial recharge and roof top rainwater harvesting is one such method that can revive this precious resource.

It is therefore proposed to undertake renovation and development of traditional water harvesting system to facilitate water harvesting.

- **Capacity building of communities on adaptation options required for integrated demand side as well as supply side strategies during climate stressed condition**

The speedy and uncontrolled usage of ground water has also created many problems. The intensive ground water development in many parts of the country has resulted in depletion of ground water levels and availability of the resource. The pristine ground water quality too became its victim. Though, for the State as a whole the availability of ground water resources appears quite comfortable but localised areas have shown the deleterious effects of excessive ground water development.

Capacity building is thus planned for communities on adaptation options required for integrated demand side as well as supply side strategies during climate stressed condition.

- **Impact assessment study of climate change on aquatic ecosystem**

The climate change might impact the aquatic ecosystem , it is therefore essential to determine the possible impact and degree of impact. The study is also planned to focus on estimating the adaptation path way for reducing the impact and restoration of the aquatic eco system.

4.6.6 Key Priorities

Sl. No.	Key Priorities	Depart ments/ Organi sation	Budget (Rs. Crore)			Source of funding
			State Source	Other Source	Total	
1	Climate change impact assessment of present status of water resources like river, wetland, streams and lakes	Water Resources Dept/ Mizoram PHED		2.64	2.64	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
2	Finalisation of plan for conservation and preservation of water resources	Water Resources Dept/ Mizoram PHED		160	160	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
3	Formulation of State Water policy	Water Resources Dept/ Mizoram PHED		0.1	0.1	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
4	Catchment and command area treatment through reverine afforestation	Water Resources Dept/ Mizoram PHED/forest Department		22	22	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
5	Capacity building of Water Resources department/ Mizoram PHED for integrated water resources management	Water Resources Dept/ Mizoram PHED		10	10	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
6	Expansion of hydrometric network and establishment of micro weather station for regular monitoring	Water Resources Dept/ Mizoram PHED		3	3	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
7.	Community tank management for combating water borne diseases	Water Resources Dept/ Mizoram PHED		100	100	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
8.	Promoting zero energy water purification for domestic water supply	Water Resources Dept/ Mizoram PHED		80	80	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies

9.	Renovation and development of traditional water harvesting system with scientific intervention in district level	Water Resources Dept/ Mizoram PHED		80	80	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
10.	Capacity building of communities on adaptation options required for integrated demand side as well as supply side strategies during climate stressed condition	Water Resources Dept/ Mizoram PHED		10	10	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies
11.	Impact assessment study of climate change on aquatic ecosystem	Water Resources Dept/ Mizoram PHED		2	2	Govt of Mizoram, Govt of India, External source of funding from Multilateral agencies

Comprehensive list of Activities Considered

Sl. No.	Activities	Departments/ Organisation	Priority	Type	Scale	Nature	Time frame
1	Climate change impact assessment of present status of water resources like river, wetland, streams and lakes	Water Resources Dept/ Mizoram PHED	High	AD	S	RS, PS	ST
2	Finalisation of plan for conservation and preservation of water resources	Water Resources Dept/ Mizoram PHED	High	AD	S	RS, PS, DP, IP	MT
3	Formulation of State Water policy	Water Resources Dept/ Mizoram PHED	High	AD	S	PA	MT
4	Catchment and command area treatment through reverine afforestation	Water Resources Dept/ Mizoram PHED/forest Department	High	AD	S	DP, IP	MT
5	Assessment of climate change impact on food security due to water stress	Water Resources Dept/ Mizoram PHED	Medium	AD	S	RS	ST

6	Capacity building of Water Resources department/ Mizoram PHED for integrated water resources management	Water Resources Dept/ Mizoram PHED	High	AD	S	CB	ST
7	Expansion of hydrometric network and establishment of micro weather station for regular monitoring	Water Resources Dept/ Mizoram PHED	High	AD	S	IP	ST
8	Assessment of Ground water availability in usage and conservation plan	Water Resources Dept/ Mizoram PHED	Medium	AD	S	RS	MT
9	Mandating water harvesting and artificial recharge in water stressed area	Water Resources Dept/ Mizoram PHED	Medium	AD	S	PA	MT
10	Enhancement of recharge of the source and recharge zone of deeper ground water aquifers	Water Resources Dept/ Mizoram PHED	Medium	AD	S	DP, IP, OM	MT
11	Institutional development of ground water board	Water Resources Dept/ Mizoram PHED / Ground water Authority	Medium	AD	S	CB	MT
12	Community tank management for combating water borne diseases	Water Resources Dept/ Mizoram PHED	High	AD	S	DP, IP	ST
13	Promoting zero energy water purification for domestic water supply	Water Resources Dept/ Mizoram PHED	High	AD	S	DP, IP	ST
14	Capacities (Storage) through multipurpose hydro projects and integration of drainage with irrigation infrastructure	Water Resources Dept/ Mizoram PHED	Medium	AD, MI	S	DP, IP	MT
15.	Renovation and development of traditional water harvesting system with scientific intervention in district level	Water Resources Dept/ Mizoram PHED	High	AD	S	OM, IP	ST

16.	Capacity building of communities on adaptation options required for integrated demand side as well as supply side strategies during climate stressed condition	Water Resources Dept/ Mizoram PHED	High	AD	S	CB	ST
17.	Impact assessment study of climate change on aquatic ecosystem	Water Resources Dept/ Mizoram PHED	High	AD	S	RS	ST
18.	Awareness generation of local communities on importance of aquatic ecosystem	Water Resources Dept/ Mizoram PHED	Low	AD	S	CB	ST

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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