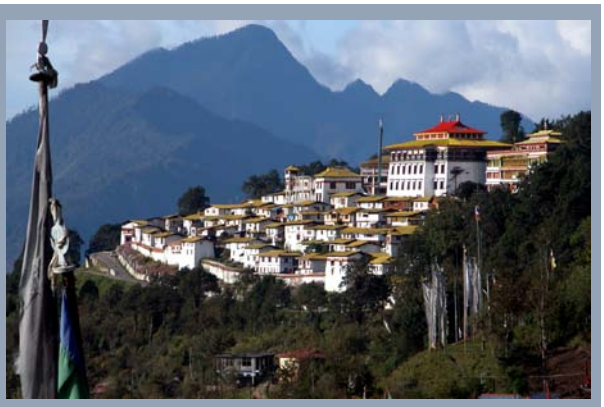
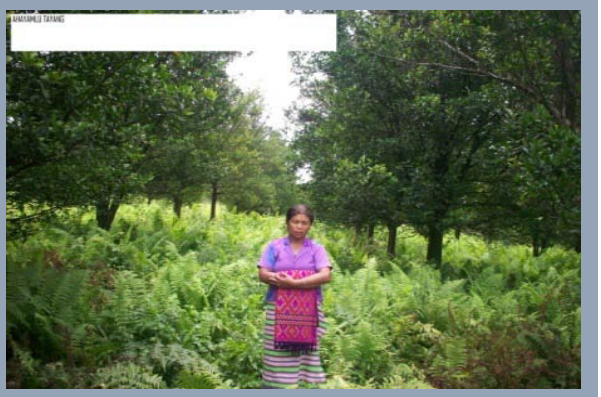
Arunachal Pradesh State Action Plan on Climate Change



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100 YEARS

Arunachal Pradesh State Action Plan on Climate Change

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Indian Institute of Management, Ahmedabad (IIMA)

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Disclaimer

"The data and information used for preparing this report have been sourced from secondary sources including state government departments and officials, published sources of Government of India, and climate change assessment made by the consultants. While due care has been taken to ensure authenticity of the data and other information used, any inadvertent wrong data or information used is regretted. We are not liable to any legal or penal responsibilities arising from this and also from the use of this report by anyone."

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Abbreviations

AP	Arunachal Pradesh
APDMA	The Arunachal Pradesh Disaster Management Authority
APEDA	Arunachal Pradesh Energy Development Agency
ASCR	Aluminium Conductors Steel Reinforced
BADP	Border Area Development Programme
BCM	Billion Cubic Meters
BEE	Bureau of Energy Efficiency
BL	Base Line
BMP	Best Management Practices
BPL	Below Powerty Level
CAA	Constitutional Amendment Act
CAGR	Compound Annual Growth Rate
CCA	Climate Change
CCA	Culturable Command Area
CDM	Clean Development Mechanism
CEO	chief executive officer
CFL	Compact Fluorescent Lamp
CHC	Community Health Centre
COMAP	Comprehensive Mitigation Analysis Process
CV	Coefficient of Variation
CWL	Culturable Waste Land
EC	End Century
FAO	Food and Agriculture Organization
FRU	First Referral Unit
GCM	Global Circulation Models
GDP	Gross Domestic Product
GHG	Green House Gas
GIM	Greening India Mission
GIS	Geographical Information Syatem
GSDP	Gross State Domestic Product
HDP	High Density Plantation
ht	High Tension
HVDS	High Voltage Distribution System
IAY	Indira Awaas Yojana
IIDC	Industrial Infrastructure Development Centers
IIM	Indian Insitute of Management
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
IITM	Indian Institute of Tropical Meteorology
IMD	Indian Metrological Department
IPCC	Intergovernmental Panel on Climate Change
JF	January, February
JFM	Joint Forest Management
JJAS	June, July, August, September
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
km2	Square Kilometer
KV	Kilo Volts
KW	Kilowatt
KWh	Kilowatt Hours

LBC	Lateral Boundary Conditions
LED	Light Emitting Diode
lpcd	Liters Per Capita Daily
lt	Low Tension
LULUCF	Land Use, Land Use Cover Change and Forestry
m	meter
M&A	Mitigation and Adaptation
MAM	March, April, May
MC	Mid Century
Mha	Million hectares
MI	Minor Irrigation
mm	millimetre
MOA	Memorandum of Agreement
MoEF	Ministry of Environment and Forest
MT	Million metric tonne
MW	Megawatt
NAPCC	National Action Plan of Climate Change
NATCOM	India's National Communication
NFSM	National Food Security Mission
NGO	Non-governmental organization
NMEEE	National Mission for Enhanced Energy Efficiency
NTFP	Non Timber Forest Produce
NUDB&I	through National Urban Databank and Indicators
NUIS	National Urban Information System
NUO	National Urban Observatory
NWDPRA	National Watershed Development Project for Rainfed Areas
oC	Degree Centigrade
OND	October, November, December
PHC	Public Health Centre
PMGSY	Pradhan Mantri Gram Sadak Yojana
PPP	Public Private Partnership
PRECIS	Providing Regional Climates for Impact Studies
QUMP	Quantifying Uncertainty in Model Predictions
R&D	Research and Development
RCM	Regional Climate Models
RGNDWM	Rajiv Gandhi National Drinking Water Mission
RPO	Renewable Purchase Obligation
RWH	rain Water Harvesting
SAPCC	State Action Plan of Climate Change
SECF	State Energy Conservation Fund
SERC	State Electricity Regulatory Commission
SEZ	Special Economic Zones
sq km	Square Kilometer
SRES	Special Report on Emission Scenarios
SRTM	Shuttle Radar Topography Mission
SWAT	Soil and Water Assessment Tool
Tg	Teragrams
WRC	Wetland Rice Cultivation

Chapter 1

Introduction

Chapter 1 - Introduction

Background

India's National Action Plan on Climate Change (NAPCC) released in 2008[1] outlines its strategy to meet the challenge of Climate Change. NAPCC is guided by the principles of sustainable development (SD) and aligns the environmental and economic objectives. .It outlines a national strategy that aims to enable the country adapt to climate change and enhances the ecological sustainability of India's development path. It stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability of the impacts of climate change. There are eight "National Missions" which form the core of the National action plan. They focus on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

As a second step, after the National Action Plan on Climate Change (NAPCC) was announced, all States have been asked to prepare a State level action plan to deal with the challenges of climate change. Broadly the State level action plans are envisioned to be an extension of the NAPCC at various levels of governance, aligned with the 8 National Missions. Building on such a need, a National Consultation Workshop was held on 19th August 2010 in New Delhi for discussing the common framework/approach for preparing State level action plans on climate change. During the workshop, it was suggested that States can take their lead from the Mission documents while formulating mitigation/adaptation strategies under the State level strategy and Action plan (SAPCC). It was recommended that all state governments finalize their SAPCC by 31st March 2011. Delhi and Orissa became the first two states in the country to complete and launch their State Action Plans. Although all State governments are implementing climate-friendly strategies (broadly aligned with the missions) as a part of their development programmes, some states have taken specific leads in the matter.

Organization of the Report

The Draft Final Report consists of seven chapters and an Executive Summary. The Chapter 1 is an introduction to the study and describes the study area with background information. Current observed climatology of Uttar Pradesh and the predicted climate change analysis is covered in Chapter 2. The Chapter 3 describes state green house gas emission sector-wise and district-wise. Impacts and vulnerability due to climate change on various sectors based scientific studies carried out at the national level is presented in Chapter 4. The Chapter 5 covers details of ongoing projects addressing possible mitigation, local coping strategy and adaptation options in terms of present policies and programs of the state and linkages with NAPCC. Sectoral Climate Change Strategy and Action Plan for the state is discussed in the Chapter 6 followed by a broad view on cross cutting issues and integrated approach in the Chapter 7.

[1] http://pmindia.nic.in/climate_change.htm

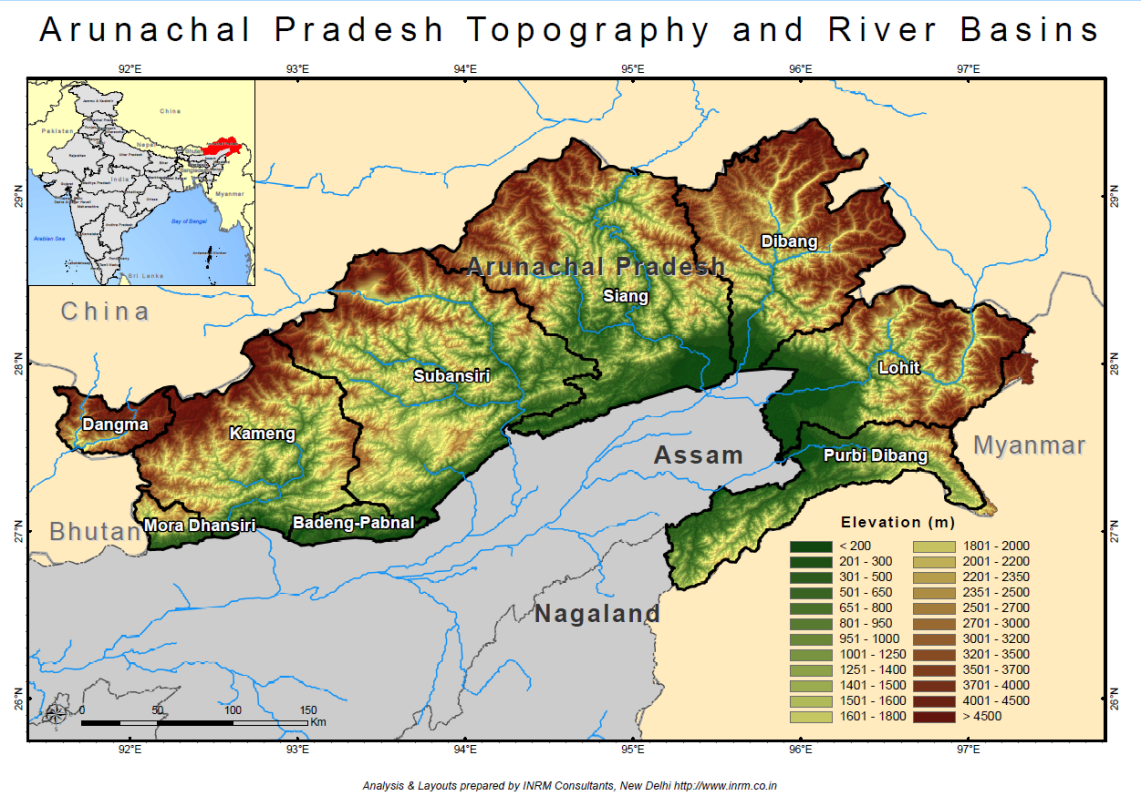
Arunachal Pradesh State profile

Physiography

Arunachal Pradesh is the largest State in North East India and is bounded by Bhutan to the west, China to the north-east, Myanmar (Burma) to the east and the plains of Assam to the south. Arunachal Pradesh is the home of 26 major tribes and acknowledged to be one of the most splendid, variegated and multilingual tribal areas of the world.

The state is situated in the Eastern Himalayas between latitudes 26° 30'N and 29° 30'N, longitudes 91° 30'E and 97° 30'E. The state has a geographical area of 83,743 km^2 (Figure 1). Terrain of the state has deep valleys rising to steep mountains. Much of the state is covered by the Eastern Himalayas. However, parts of Lohit, Changlang and Tirap districts are covered by the Patkai hills. The state has complex hill system with varying elevations ranging from 50 m in the foot hills gradually ascending to about 7000 m. The important hill systems are Kangto Massif and Namcha Barwa Massif. The Kangto Massif lies in a gigantic S curve running roughly west-southwest and east-north east. It is because of the existence of the the Kangto Massif in this region that the rain bearing monsoon winds are traped. Namcha Barwa is situated on the eastern most frontiers of Himalayas and not considered as part of Himalayas. Standing at an elevation of 7, 756 m above sea level Namcha Barwa is the highest point of this range.

Figure 1 : Geographical Context of the Study Area Brown to green



The major river in the state is Brahmaputra. Other rivers are Changlang, Dibang, Kameng, Lohit, Subansiri, Papum pare, Tawang, Tirap and Siang. Many districts in the state are named after the rivers.

Climate

Climate of the state is influenced greatly by the Himalayan Mountains and large variations in altitude across the state. Areas that are at a very high elevation in upper Himalayas close to the Tibetan border experience alpine and tundra climates. In the middle Himalayas temperate climate is experienced. Areas at the sub Himalayan generally experience humid sub tropical climate with hot summers and mild winters. The rainfall of Arunachal Pradesh is amongst the heaviest in the country receiving more than 3500 mm in a year. The state receives rainfall over a period of 8 to 9 months excepting in winter, however, most of rainfall is between May and September. Higher regions experience snow fall during winter. The average annual rainfall is 1000 mm in the higher elevations and 5750 mm in the foot hill areas.

Winter months have average temperatures in the range 15^{o}C to 21^{o}C, and the monsoon month temperatures are in the range of 22^{o}C – 33^{o}C, and the summer months temperatures sometimes are higher well over 37^{o}C. The foot hills experience maximum temperatures around 40^{o}C during summer.

Natural Resources

Water Resources

The major river is the Brahmaputra basin and 82.8 % of its area falls in Arunachal Pradesh. The state has the highest average run-off of 350 BCM. About 80% of mean annual flow of River Brahmaputra is contributed by more than 3,000 small and big river tributaries.

Glaciers are found in the Kameng Basin (52 glaciers covering an area of 66 km^2), in the Subansiri Basin (91 glaciers covering an area of 146 km^2) and in the Dibang Basin (14 glaciers covering an area of 11 km^2).

Arunachal Pradesh has 2.56 BCM annual replenishable ground water resources. The development of ground water potential in the State is negligible. With the depletion of surface water resources in the foot hill areas of Arunachal Pradesh, especially Changlang, Lohit, Lower Dibang Valley, East Siang, Papum Pare and East Kameng Districts, necessity on ground water for meeting the requirements of drinking water and irrigation are increasing day by day.

The CGWB had assessed an irrigational potential about 18,000 hectares through ground water in the State An area of more than 87,500 hectares has been irrigated in Arunachal Pradesh. Minor Irrigation Census of the State reveals that about 0.12-million hectare (about 66.67% of available potential) area is irrigated. Fresh Potential Assessment is being done under GIS environment and ultimate potential is expected to increase to around 0.85 million hectares.

The Command Area Development Water Management (CADWM) programme envisages the utilization of irrigation potential. Available records indicate that a wide utilization gap exist till today. It is estimated that about 55% of created potential is utilized and 45% remains unutilized due to poor resource support, debris and energy, inflicting heavy flood damages.

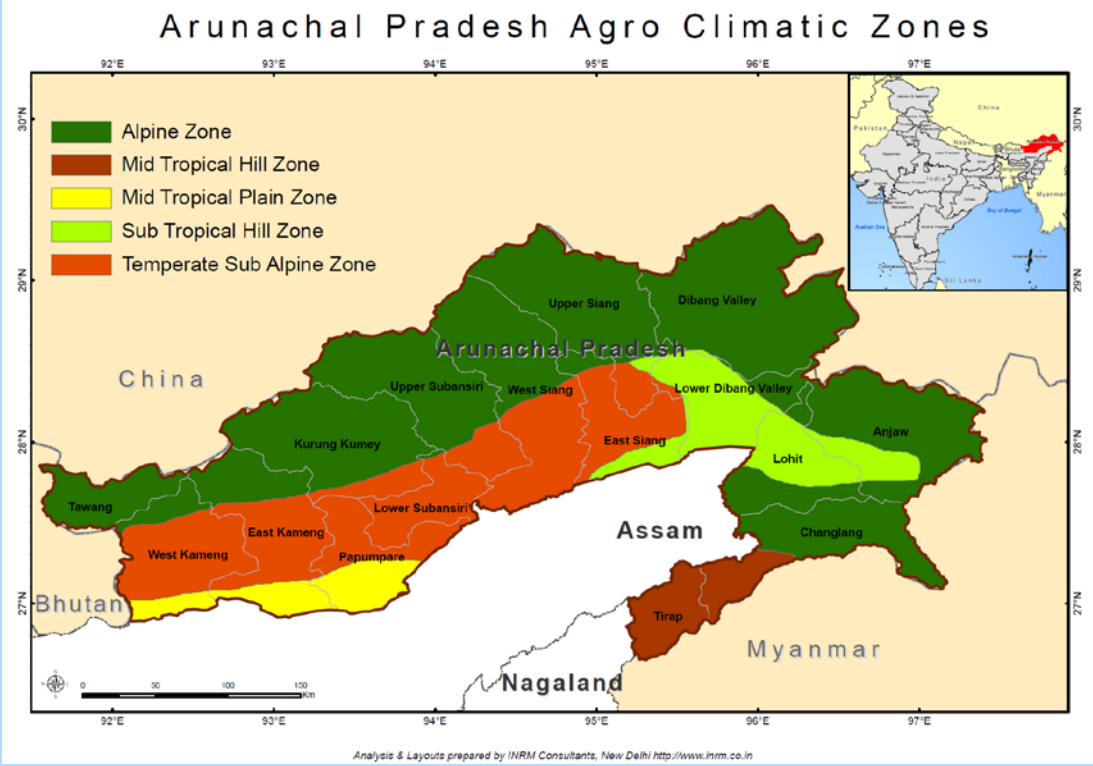
Flood is a recurring phenomenon in the State due to high precipitation. Magnitude of floods and river bank erosion problems are increasing every year in the State. An estimated 8155 sq km area of

the state is flood prone. To tackle the flood problems, construction of embankment, spurs and guide bunds etc. are utmost necessary. Presently, protection and restoration works have been taken-up.

Landuse

There are 5 Agro-climatic zones in Arunachal Pradesh reflecting the climatic diversity due the large size of the state. Figure 2 shows the agro climatic zones of the state.

Figure 2 : Agro ecological zones of Arunachal Pradesh



Around 5.15 million hectares (61.54%) is under forests. The arable land (the net area sown plus the current & fallow lands) is estimated at 0.25 million hectares (3.08 %) of the total reporting area (8.37 million ha). Land under miscellaneous tree crops and groves, not included in the net area sown, is 0.04 million hectares (0.53%) and the culturable waste-land is 0.03 million hectares (0.4%) of the total reporting area.

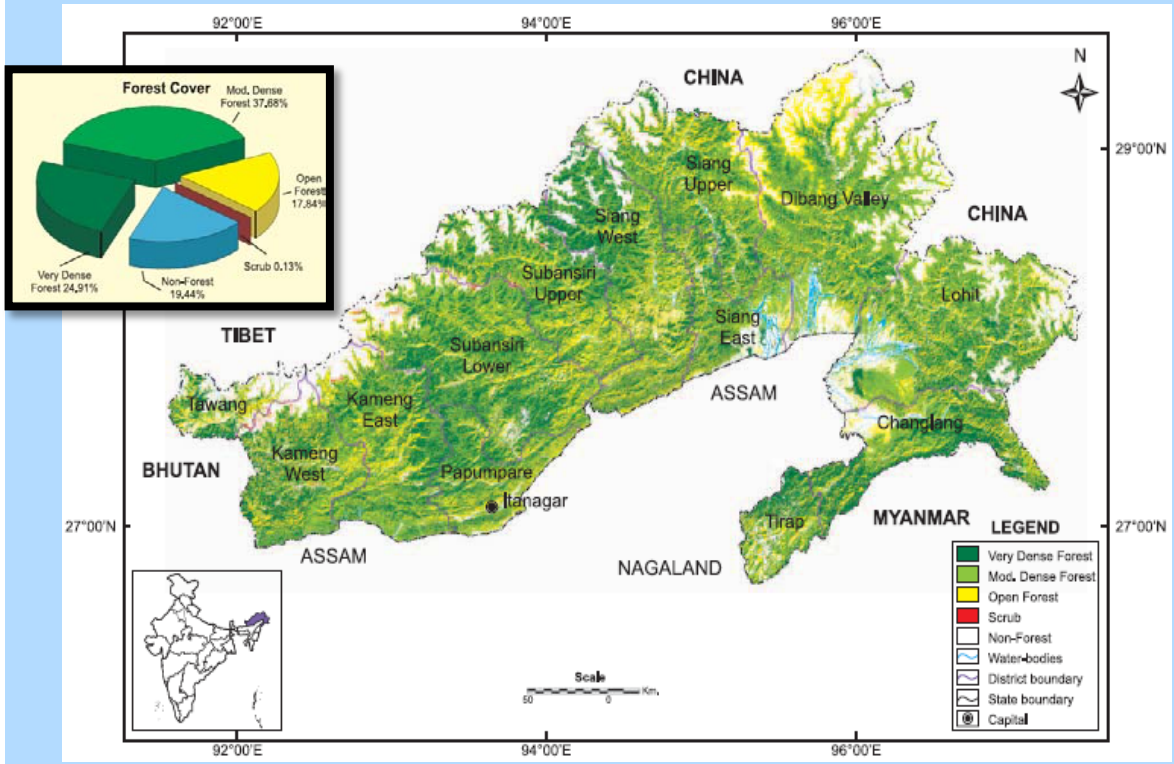
Forest

Forest is the most important resource in Arunachal Pradesh with the predominantly large tribal population living in close association with forests and highly dependent on it. Traditional shifting (jhum) cultivation is practiced by the people which impacts upon forest conservation. The total forest and tree cover of the state is 6.79 Mha, which is 81.14% of the total geographical area (FSI, 2009[2]). The Protected Areas (PA) constitutes 11.82% of the geographical area of the state. Forests in the state can be categorized as tropical, sub tropical, pine, temperate and alpine with bamboos and grasses common in the degraded forests. Carbon sequestration of forests of Arunachal Pradesh is very significant in India. The distribution of forests along with crown densities in Arunachal Pradesh is given in Figure 3. Moderate dense forests account for about 37.68% of the forest area followed by

[2] Source : Source: State of Forest Report, FSI, 2009

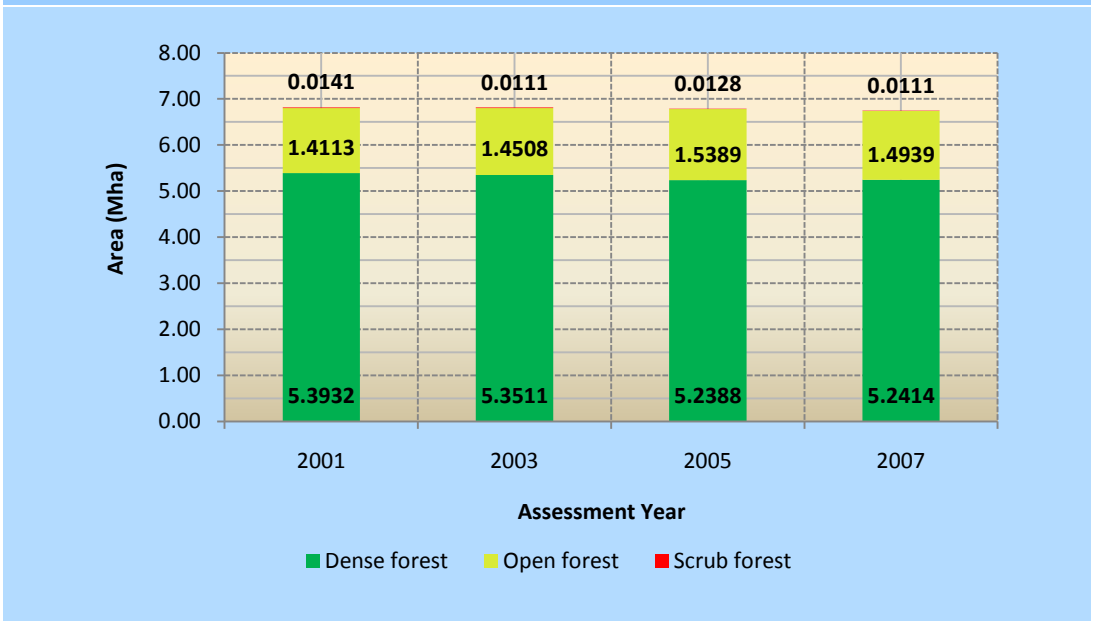
very dense forests accounting for about 24.91%. Forests are classified as Reserved Forests (20.46%), Protected Forests (18.49%) and Unclassed Forests (61.05%). In Arunachal Pradesh, indigenous community institutions play an important role in forest protection, management and administration with much of the forests listed as "unclassified". Apart from projected vulnerability due to climate change, the forests in Arunachal Pradesh also face several threats and biotic pressures in the form of shifting cultivation, grazing, forest fires, encroachment, commercial plantations, human-wildlife conflicts and illegal extraction of forest products.

Figure 3 : Forest cover of Arunachal Pradesh



According to the Forest Survey of India, area under forests seems to have marginally declined during the period 2001 to 2007 (Figure 4).

Figure 4 : Trends in area under different types of forest in Arunachal Pradesh



The dense forest has declined significantly during this period and consequently the area under open forest has increased. According to the 2007 assessment however, a slight increase in area under dense forests and a decline in scrub forests owing to plantation activities undertaken in the state is reported.

Biodiversity

Arunachal Pradesh possesses India's second highest level of genetic resources. Although occupying only 2.5% of India's geographical area, the state occupies a significant place in terms of floral and faunal biodiversity, being considered one of the world's 18 biodiversity hotspots and home to 85 species of terrestrial mammals, 760 species of birds, 4,500 species of angiosperms and 550 species of orchids. It has been recognized by International World Conservation Union in 1995 as one of the major centers of plant diversity.

Agriculture and Horticulture

Agriculture is the main occupation for about 35 percent of the population of Arunachal Pradesh. Jhum cultivation (Shifting Cultivation) and Terrace farming (Wetland Rice Cultivation (WRC)) are the two major patterns that farmers employ. Jhum is a way of life in the high altitude areas. Jhum area productivity is very low (0.7 to 0.8 tonnes/ha of organic rice against average of 3 tonnes/ha). Jhum/shifting cultivation accounts for 0.11 million hectares and permanent cultivation is about 0.09 million hectares. 17% of total cultivated area is under irrigation. Jhum cultivation contributes only about 14% as compared to Terrace farming contribution of 86% of total grain production in the state.

Topography and climate of Arunachal Pradesh is conducive for cultivation of rice, millets, wheat, maize, pulses, sugarcane and potatoes.

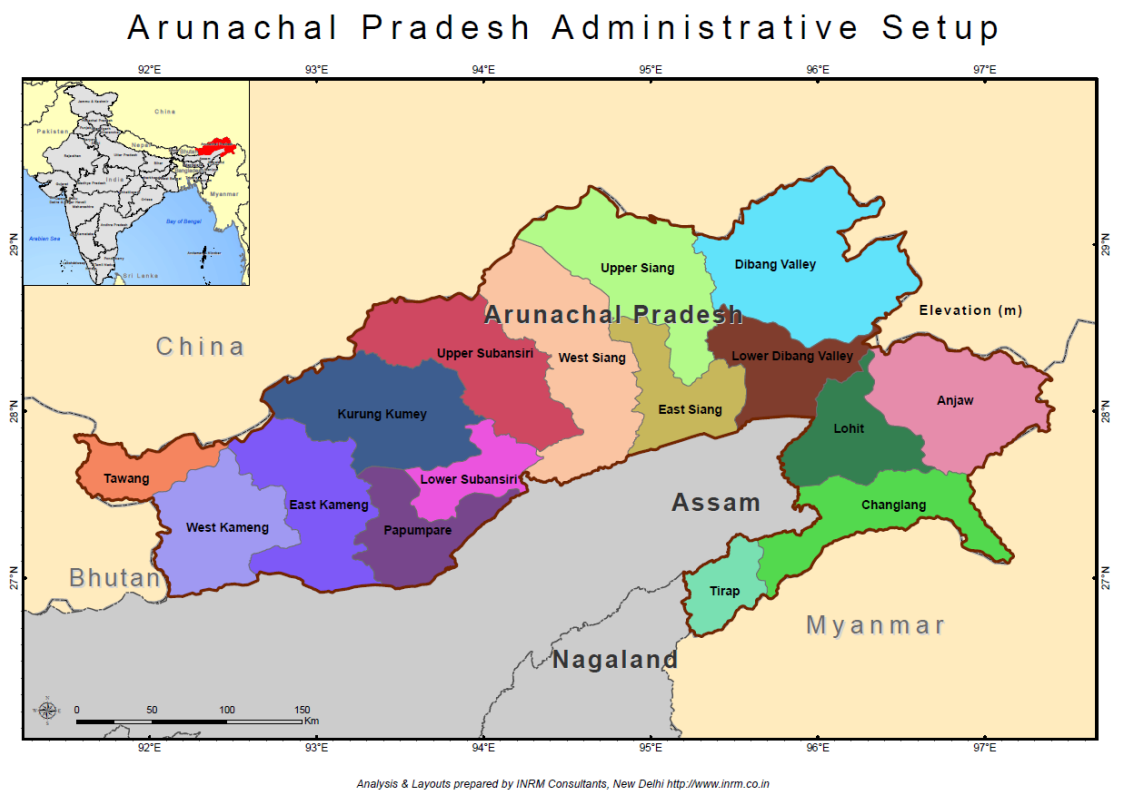
Horticulture is an important sector in Arunachal Pradesh having tremendous potential for alleviation of rural poverty due to existence of varied agro-climatic zone and high adaptability to hilly

topography of the state. Total area suitable for horticulture is 1.8 Mha. However, the present total area under horticulture is only 0.088 Mha with production of 0.12 MT. Horticulture comprises of cultivation of fruits such as apple, kiwi, walnut, orange, pine apple, litchi, lemon, ginger and banana.

Demography

Arunachal Pradesh is administratively divided into 16 districts, 57 blocks and 4065 villages (Figure 5). Arunachal Pradesh is the state with lowest population density in India. According to 2001 census, Arunachal Pradesh has a population density of 13 per sq. km (as against the national average of 312) with total population of about 1.1 million (Figure 6). The decadal growth rate of the state is 27 % (against 21.54% for the country) and the population of the state continue to grow at a much faster rate than the national rate.

Figure 5 : Administrative setup of Arunachal Pradesh



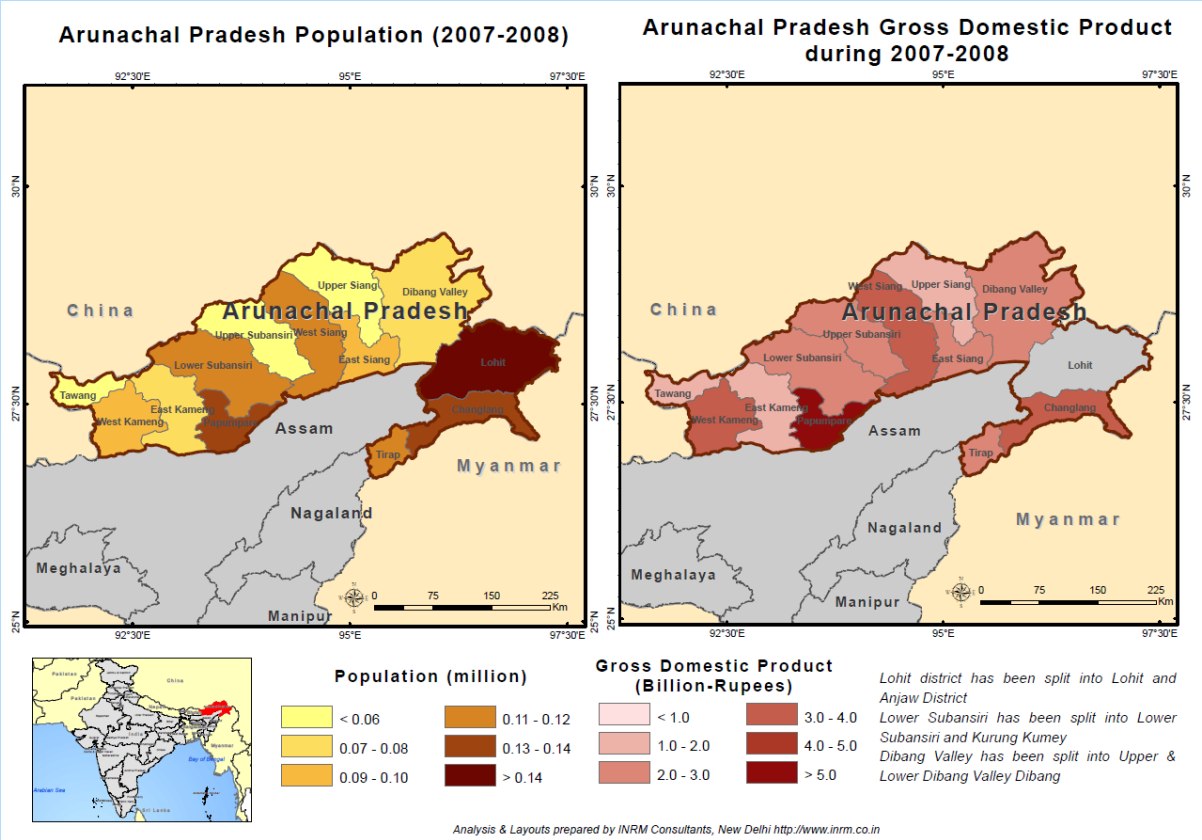
Economy

Agriculture is the primary source of the economy of the State. Food grains cultivation includes; rice, maize, millet, wheat, pulses, sugarcane, ginger and oilseeds. About 80% of population living in rural area is dependent on agriculture and about 62 % of total working populations are engaged in agriculture. Forest-products are the secondary source in the sector of the economy. Arunachal is also ideal for horticulture and fruit orchards. Major industries of sawmills and plywood, rice mills, fruit preservation units and handloom handicrafts contributes their share to the economy of the state.

Per capita income is around Rs. 23788 per annum in 2005-2006 (national average is Rs. 31,000/-). In Human Development Index rating of the states, Arunachal Pradesh ranks at 20th position[3].

Arunachal Pradesh registered a growth rate of 5.5 percent in GSDP against GDP growth rate of 7.8 percent (All-India) during the Tenth Plan. Agriculture and animal husbandry constitutes major part (25%) of the state GSDP followed by manufacturing industry (13%), trade, hotel and restaurant (11%), transport, storage and communication (10%) and construction (9%). District level gross domestic product (GDP) distribution of the state is shown in Figure 6.

Figure 6 : District Population and Gross domestic Product of Arunachal Pradesh*



Infrastructure

Physical infrastructure like road and transport, irrigation, power, telecommunication etc contributes to economic growth through generation of income and employment and social infrastructure consisting of education, health, housing and financial infrastructure like banking and insurance contributes to the process of growth through generation of human capabilities and capacity building.

Physical infrastructure

Transport

The State has the lowest road development index in the country with road density of 25.16 km per 100 sq. km (national average is 73 km per 100 sq km). The National highways account for about 1992 km, and major distract roads is about 12169 km.

[3] http://wcd.nic.in/publication/GDIGEReport/Part2.pdf

Irrigation

An area of more than 87,500 hectares has been irrigated in Arunachal Pradesh. Minor Irrigation Census of the State reveals that about 0.12 million hectare (about 66.67% of available potential) area is irrigated. The net irrigation area under utilization is around 51,700 hectares with cropping intensity in the level of 130.56%. Fresh Potential Assessment being done under GIS environment and ultimate potential is expected to increase to around 0.85 million hectares.

The Command Area Development Water Management (CADWM) programme envisages the utilization of irrigation potential. Available records indicate that a wide utilization gap exist till today, it is estimated that about 55% of created potential is utilized and 45% remains unutilized due to poor resource support.

Power

The State is largely dependent on the power from the micro/mini/small hydels stations now besides supplements from the DG sets and Central sector power. Arunachal Pradesh has a total installed power capacity of 201.9 MW, under the state and central sector. While 83.3 MW of installed capacity was under state sector, 118.6 MW was under central sector. Hydro power is the major source of electricity generation in the state, contributing around 97.6 MW, followed by 67.4 MW of renewable energy resources and 36.9 MW of thermal power.

The present average energy consumption per capita in the State is only 300 units which is far below the National Average of about 704 units[4]. The current demand for power is 170 MW as against the generation/supply capacity of 115 MW. The transmission losses are also high said to be around 50%. The state lacks grid of its own and there are high voltage/extra high voltage transmission lines.

The Hydro power potential estimated in the State from the mega hydro electric projects is around 58676.40 MW and an additional 2000 MW hydropower potential is assessed from micro/mini/small hydro electric projects.

Telecommunication

The state has a tele-density of 27.05 (telephone connections per 100 populations). The state has about 107 telephone exchanges.

Urban infrastructure

Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), three projects have been sanctioned for Itanagar, the state capital. Projects for water supply, solid-waste management and urban transport have been identified for development under the JNNURM. The urban transport project was approved in 2009 while two other projects on water supply and solid-waste management were approved in 2007.

Water supply

Average per capita supply of water in the cities is 119 lpcd, higher than the desired supply of 150 lpcd.

[4] www.arunachalplan.nic.in/html/docs/Draft_Annual_Plan10.doc

Industrial infrastructure

Arunachal Pradesh has several small and medium scale industries based on forest products. The industries include plywood, rice mills, fruit preservation units and handicrafts.

The state has its own mineral development and trading corporation which looks after the fair transportation and exploration of various minerals. The Corporation also gives an industrial shape to its mineral products. The state has 12 industrial estates, established across districts. To support industrial growth, the State Government has also notified integrated infrastructure development centres, industrial growth centres and industrial areas

Social infrastructure

Education sector

Arunachal Pradesh had a literacy rate of 54.3 % about 20 institutes of higher education. The state has 2 universities, 2 polytechnic, 4 professional collages15 degree colleges.

Health infrastructure

The state has a three-tier public healthcare infrastructure, comprising primary health centres (116), health units (44), community health centres and sub-centres (592). On an average, about 10,400 persons are served by around 5 hospitals and 20 hospital beds.

Chapter 2

Climate – Current Baseline & Climate Projections

Chapter 2 – Climate Current Baseline and Climate Projections

The long term trends in observed seasonal precipitation and temperature over Uttar Pradesh using IMD gridded rainfall and temperature at daily time scales has been performed to arrive at current baseline climatology for Arunachal Pradesh. Summary is presented in the following paragraphs.

Data used

- IMD gridded rainfall at 0.5 degree spatial resolution for the time period 1971-2005 (35 years)
- IMD gridded maximum and minimum temperature at 1 degree spatial resolution for the time period 1969-2005 (37 years)

Precipitation trends

Rainfall in Arunachal Pradesh varies considerably both in space and time from year to year.

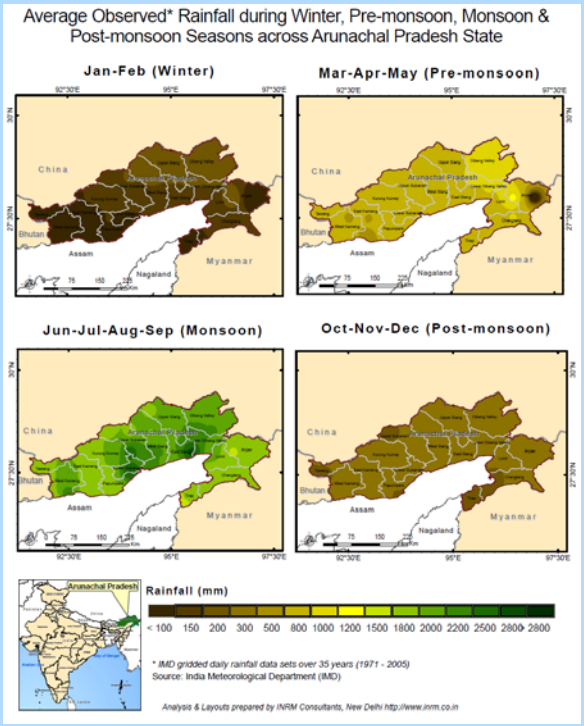
Table 1: Rainfall Statistics for Arunachal Pradesh

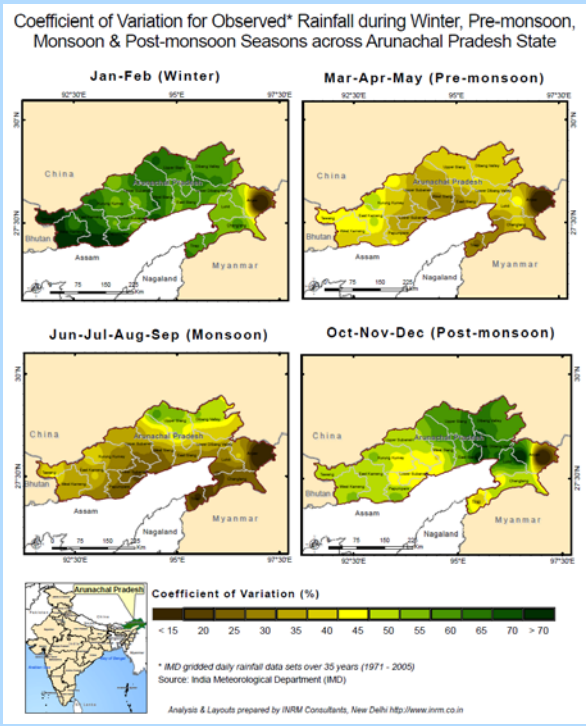
Season	Statistics	Value	Contribution in Annual Rainfall (%)
Annual	Average (mm)	2818.02	
	Inter-annual variation (CV[5])	0.25	
	Range - Average (mm)	0 - 3764.75	
	Range- Inter-annual variation	0.38 - 0	
Winter (JF)	Average (mm)	120.75	4.3
	Inter-annual variation (CV)	0.59	
	Range - Average (mm)	0 - 200.52	
	Range- Inter-annual variation	0 - 0.9	
Pre Monsoon (MAM)	Average (mm)	660.15	23.4
	Inter-annual variation (CV)	0.35	
	Range - Average (mm)	0 - 1051.95	
	Range- Inter-annual variation	0 - 0.5	
Monsoon (JJAS)	Average (mm)	1815.06	64.4
	Inter-annual variation (CV)	0.32	
	Range - Average (mm)	0 - 2654.28	
	Range- Inter-annual variation	0 - 0.58	
Post Monsoon (OND)	Average (mm)	222.06	7.9
	Inter-annual variation (CV)	0.51	
	Range - Average (mm)	0 - 284.86	
	Range- Inter-annual variation	0 - 0.83	
Source: IMD Gridded rainfall data (1971-2005)			

[5] Coefficient of Variation (CV): A statistical measure of the dispersion of data points in a data series around the mean. The coefficient of variation represents the ratio of the standard deviation to the mean, and is a measure of relative dispersion used to compare variation in series which differs in magnitude of their averages.

The mean south-west monsoon (June, July, August & September) rainfall (1815 mm) contributes 64.4% of annual rainfall (2818 mm). Mean monthly rainfall during July (581 mm) is highest and contributes about 20.6% of annual rainfall. The mean rainfall during June is slightly lower and contributes about 18.0% of annual rainfall. August and September rainfall contribute 14.8% and 13.2% of annual rainfall, respectively. Contribution of pre-monsoon (March, April & May) rainfall and post-monsoon (October, November & December) rainfall in annual rainfall is 23.4% and 7.9% respectively. Coefficient of variation is higher during the months of November, December, January and February Figure 7).

Figure 7 : Observed rainfall Statistics – Seasonal Average and Inter annual variation

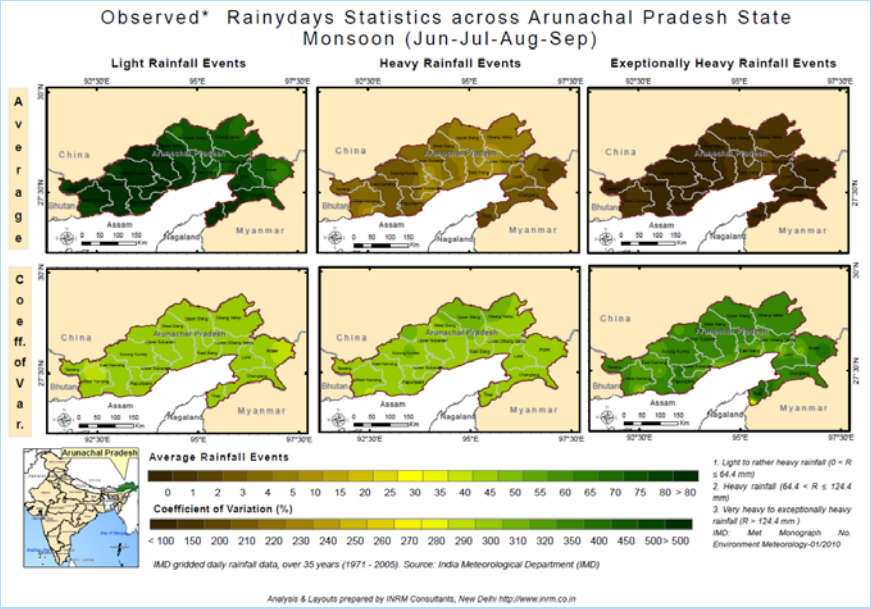




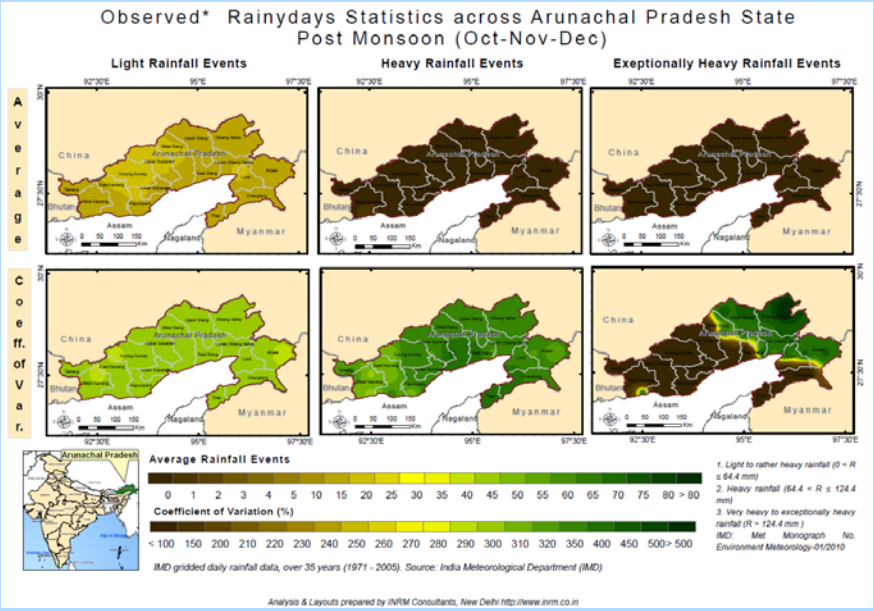
Rain has been regrouped into three broad categories (Pattanaik and Rajeevan, 2010[6]) for calculating extreme rainfall, i) light to rather heavy rainfall (0 < R≤ 64.4 mm), ii) heavy rainfall (64.4 < R ≤ 124.4 mm) and iii) very heavy to exceptionally heavy rainfall (R > 124.4 mm). Rainfall > 124.4 mm is referred as extreme rainfall events. Figure 8 shows these events during monsoon and post monsoon period.

[6] Pattanaik, D. R. and Rajeevan, M., 2010, Variability of Extreme Rainfall Events over India During Southwest Monsoon Season; 2010, Meteorological Applications Vol. 17, 88-104

Figure 8 : Observed rainfall Statistics – Average and inter annual variation in rainy days



Average number of rainy days in the state during the south west monsoon is about 78 days and varies from 60 days to 88 days. Days when there is high rainfall events range from 1 to 9 days and similarly the extreme rainfall days are less and is about 1 to 2 days



Average number of rainy days in the state during the post monsoon (winter) is about 15 days and varies from 12 days to 17 days. Days when there is high and extreme rainfall events are negligible

Temperature trends

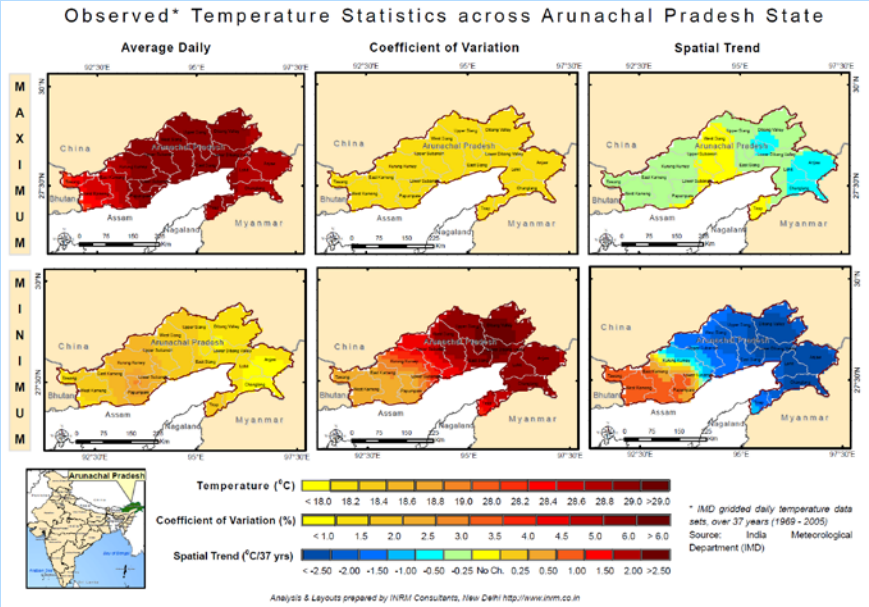
Arunachal Pradesh shows a large spatial as well as temporal variability.

Table 2: Temperature Statistics

Season	Statistics	Maximum Temperature (^{0}C)	Minimum Temperature (^{0}C)
Annual	Average	33.1	22
	Inter annual variation (CV)	0.01	0.017
	Range - Average (0C)	31.5 - 34.3	20.8 - 23.5

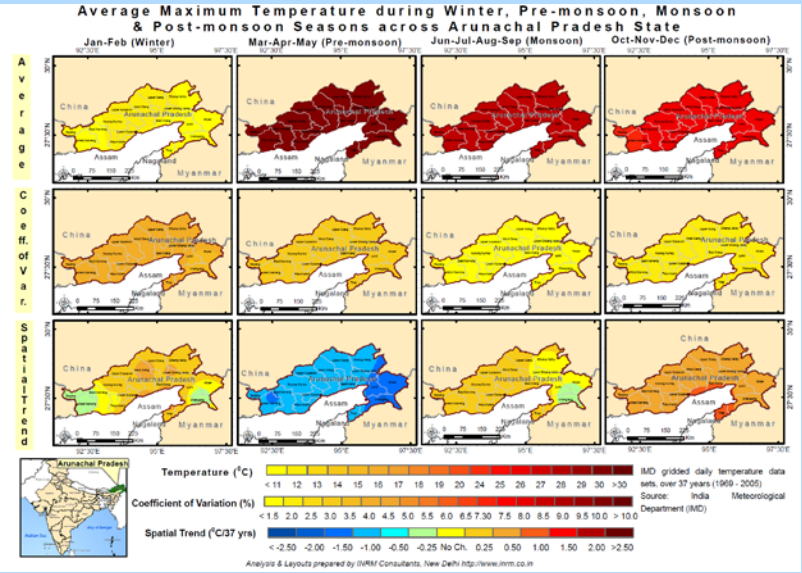
	Trend	0.34	0.25
Winter (JF)	Average	31	18
	Inter annual variation (CV)	0.022	0.047
	Range - Average (0C)	29.2 - 32.4	16 - 19.6
	Trend	0.37	0.36
Pre Monsoon (MAM)	Average	37.7	24.5
	Inter annual variation (CV)	0.017	0.023
	Range - Average (0C)	34.8 - 40	25.5 - 22.7
	Trend	0.08	0.05
Monsoon (JJAS)	Average	32.9	24.2
	Inter annual variation (CV)	0.02	0.016
	Range - Average (0C)	31.6 - 35	22.4 - 25.7
	Trend	0.24	0.29
Post Monsoon (OND)	Average	30.2	19.4
	Inter annual variation (CV)	0.022	0.041
	Range - Average (0C)	28.8 - 31	17.2 - 21.4
	Trend	0.72	0.33
Source: IMD Gridded temperature data (1969-2005)			

Figure 9 : Observed Temperature Statistics – Average, inter annual variation and trend



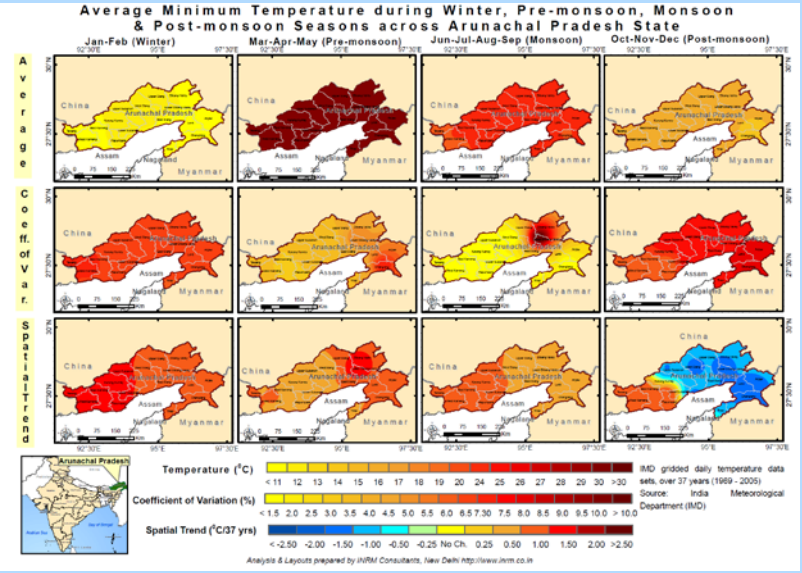
Annual Statistics:

Spatial pattern of trends in the mean maximum annual temperature shows marginal negative (decreasing) trend over most parts of Arunachal Pradesh and mean minimum annual temperature shows significant negative (decreasing) trends over eastern Arunachal Pradesh and western Arunachal Pradesh shows positive (increasing) trend.



Seasonal Statistics:

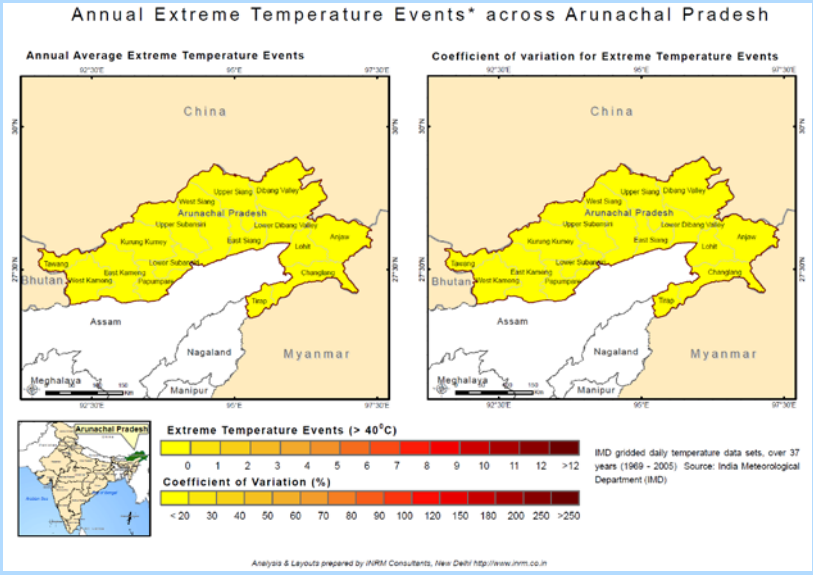
Average Maximum temperature is higher is ore monsoon season and ranges between 31 to 32^{0}C. Season wise, maximum rise in mean maximum temperature is observed during the post monsoon season (0.4^{0}C). Rise in maximum temperature is appreciably higher during post monsoon months.



Rise in maximum temperature is appreciably higher than that of minimum temperature over Arunachal Pradesh.

The rise is nearly 0.7^{0}C in the south western part during post monsoon followed by winter season (0.4^{0}C) and monsoon season (0.2^{0}C).

There is no significant Interannual variation.



Days with maximum temperature exceeding 40^{0}C does not exist in Arunachal Pradesh.

Climate Change Climatology – Arunachal Pradesh

The projected climate change in 2030s (average of 2021-2050) and in 2080s (average of 2071-2098) over Arunachal Pradesh using IPCC SRES A1B scenario have been studied. The following paragraphs give the analysis of the same.

Emission scenarios

The IPCC scenarios provide a mechanism to assess the potential impacts on climate change. The IPCC Special Report on Emission Scenarios (IPCC SRES November 2000[7]) has been published for Global emission scenarios. These scenarios provided input into the Third and Fourth Assessment Reports and were the basis for evaluating climatic and environmental consequences of different levels of future greenhouse gas emissions and for assessing alternative mitigation and adaptation strategies.

Climate models are mathematic models used to simulate the behaviour of climate system. The latter, known as Global Circulation Models (GCM), incorporate oceanic and atmospheric physics and dynamics and represent the general circulation of the planetary atmosphere or ocean. The GCMs are usually run at very course grid (about 3^0 X3^0) resolution. These GCMs are strengthened with the incorporation of local factors and downscaled, in general with a grid resolution of about 0.5^0X0.5^0 or less. The downscaling can be of dynamic or statistical type. These models are referred to as Regional Climate.

Regional Climate Change Scenarios (RCM – A1B)

A regional climate model is a comprehensive physical high resolution (~50km or less) climate model. A RCM contains representations of the key processes within the climate system e.g., cloud, radiation, rainfall, soil hydrology. Providing REgional Climates for Impact Studies (PRECIS) is an atmospheric and land surface model of limited area and high resolution which is locatable over any part of the globe. PRECIS is the Hadley Centre portable regional climate model developed to run on a PC with a grid resolution of 0.44° x 0.44°. High-resolution limited area model is driven at its lateral and sea-surface boundaries by output from global coupled atmosphere-ocean (HadCM3) and global atmospheric (HadAM3) general circulation models. PRECIS captures important regional information on summer monsoon rainfall missing in its parent GCM simulations.

Indian RCM PRECIS has been configured for a domain extending from about 1.5°N to 38°N and 56°E to 103°E. For the analysis the weather conditions of the present and future have been provided by the IITM Pune[8] as the output of a regional climate model (RCM-PRECIS) at daily interval at a resolution of about 50 km. Simulated climate outputs from PRECIS regional climate model for present (1961–1990, BL) near term (2021-2050, MC) and long term (2071-2098, EC) for A1B IPCC SRES socio-economic scenario (characterized by a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies, with the development balanced across energy sources) has been

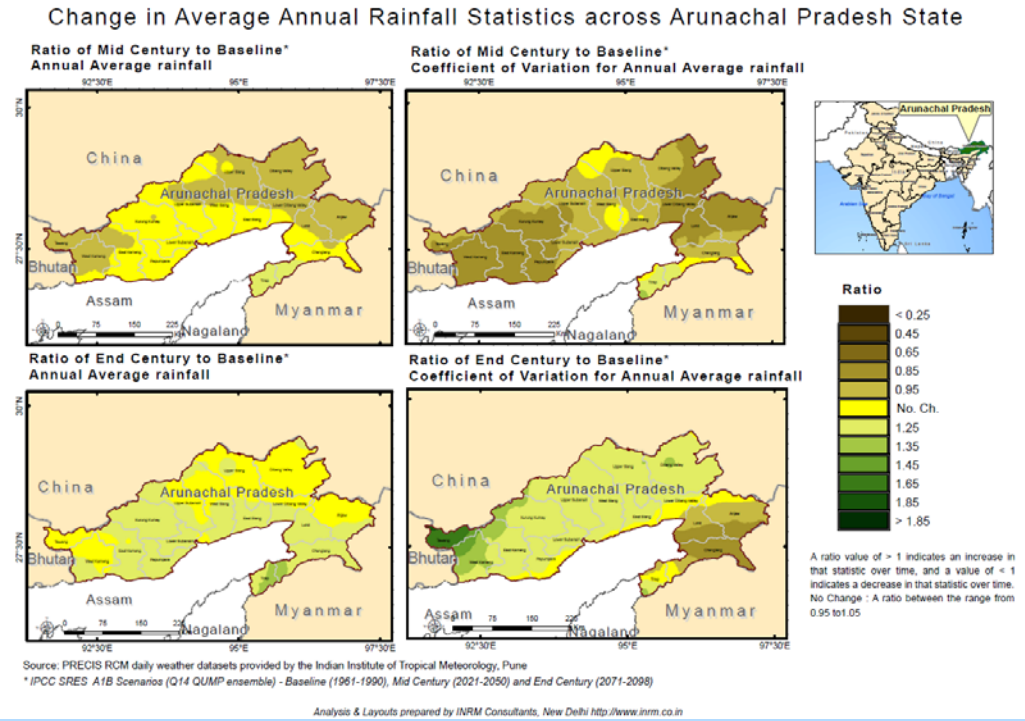
[7] Intergovernmental Panel on Climate Change, 2000. Special Report on Emissions Scenarios, Cambridge University Press, Cambridge, UK; 2000

[8] PRECIS (Providing Regional Climate for Impact Studies) is the Hadley Centre portable regional climate model, developed to run on a PC with a grid resolution of 0.44° x 0.44°. PRECIS simulation datasets is provided by the Indian Institute of Tropical Meteorology, Pune

used. Q14 QUMP (Quantifying Uncertainty in Model Predictions) ensemble has been used for the simulation.

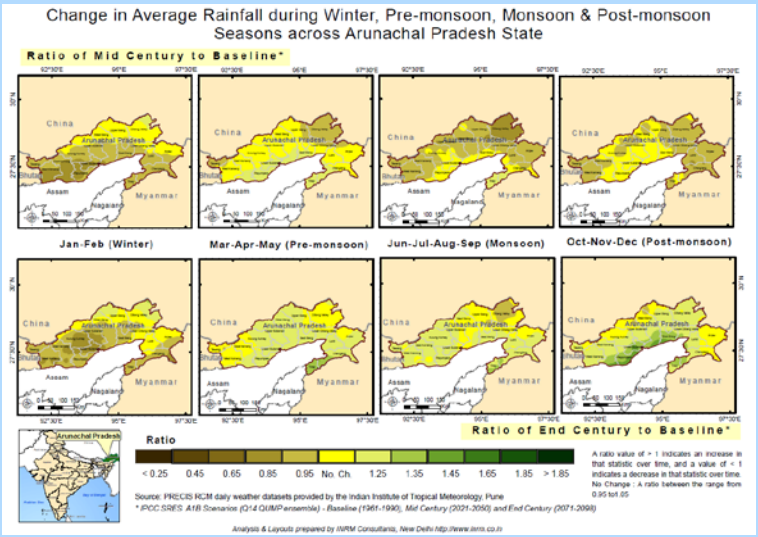
Figure 10 shows the annual rainfall statistics. Annual rainfall predicted to decrease by 5% to 15% in the 2050's as compared to the baseline and increase by 25% to 35% towards 2080's. Inter annual variability is higher towards 2080's. Spatial variability can also be seen from the figure.

Figure 10 : Climate Change scenario rainfall Statistics – Average and inter annual variation



Change in seasonal rainfall for 2050's and 2080's as compared to the baseline is shown in Figure 11.

Figure 11 : Climate Change scenario rainfall Statistics – Average and inter annual variation in rainy days

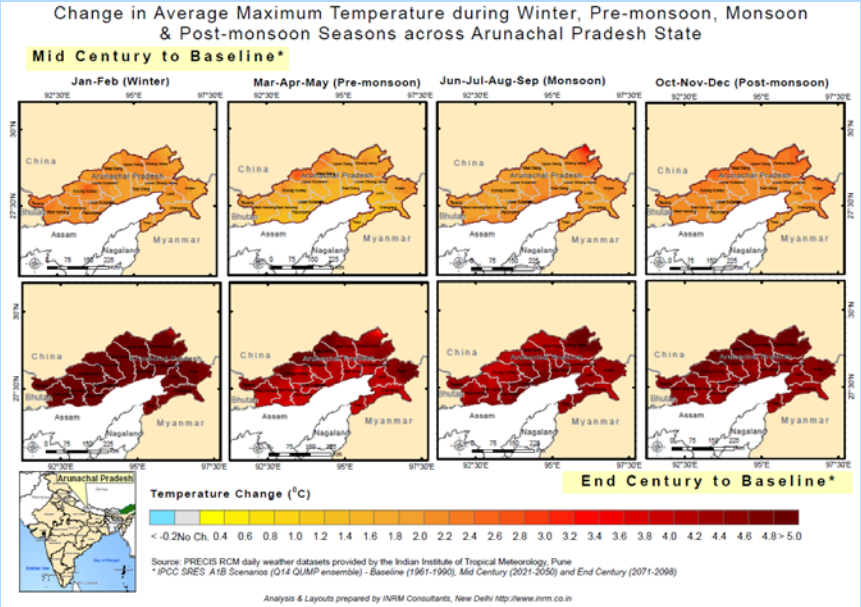


Seasonal Statistics:

Season wise, decrease in rainfall is predicted for all seasons execpt pre monsoon for 2050's where as in 2080's increase in pre-post monsoon & monsoon period is predisted as compared to baseline. Monsoon rainfall shows no significant change towards 2050's and show increase to the tune of 25% 35% towards 2080's.

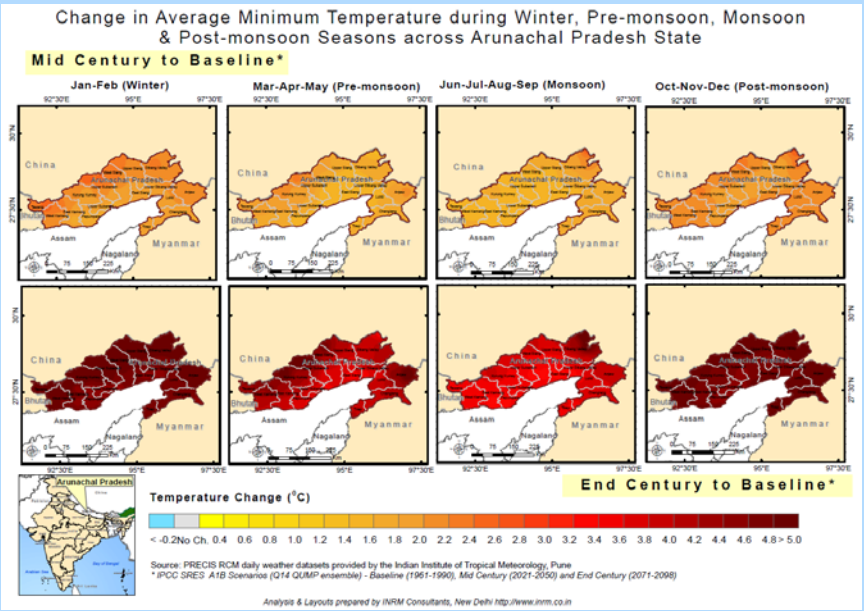
Figure 12 depict the annual maximum and minimum temperature statistics for the mid century and end century period.

Figure 12 : Climate Change scenario Temperature Statistics – Average and inter annual variation



Annual Statistics:

The increase in temperature is shown in both towards 2050's and 2080's as compared to the baseline. Maximum temperature is predicted to increase by 2.2^{0}C to 2.8^{0}C during 2050's as compared to 2080's where the increase is much higher (3.4^{0}C - > 5^{0}C)



Seasonal Statistics:

The increase in temperature is shown in both towards 2050's and 2080's as compared to the baseline. Minimum temperature is predicted to increase by 1^{0}C to 2.6^{0}C during 2050's as compared to 2080's where the increase is much higer (2.8^{0}C - > 5^{0}C)

Chapter 3

State GHG Emission

Chapter 3 - State GHG Emission

A greenhouse gas (GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. GHGs of anthropogenic origin in the atmosphere such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) contribute directly in increasing the warming of the earth's surface. GHG inventory is estimated for all the IPCC sectors except LULUCF (Land use, land change and forestry), since no state level estimates are available and LULUCF sector was insignificant to India's national GHG inventory[9]. Current GHG emission and relative increase in GHG emission at district level and for different sectors is covered in the following paragraphs.

Assessment of existing GHG emissions gases

Arunachal Pradesh ranks among the lowest greenhouse gases (GHG) emitting states of India. Less infrastructure development, low urbanization levels, high utilization of biomass for energy, and power generation from renewable source (hydro) are the major factors contributing to low GHG emissions (Table 3). Most of the state land is covered with dense and rich forests. Industries in the state are small scale and majority of them are based on forest products such as timber, veneer and plywood. Apart from these, there are industries on rice and oil mills, soap and candle making, sericulture and handicrafts. More than 90% of the state population depends on biomass as primary source of energy for cooking, water heating, space heating, lighting and livestock rearing.

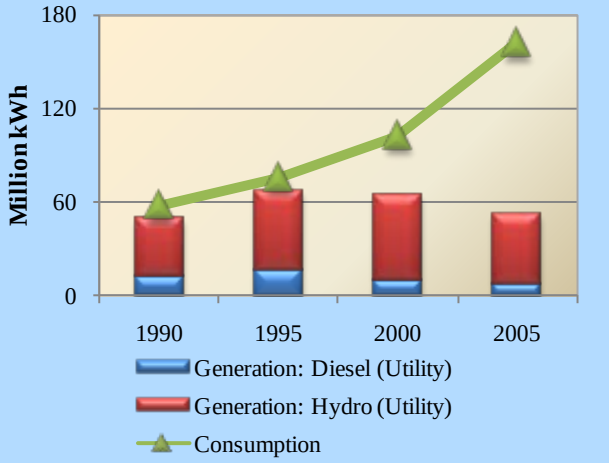
Table 3: Major driving forces of greenhouse gases in Arunachal Pradesh

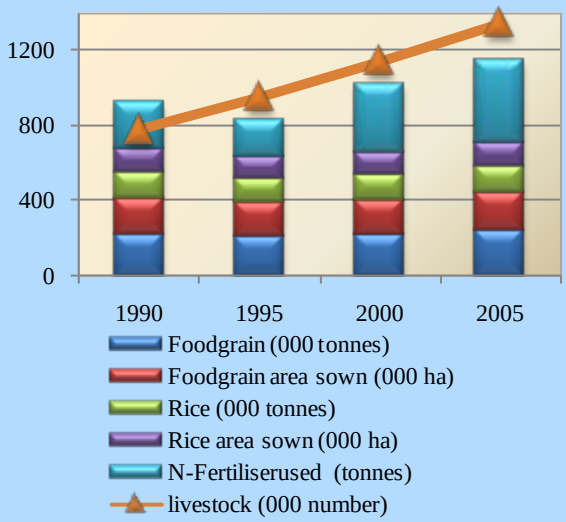
	Means of Source	Installed capacity (MW)
1.	As per Central Sector Projects of Installed Capacity of 1235 MW (Arunachal Share 9.9 %)	125
2.	79 Nos. Mini/Micro	
Isolated hydel Stations	58	
3.	140 Nos. Diesel Generating Stations	25
Total:	208	

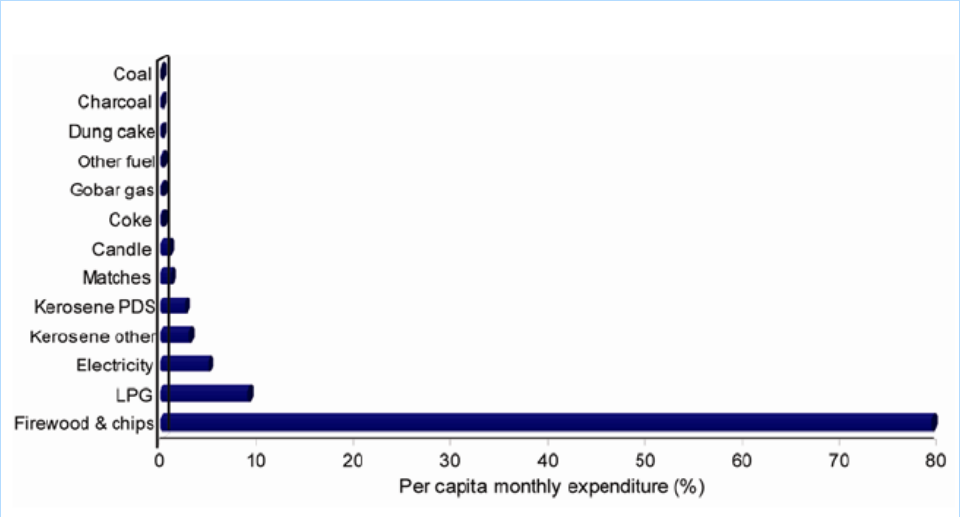
The trends of power generation and consumption can be seen from Figure 13. Hydro power generation by the state utility accounts for about 85% of the state power generation and has increased at 1.2% rate per annum since 1990 where as power consumption has increased at around 7.1% rate per annum during the same period. The gap in the power generation and consumption is fulfilled through central power supply. Per capita monthly expenditure (%) on fuel and light in rural area can also be seen from the figure[10]. Firewood is the main domestic energy source, followed by LPG and electricity. Figure13 also indicates the major driving forces of non-CO2 emissions - nitrogenous fertilizer application, rice production and livestock population in Arunachal Pradesh. As can be seen, fertilizer usage has grown at a rate of 4% per annum against only 0.7% and 0.2% growth rate of foodgrain and rice production respectively.

[9] India: Greenhouse Gas Emissions 2007, 2010, Ministry of Environment and Forests, Government of India
[10] Rawat J.S., Sharma D., Nimachow G., and Dai O (2010), Energy efficient chulha in rural Arunachal Pradesh. CURRENT SCIENCE, VOL. 98, NO. 12, 25 JUNE 2010

Figure 13 : Trends in power generation and consumption in Arunachal Pradesh

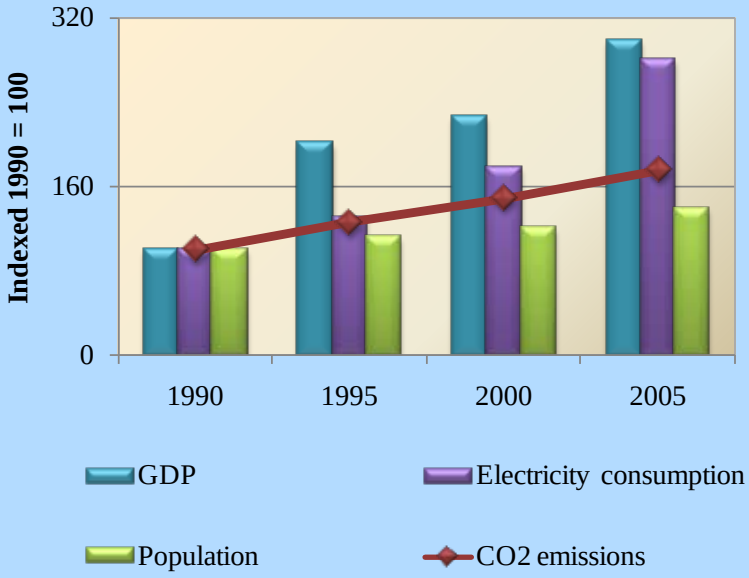






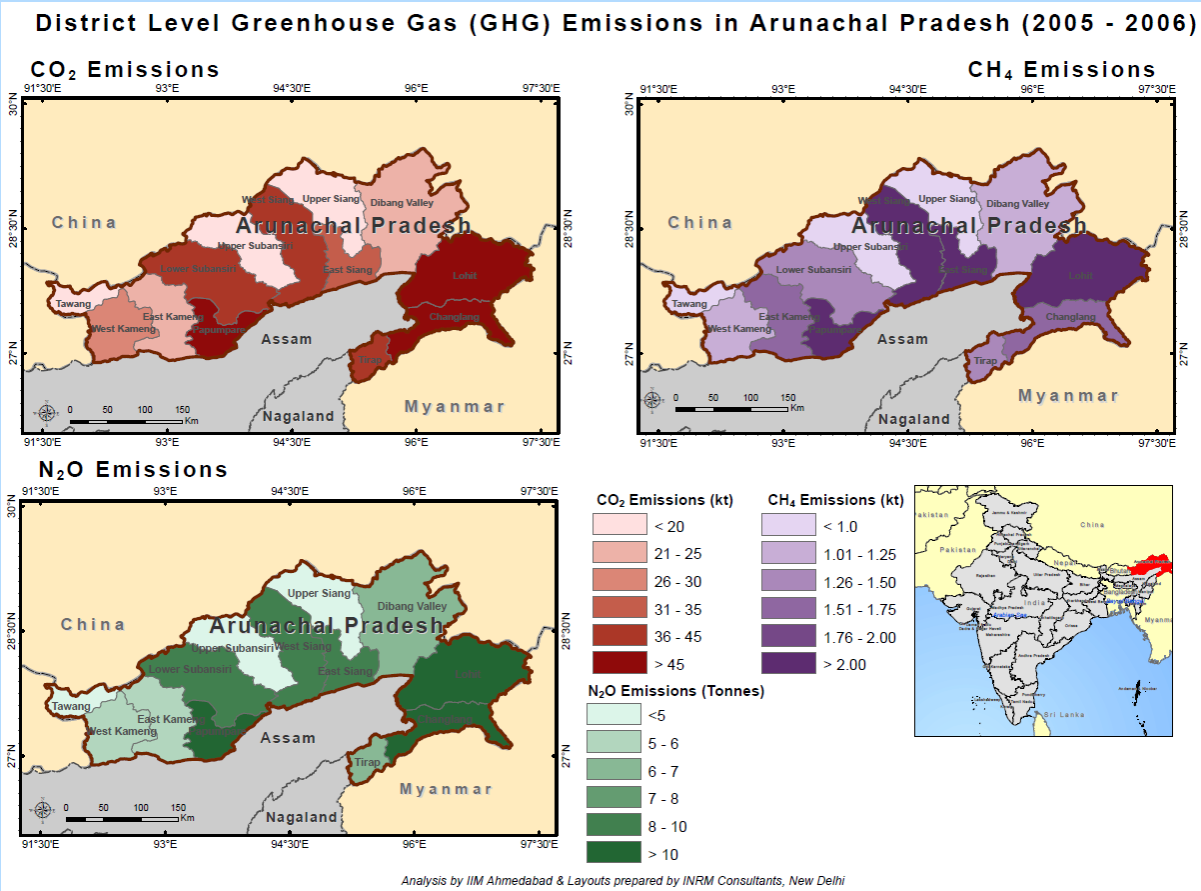
Total 898 Kt (kilo or thousand tonnes) CO_2e (CO_2 equivalent) GHGs have been emitted from Arunachal Pradesh during the year 2005. CH_4 emission contributes about 51% of the state's GHG emissions followed by CO_2 (46%) and N_2O (3%). The trend of GHG emissions and other indicators of Arunachal Pradesh state during 1990 to 2005 can be seen from Figure 14. GDP and population, the main driving forces of GHG emissions, have increased at 7.5% and 2.3% CAGR respectively. While electricity consumption and CO_2 emissions have increased at 7.1% and 3.9% CAGR respectively. Per capita GHG emissions of Arunachal Pradesh are 0.7 tonnes, which is quite lower than the national average of 1.8 ton CO_2e per person. The state has continuously improved efficiency of its economy and has reduced GHG intensity of its GDP by 40% during the same period. Figure 15 indicates district level emissions of various greenhouse gases in Arunachal Pradesh. Papum Pare, Lohit and Changland are the three highest CO_2 emitting districts during 2005. In case of CH_4 and N_2O emissions, few highest emitting districts are Lohit, East Siang, Papum Pare and Changland. Higher population, livestock rearing and agricultural activities in these districts are the major contributor to their higher emissions.

Figure 14 Relative increase in GDP, population, electricity consumption and GHG emissions in Arunachal Pradesh (Indexed 1990 = 100)



Spatial variation showing district level emissions of various greenhouse gases in Arunachal Pradesh is shown in Figure 15.

Figure 15 : District level emissions of various greenhouse gases in Arunachal Pradesh during 2005-2006



Assessment of existing GHG emissions by sector

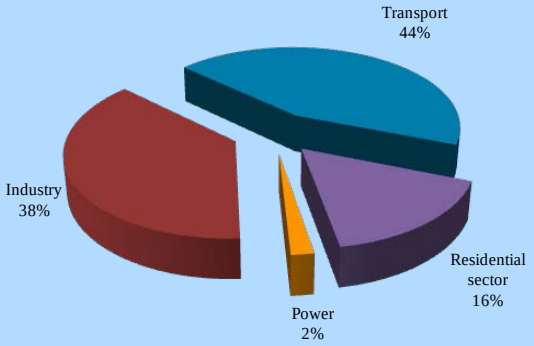
Emissions from various categories a) energy, b) industrial process and product use, c) agriculture and 4) waste as well as relative share of source activities in CO_2, CH_4 and N_2O emissions of Arunachal Pradesh can be seen from Figure 16. About 59% of GHG emissions from Arunachal Pradesh come from energy category. This category includes emissions due to fossil fuel and biomass burning within power plants, manufacturing industries, transport sector and residential sector. Agriculture sector contributes about 75% and 39% of CH_4 and N_2O emissions of the state. Majority of CH_4 emissions occur from enteric fermentation of livestock (62%) followed by biomass burning (21%) and manure management (13%). While majority of N_2O emissions occur from biomass burning (48%) followed by organic nitrogen applied on field (22%) and Municipal solid waste and domestic waste water treatment (10%). Each of Synthetic nitrogen fertilizer application and nitrogen from crop residue left on field contribute about 5% to N_2O emissions of the state.

Emissions from various categories and source activities with their relative share in Arunachal Pradesh emissions are shown in Figure 16.

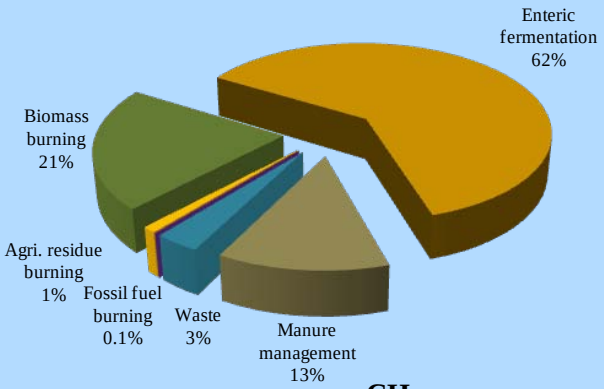
Figure 16 : Sectoral greenhouse gas emissions (excluding LULUCF) from Arunachal Pradesh during the 2005-06

GHG emissions (excluding LULUF) from Arunachal Pradesh during 2005 (Tg)

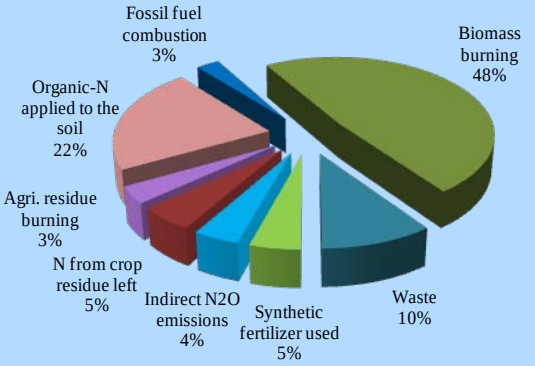
	CO2	CH4	N2O	CO2e
Energy	414	4.63	0.051	527
Agriculture		16.25	0.039	353
Waste		0.72	0.010	18
Total	414	21.60	0.099	898



CO_2



CH_4



N_2O

Chapter 4

Climate Change Impacts and Vulnerability

Chapter 4 - Climate Change Impacts and Vulnerability

A brief summary of assessment of the impact of projected climate change on water, forest and energy sectors carried out by IIT Delhi, IISc Bangalore and IIM Ahemedabad is presented here.

Impact of climate change on waterv resources of Arunachal Pradesh

Methods and Models: An assessment of the impact of projected climate change on water resources in Arunachal Pradesh is made using the hydrologic model SWAT[11] (Soil and Water Assessment Tool). The model requires information on terrain, soil profile and landuse of the area as input which have been obtained from the global sources. These three entities are assumed to be static for future as well.

The Brahmaputra River basin which is the main river system in Arunachal Pradesh has been modelled using the following:

Spatial data and the source of data used for the study areas include:

- Digital Elevation Model: SRTM, of 90 m resolution[12]
- Drainage Network – Hydroshed[13]
- Soil maps and associated soil characteristics (source: FAO Global soil)[14]
- Land use (source: Global landuse)[15]

The Hydro-Meteorological data pertaining to the river basin required for modelling, includes daily rainfall, maximum and minimum temperature, solar radiation, relative humidity and wind speed. Climate Change PRECIS Regional Climate Model outputs for Baseline (1961–1990, BL), near term (2021-2050, MC) and long term or end-century (2071-2100, EC) for A1B IPCC SRES scenario (Q14 QUMP ensemble) has been used.

Impacts of Climate Change on Water Resources

The climate change impact assessment on water resources of Arunachal Pradesh has been taken from the recent study conducted (Gosain et al, 2011[16]) as part of the NATCOM Phase II study of

[11] The Soil and Water Assessment Tool (SWAT) model (Arnold et al., 1998, Neitsch et al., 2002) is a distributed parameter and continuous time simulation model. The SWAT model has been developed to predict the response to natural inputs as well as the manmade interventions on water and sediment yields in un-gauged catchments. The model (a) is physically based; (b) uses readily available inputs; (c) is computationally efficient to operate and (d) is continuous time and capable of simulating long periods for computing the effects of management changes. The major advantage of the SWAT model is that unlike the other conventional conceptual simulation models it does not require much calibration and therefore can be used on ungauged watersheds (in fact the usual situation).

[12] http://srtm.csi.cgiar.org

[13] http://hydrosheds.cr.usgs.gov/

[14] http://www.lib.berkeley.edu/EART/fao.html

[15] http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp

[16] NATCOM II – Unpublished report, 2011

MoEF. For the present analysis pertains to the modeling of River Brahmaputra using the hydrologic model SWAT.

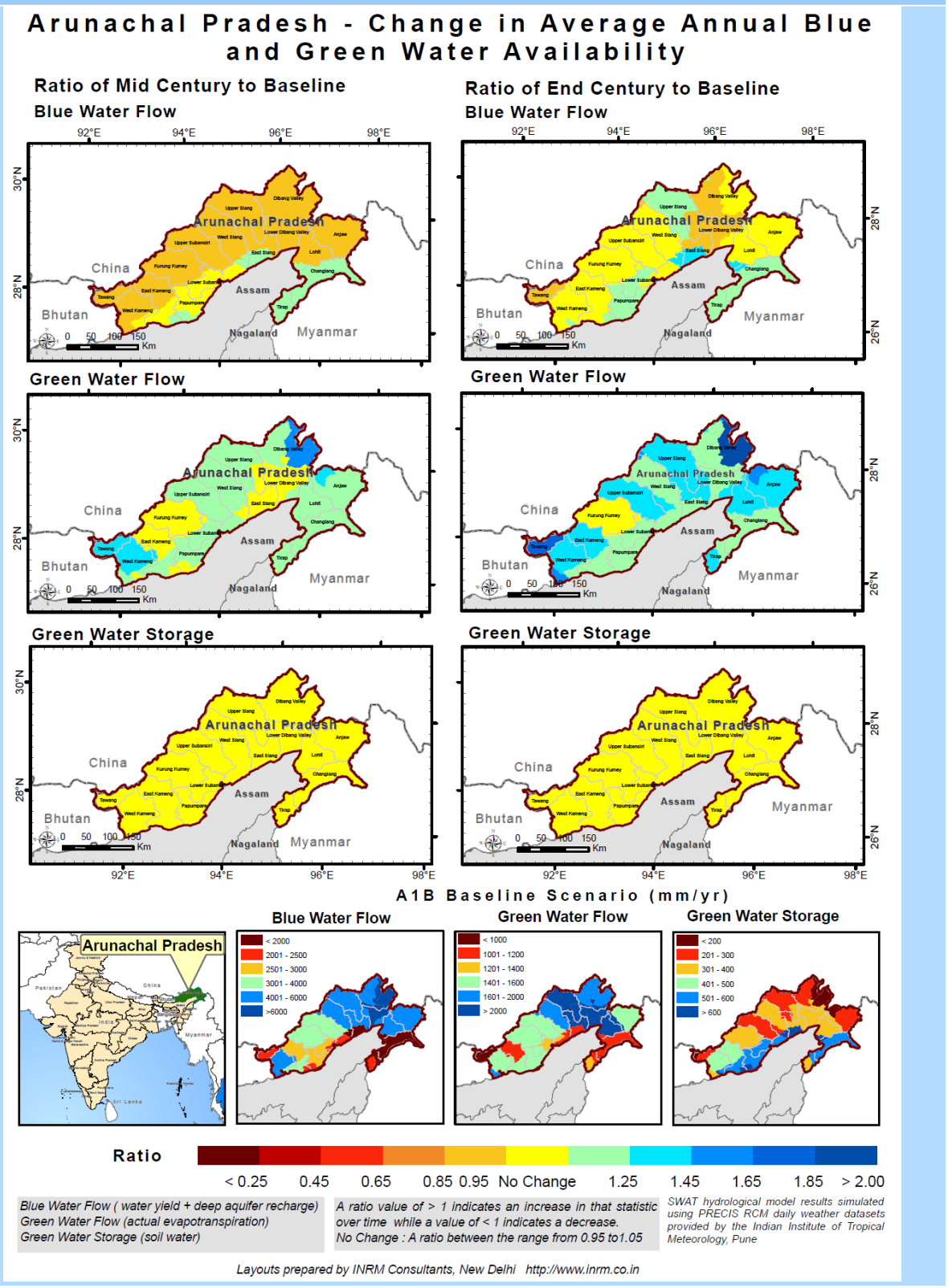
The study determines the present water availability in space and time without incorporating any man made changes like dams, diversions, etc. The same framework is then used to predict the impact of climate change on the water resources with the assumption that the land use shall not change over time. A total of 90 years of simulation have been conducted; 30 years belonging to IPCC SRES A1B baseline (BL), 30 years belong to IPCC SRES A1B near term or mid-century (MC) climate scenario and 30 years belong to IPCC SRES A1B long term or end-century (EC) climate scenario.

While modelling, the river basin has been further subdivided into reasonable sized sub-basins so as to account for spatial variability of inputs under the baseline and GHG scenarios. Detailed analyses have been performed to quantify the possible impacts on account of the climate change.

Analysis for the Brahmaputra basin reveals an increase in the annual precipitation of 2.3% for MC and decrease by 20.0% for EC from the BL. The outcome of the SWAT hydrological modeling has predicted a consequent increase of water yield by 3.5% under MC and a reduction by 8.7% under EC from the BL water yield. The situation of the actual evapotranspiration is decrease by 8.0% under MC and by 7.0% under EC from the actual evapotranspiration under BL respectively.

Detailed assessment of the different components of freshwater availability both in space and time is critical for identifying the vulnerable regions/hotspots. This enables a proper development / identification of the adaptation and mitigation strategies in addressing climate change coping mechanisms. Freshwater components i.e., blue water flow (i.e., water yield plus deep aquifer recharge), green water flow (i.e., actual evapotranspiration), and green water storage (i.e., soil water) has been estimated at a sub-basin level with daily weather data for Brahmaputra basin under baseline as well as GHG scenarios (Figure 17). This depiction is important in understanding the general availability of blue and green water across the basin. The change in blue water availability show spatial variation from marginal reduction (5%) to no change across the state towards 2050's as compared to the baseline and there is almost 25 to 35% increase towards 2080's. The green water flow also shows increase but the magnitude is marginal under both MC and EC scenario and may increase to 25% for some of the area. The situation of Green water storage shows no change from the baseline under both scenarios. The green water storage can potentially benefit the agriculture in months with little or no precipitation. This information is quite helpful in planning cropping season and helps to model scenarios of changing cropping seasons and patterns and arriving at appropriate adaptation measures.

Figure 17 : Change in Annual blue and green water availability towards 2030s and 2080s with respect to 1970s (IPCC SRES A1B scenario) in Arunachal Pradesh



Impact of climate change on forests of Arunachal Pradesh

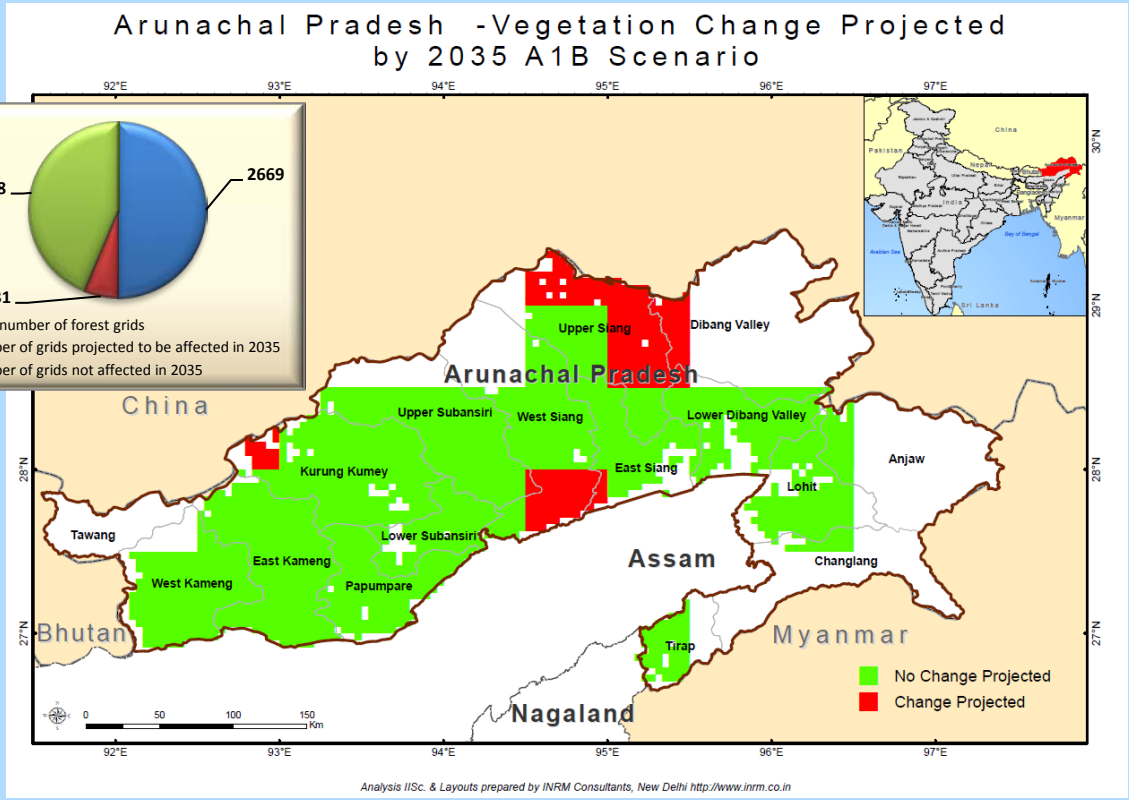
Methods and Models: An assessment of the impact of projected climate change on forest ecosystems in Arunachal Pradesh is made using the following:

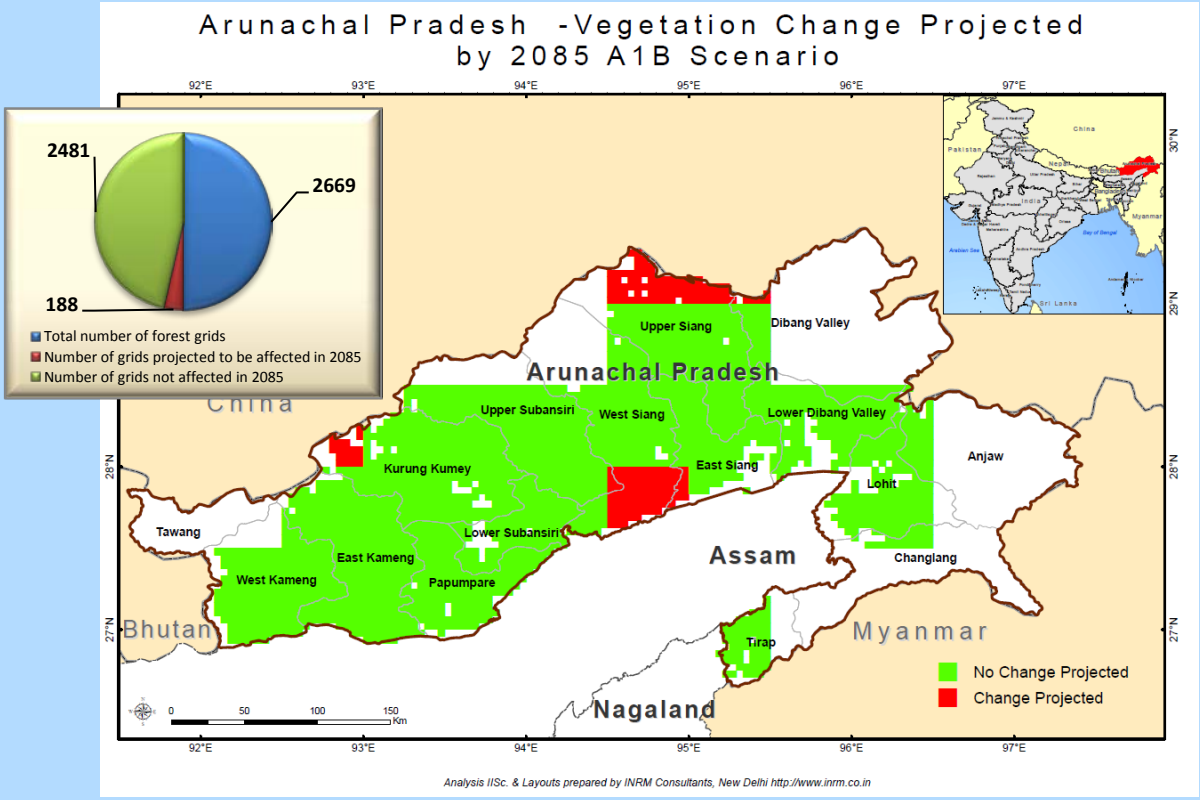
- Climate impact model; global dynamic vegetation model IBIS
- Climate change scenario; A1B scenario
- Period of assessment; short-term (2021-2050) and long-term (2071-2100) periods.
- Input data; monthly mean cloudiness (%), monthly mean precipitation rate (mm/day), monthly mean relative humidity (%),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

Impacts of climate change: The impacts of projected climate change are assessed at regional climate grid scales (about 50 X 50 km).The dynamic global vegetation model (IBIS[17]) has been validated by IISc for its suitability to Indian conditions. The dynamic vegetation model outputs show that during the short-term period of 2030s, out of the 2669 forested grids in Arunachal Pradesh, 331 (12.4%) will be impacted by climate change. Percentage of the forested grids is projected to be impacted by 2080s is lesser to the tune of 7%. The distribution of forested grids projected to be impacted by climate change is presented in Figure 18 for 2030s and 2080s. A change in forest types is projected in the northern region of Upper Siang district, western region of Dibang Valley, southern West Siang and western region of Kurung Kumey districts. Thus the biodiversity rich districts of Arunachal Pradesh are projected to be adversely impacted by climate change by 2030s.

[17] Foley, J. A., I. C. Prentice, N. Ramankutty, S. Levis, D. Pollard, S. Sitch, and A. Haxeltine. 1996. An integrated biosphere model of land surface processes, terrestrial carbon balance, and vegetation dynamics. Global Biogeochemical Cycles 10(4), 603-628.

Figure 18 : Forest vegetation change projected by 2035 and 2085 under A1B scenario in Arunachal Pradesh





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Chapter 5

Present Policies & Programs and Linkages with NAPCC

Chapter 5 - Present Policies & Programs and Linkages with NAPCC

At the national level, the integration of climate change in national development is guided by the Prime Minister's Council on Climate Change, which includes representation of key Ministries, as well as experts, and representatives of industry and of media. The Council provides overall strategic guidance on mainstreaming climate change in development, identifies key intervention priorities, and monitors the implementation of these interventions.

The National Committee to Assess the Impacts of Climate Change is chaired by the Principal Scientific Advisor to the Prime Minister, and includes meteorologists, climate modelers, hydrologists, energy economists, as well as representatives of key Ministries. The Committee is evaluating the impact of climate change on key development activities, and assessing options to mitigate climate risks.

The NAPCC identifies measures that promote development objectives which also result in co-benefits for addressing climate change. There are eight National Missions, which form the core of the NAPCC, representing a "multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change".

Eight Missions of National Action Plan on Climate Change

National Solar Mission (renamed as Jawaharlal Nehru National Solar Mission) aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil based energy options.

National Mission for Enhanced Energy Efficiency (NMEEE) recommends mandating specific energy consumption decreases in large energy consuming industries. It also recommends financing for public-private participants to reduce energy consumption through demand side management programs

National Mission on Sustainable Habitat aims to promote energy efficiency as a core competent for urban planning. The plan calls for a greater emphasis on urban waste management and recycling including production of power from waste.

National Water Mission sets a goal of 20 % improvement in water use efficiency through pricing and other measures

National Mission for Sustaining the Himalayan Ecosystem aims to conserve biodiversity, forest cover and other ecological values in the Himalayan region

National Mission for a Green India aims at afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 % to 33 % of India's territory.

National Mission for Sustainable Agriculture aims to support climate adaptation in agriculture through the development of climate resilient crops and appropriate agricultural practices

National Mission on Strategic Knowledge for Climate Change is for gaining a better understanding of climate science, impacts and challenges. It envisions improved climate modeling and increased international collaboration to develop adaptation and mitigation technologies.

Linkages with NAPCC

As a follow up to the Prime Minister's Action Plan for combating the impacts of climate change several steps have been taken by the Government of Arunachal Pradesh.

Water Mission - Existing State Policies and programs

At present there is no State Water Policy. However, the emphasis is on expansion of irrigation and control of floods. The focus is on optimum utilization of the created irrigation potential through augmentation, renovation and maintenance of irrigation projects. Survey and exploitation of ground water for irrigation in the foot hill areas of the state is also being undertaken.

The undulating topography of State offers no scope for Major Irrigation Projects. However, the foothill belts of Arunachal have irrigable lands to be put under command through medium irrigation projects. So far three Detailed Project Reports for Pappu Valley in East Kameng, Deopani Multipurpose project in Lower Dibang Valley and Paya, Hati Duba, Yeliang and Zeko in Lohit district have been completed by the department. Further, the Department has also taken up survey and investigation of medium irrigation project at Sille Remi in East Siang District. This project is expected to cater to irrigation potential of about 3000 hectares.

Two programmes, namely, Arunachal Pradesh State Water & Sanitation Mission (APSWSM) as per the guidelines of NRDWP and PMGY / MNP for Rural Drinking Water are being implemented. As per new guidelines of NRDWP, stress is given to take up schemes to augment and share the natural resources in a sustainable manner so as to enhance the service efficiencies in the sector. Schemes like, source protection, gully plugging, check dam, catchment protection, contour trenching, impounding reservoirs and artificial recharge etc., have been the main focus to create sustainability. At present 31 schemes are being executed in 30 habitations/villages under this scheme at a cost of 35.6 million rupees. Roof top rain water harvesting schemes are also being taken up and likely to be completed by March 2011 in 428 schools at a cost of 3o8.7 million rupees.

The other acts which are in place include, Arunachal Pradesh Water Supply Act 2000 enacted by the State Legislature deals primarily with the regulations for domestic water supply, Arunachal Pradesh Water Resources Regulatory Authority Act 2006, under which it is proposed that Arunachal Pradesh Water Resources Regulatory Authority (APWRRA) shall be established to work according to the State Water Policy at the river basin level. Arunachal Pradesh Water Resources Regulatory Authority Act 2006 envisages to promote efficient use of both surface and ground water resources, equitable water distribution for domestic agriculture/ horticulture, industry, and forest etc, and sustainable water use, water conservation and management practices amongst users.

Sustainable Agriculture Mission and Horticulture - Existing State Policies and programs

The State's strategy of agriculture development is centred on achieving self sufficiency in food grain production and marketing the produce at remunerative prices and generating revenue and employment opportunities. The broad strategy is to provide food (rice) security through

- Area expansion by land development
- Creation of assured irrigation in settled cultivation areas
- Promotion of scientific planning and cropping pattern to improve the yield per hectare
- Integrated efforts for enhanced productivity in Jhum areas
- Integrated crop management
- Continuation of the traditional organic farming to meet market demands for organic products
- Efforts for improving the rice production rate @ 8%
- Ecologically sustainable and economically viable diversification of agriculture
- Major emphasis on growing off season vegetables and fruits

Under the Technology Mission for Horticulture four mini programmes have been taken up since 2001 with the objective to increase the area under fruits, spices, vegetables, drip irrigation and post harvest technology for processing and marketing of fruits and vegetables. The present focus is on intensive form of horticulture gardening rather than extensive horticulture. Success has been achieved by improving the livelihood of farmers by growing Apple, Orange, Kiwi, Tomato and Large cardamom. The ongoing National Missions in the state are National Bamboo Mission, National Mission on Medicinal Plants, and National Mission on Micro Irrigation.

Green India Mission Forests and Horticulture - Existing State Policies and programs

The major programmes in this area are:

- Social forestry programmes through distribution of seedlings and creation of Apnavan through involvement of people.
- Development of Non Timber Forest Produce (NTFPs), including medicinal and aromatic plants.
- Strengthening of Forest Protection measures including protecting against fire
- Intensification of scientific management of the forests for sustainable optimum yield.
- To improve and extend protected area network for conservation, protection and development of Biodiversity and Wild Life and also to involve communities in wildlife conservation in high altitude non protected areas.

Solar Mission - Existing State Policies and programs

Implementation of the Jawaharlal Nehru National Solar Mission was started by the state in 2010. The State has been making serious efforts to harness solar energy. A variety of solar power devices have been distributed and installed

Activity	Achievement
Remote Village Electrification through Solar Home System	720 villages
Solar Home System distributed	7270 Nos
Solar Lantern Distributed	14433 Nos
Solar Pump Installed	18 Nos
Solar Water Heater Installed	33000 LPD
Solar Power Plant	7 Nos (42.00 Kw)

Energy Efficiency Mission – Existing State Policies and programs

Under the Prime Minister's 50,000 MW hydro power initiatives the Ministry of Power Government of India had identified 89 projects in Arunachal Pradesh. The Arunachal Pradesh is privileged to share 50 % of the PM's 50,000 MW hydro initiative.

As per the Hydro Power Policy 2008 of the State the state government may award the projects which have the projected capacity between 25MW and 100 MW to persons, including private developers, through a negotiated MOA route. In respect of projects envisaging capacity between 25 MW to 100 MW which have already been awarded to private developers on the negotiated MOA route and in cases where the final capacity as per the DPR exceeds 100 MW, necessary enhancement in the installed capacity of the project would be allowed. The state government shall be entitled free of cost power to the extent of not less than 12 % of power generated by the developer. The state will further reserve the right to purchase power so generated over and above the state share of 12 %.

Arunachal Pradesh has entered into agreements with public and private companies to harness hydropower, thus, contributing towards a low carbon economy. The installed capacity of the State is about 30,735 MW. Around 2,600 villages have been electrified out of 3,649 villages in the State.

The state Plan for 2010- 11 envisages exploitation and generation of mini/micro and large hydel power potential available in the State as well as development of T&D line with inter-state/ intra-state grid along with exploration of hydro power potential and establishment of 132 KV state-grid to serve as the backbone for the electrification programme.

An amount of Rs. 5500 million was meant to be spent to provide electricity through solar power as well as small hydro-power project to all villages. It includes completion of 46 ongoing small hydro projects being funded by Planning Commission and electrification of 1058 villages through solar and micro- hydel projects being funded by Ministry of Nea and Renewable Energy involving a cost of Rs 2755 million.

APEDA programs

The APEDA is the State Designated Agency of Bureau of Energy Efficiency (BEE), GoI for the implementation of programmes related to energy efficiency and energy conservation.

Under BEE sponsored schemes, following activities are being carried out.

Energy conservation activities

- State level Energy Conservation Day is being organized
- Awareness campaign on Energy Conservation in schools and colleges, news paper and Television, Pamphlets, Documentary show are organized.
- Training Programmes are being organized with the resource persons from party such as NPC etc.
- Energy Audit for 15 Govt building completed.
- As Per the Survey conducted through Government Polytechnic college ,33 establishments have electrical connected load more than 200 Kw

Demonstration projects on energy efficiency

- Replacement of 150 Nos. of 150 Watt Sodium Vapour Lamp with 70 watts LED Street Lighting Completed.
- LED Village Campaign with replacement of existing incandescent Household Lighting and Street Light with LED Lamps in Darka Village, West Siang District completed.
- Survey Report for replacement of existing incandescent bulbs & tube lights with energy efficient LED lights in Tawang Monastry has been submitted to BEE for sanction.

State Energy Conservation Fund (SECF):

The BEE has introduced a fund called SECF for the purpose of promotion of efficient use of energy and its conservation in the state under Energy Conservation Act, 2001. Accordingly, SEFC has been formed in the state, however,

- contribution of fund from the state equivalent to the fund released by the BEE is yet to be done
- Activities as per the guidelines are yet to be taken up.

Industry

The Industrial Policy, 2008 of Arunachal Pradesh is formulated to achieve the following objectives:

- To create an investment-friendly environment in the State for industrial growth in the private/ joint venture / cooperative sectors for sustainable economic development of Arunachal Pradesh.
- To generate employment opportunities in the State.
- To make Arunachal Pradesh a preferred destination for outside investors.
- To encourage local entrepreneurs to set up enterprises based on locally available raw materials.
- To promote export oriented industrial units.
- To take steps to promote hand loom and handicrafts.
- To promote local investors through joint ventures with outside investors.
- To encourage industrial units producing high value - low volume products.
- To ensure fast track clearance of industrial proposals.

The State Government has identified the following industries as thrust areas, which will be eligible for various incentives:

- Industries based on agricultural, horticultural and plantation produce.
- Industries based on non-timber forest produce: bamboo, cane (rattan), medicinal plants / herbs, aromatic grass, tea, coffee etc.
- Industries based on locally available raw materials except timber.
- Textiles (handlooms and power looms), Handicrafts and Sericulture
- Electronics and IT based Enterprises.
- Mineral Based Industries (eg. Ferro-alloys, Cement Plant etc.).
- Facilitation and Development of Industrial Infrastructure including Power, Communications etc. under Public Private Partnership (PPP).
- Food Processing Industries.
- Engineering and Allied Industries (Rolling Mill, Steel etc.).
- Tourism (tourism infrastructure including resorts, hotels,

Sustainable Habitat Mission - Existing State Policies and programs

Schemes and Project are being implemented by Department of Urban Development & Housing and Town planning department.

Urban Transport

- Metro Cable System: - To reduce the Traffic Congestion, Noise Pollution, Air Pollution the department is proposing metro Cable system from Itanagar to Naharlagun, connecting various sectors of Itanagar and within Tawang Township.
- JNNURM Buses: - To discourage using private transport, to reduce air & noise pollution Department of Urban Development has procured 23 new buses under JnNURM. In addition to that, it is propose to introduce C.N.G Buses in the State.

Solid Waste Management

Presently the Department is implementing 4 Solid wastes project in Itanagar, Roing, Jairampur and Changlang under JNNURM to dispose of the Solid waste in scientific manner.

Road

The Department is implementing road projects to improve the urban roads such as widening, re-carpeting, blacktopping and construction of drain, storm water drain and pedestrian path etc. The Avenue Plantation is proposed in both sides of all urban roads.

Other scheme

Such as working women Hostel, unemployed women Hostel, Shopping Complex, Parking Place are also Constructed/under construction by the Department of urban development and housing.

Arunachal Pradesh Building Bye Laws 2010 notified

- Integrated township policy is notified and “Integrated Township” is gaining increasing acceptance in recent times. In order to give impetus to economic growth and to enhance the vibrancy and dynamism of urban activities in urban areas of Arunachal Pradesh, Integrated Townships with minimum 10 Ha of land having access from minimum 24 m. road width shall be allowed.
- The integrated Township shall be permitted in Residential / Institutional zones.

- Permissible land use within the town ship is (45 to 50%), Industrial, Non Polluting type (8 to 10%), Commercial (2 to 3%), Institutional (6 to 8%), Recreational, Park, Play ground (12 to 16%). Minimum internal road width 10 m.

Other Regulations for approval of Integrated Township

- 10% of the total area shall be reserved for parks and open space. It shall be developed and maintained by the developer to the satisfaction of the Authority
- The FAR shall be calculated on the total area.
- The FAR and coverage shall be 2.50 and 40% respectively.

Rural Development

Integrated Township policy has been notified. To give impetus to economic growth, integrated townships with minimum 10 ha of land having access with minimum 24 m width will be allowed. Arunachal Pradesh Building Bye Laws 2010 has been prepared according to the model bye laws of the Ministry of Urban Development Government of India. The Itanagar Master Plan is being finalised. Emphasis is being given on improving urban roads, landscaping avenue plantation, and solid waste management.

Rural Roads

The Border areas are considered to be the domain of Army and other paramilitary organisations and the states, therefore, do not consider to have a stake in developing the infrastructure facilities in the border areas. As such the border areas are under developed and backward when compared to the rest of the country. These areas lack essential facilities such as road, power and telecommunications. This in turn is discouraging development of industry and use of modern agricultural methods. Livelihood opportunities are minimal and basic facilities like education and health are almost absent.

Border Area Development Programme was started with the objective to augment the resources so that the infrastructure and socio economic services could be upgraded. Under the BADP, 1238 villages fewer than 13 blocks in 12 districts of Arunachal Pradesh are being covered.

30,000 km of roads are being constructed every year by the state under the PMGSY. At present the road connectivity in rural areas is 40 %.

Disaster Management

The State of Arunachal Pradesh is prone to a variety of natural disasters such as cloud bursts, landslides, flash floods and forest fires. The state is prone to earthquakes and is in the seismic zone V. recognizing the need for a proactive, comprehensive and sustainable approach to disaster management and reduce the detrimental effects of disasters on the overall socio economic development, the Government of Arunachal Pradesh had formulated the Arunachal Disaster Management Policy.

The aim of the policy is to establish necessary systems, structures, programs, resources, capabilities and guiding principles for reducing vulnerability to various hazards and preparing for and responding to disasters and threat of disasters in the State in order to save lives and property, avoid disruption of economic activity and damage to environment and to ensure the continuity and sustainability of development of the State.

The important principles of the policy are:

- Integrating disaster management into development planning
- Multi Hazard approach to disaster
- Sustainable and continuous approach
- Effective inter agency cooperation and coordination
- Capacity building
- Accommodating aspirations of people
- Accommodating local conditions
- Develop share and disseminate knowledge

The Arunachal Pradesh Disaster Management Authority (APDMA) was constituted with a view to provide guidelines to different agencies involved in the disaster management so as to effectively discharge their functions. Local community groups and NGOs are being involved to actively assist in prevention and mitigation activities under the direction and supervision of APDMA.

Health - Existing State Policies and programs

Inhospitable terrain and low population density makes provision of health facilities difficult. The focus is on providing integrated preventive, promotional, curative and rehabilitative health services for communicable, non communicable and nutritional related health problems. A number of surveillance activities are being undertaken as part of the Integrated Disease Surveillance Programme IDSP. EDUSAT is being used for Distance learning and communication as part of the IDSP. Since 2006 one Public Health Centre in each of the 16 districts is being run by reputed NGOs.

Tourism

The priority of the Annual Plan 2010-11 was exploitation of tourism potential through development of tourism infrastructure, stress on adventure tourism, eco tourism and cultural tourism in the State and development of tourist circuits etc.

Chapter 6

Sectoral Climate Change Strategy and Action Plan

Chapter 6 - Sectoral Climate Change Strategy and Action Plan

List of programs and policies as perceived by the State to synergize sustainable development and adaptation to climate change as identified by state departments have been discussed below:

Forestry

Greening India Mission; Mitigation and adaptation

Greening India Mission aimed at mitigation and adaptation to projected climate change is proposed by the Government of India. Greening Mission aims to enhance ecosystem services such as carbon sequestration and storage, biodiversity conservation and provision of biomass and NTFPs. The mission aims at responding to climate change by combination of adaptation and mitigation measures which would aim at; i) Enhancing carbon sinks in sustainably managed forests and other ecosystems, ii) Adaptation of vulnerable species/ecosystems to the changing climate, and iii) Adaptation of forest dependent communities. Thus consistent with Greening Mission, under the State Action Plan, both adaptation and mitigation projects are proposed for addressing climate change impacts on forest ecosystems as well as to mitigate the climate change through enhancing the carbon sinks.

Adaptation programme under the Greening India Mission:

Under the impact of climate change on forest it was shown that significant proportion of the forests in Arunachal Pradesh is vulnerable to climate change risks. There are no scientific studies to recommend specific adaptation measures suitable for different vulnerable forest types and regions. Studies by Indian Institute of Science have suggested some of the win-win adaptation strategies and practices to promote adaptation to projected climate risks. Table 4 presents a preliminary list of potential adaptation interventions and project ideas, based on the Greening India Mission. There is a need for conducting preliminary studies to identify locations for implementing the adaptation measures. The exact area for implementing the adaptation interventions is not readily available but a preliminary estimate of the investment required is provided.

Table 4: Adaptation projects proposed for Arunachal Pradesh under the Greening India Mission

Category of adaptation interventions	Proposed adaptation activities/ projects	Proposed* investment (in Million Rs)
Anticipatory planting of species across latitudinal and longitudinal gradient	Enhancing afforestation and plantations activities	4750
Promotion of natural regeneration and mixed species planting	This will be a component of all mitigation programs / projects proposed under the Mitigation component of GIM (Table 5)	-
Effective fire prevention and fire management	Fire protection measures and control of forest fires	500
Sustainable harvesting of timber and non-timber products	Promoting non timber forest product utilization	1000
Protected Areas (PAs) management	Expansion of protected area network	153

Category of adaptation interventions	Proposed adaptation activities/ projects	Proposed* investment (in Million Rs)
(securing corridors for species migration)		
Reduced forest fragmentation by conserving contiguous forest patches (use of landscape/sub-landscape approach)	Projects for reduction of dependence on timber and fuel wood for reducing pressure on forests and biodiversity	1500
** Source: Arunachal Pradesh State Biodiversity Strategy and Action Plan, 2003 by S.N. Hedge*		

Many of the adaptation interventions such as anticipatory planting, promotion of natural regeneration, mixed species forestry, and prevention of fire can become an integral part of the mitigation projects proposed under the Greening India Mission, listed in Table 5. Expansion and linking Protected Areas should be one of one priority projects under the adaptation programmes.

Mitigation projects with size, location and investment needs

Forest sector provides a large opportunity for mitigation of climate change, in particular through reducing CO2 emissions by reducing deforestation and forest degradation as well as increasing carbon sinks in the existing forests and creating new sinks in degraded lands through afforestation. The GIM has identified several sub-missions and several activities or interventions under those sub-missions. The proposed mitigation programmes and projects under the GIM are presented in Table 4, along with area proposed and the investment cost required.

Table 5: Mitigation projects proposed under the Greening India Mission

Sub-missions of National Mission for a Green India	Categories under the Sub-missions	Area (Mha)	Unit cost/ha (Rs)	Total investment cost (in Million Rs)
Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services	Moderately dense forest cover, but showing degradation	1.16	27,000/- (present cost, subject to per future cost-index/inflation)	31320
	Eco- restoration of degraded open forests	0.49	-do-	13230
	Restoration of grasslands	0.02*	-do-	540
Sub Mission 2: Ecosystem restoration and increase in forest cover	Rehabilitation of shifting cultivation areas	0.05*	1,25,000/-	
(present cost)	625			
	Restoring scrublands, ravine reclamation	0.005*	45,000/- (present cost)	2250
Sub Mission 3: Enhancing tree cover in Urban & Peri-Urban areas	Avenue, city forests, municipal parks, gardens, households, institutional lands, etc	0.002 (provided by Horticulture department)	25,000/-(present cost)	50
Sub Mission 4: Agro-forestry and Social Forestry (increasing biomass & creating carbon sink)	Farmers' land including current fallows, shelterbelt plantations	0.02 (provided by Horticulture department)	1,25,000/- (present cost)	2500
	Total	1.747		56140
** Source: Wasteland Atlas of India, 2010*				

Mitigation potential of the proposed projects under GIM

Mitigation potential of proposed activities (Table 5) is estimated using COMAP model and based on carbon sequestration rates used in the Greening India Mission. The annual incremental mitigation

potential (Table 6) is estimated to be 20.6 million tonnes of Carbon or about 75 million tonnes of CO2 by 2020. Thus forest sector indeed can play a large role in mitigation of GHG emissions not only for Aurnachal Pradesh but also for India.

Table 6: Incremental annual mitigation potential of proposed activities under different options proposed in Table 4

Sub-missions	Area (Mha)	Incremental annual mitigation potential 2020 (MtC)	Incremental cumulative mitigation potential 2010-2020 (MtC)	Incremental cumulative mitigation potential 2010-2030 (MtC)
Moderately dense forests	1.16	10.6	79.4	185.4
Degraded/open forests	0.49	9.0	67.8	158.3
Scrub/grassland ecosystems	0.075	0.8	6.0	13.9
Agroforestry & social forestry incl. urban forestry	0.022	0.2	1.2	2.8
Total	1.747	20.6	154.5	360.4

Sustainable Agriculture Mission

Department of Agriculture and Department of Animal Husbandry and Veterinary have jointly proposed the following mitigation and adaptation measures.

Identified mitigation/adaptation measures in agriculture sector:

- Rehabilitation of Shifting Cultivation areas
  - Terraced rice cultivation to cover 0.011 Mha
- Improvement in current practice
  - Use of high temperature tolerant varieties, Rain Water Harvesting, Crop diversification etc. to cover 0.054 Mha

Identified mitigation/adaptation measures in livestock sector:

- Water conservation structures.
- Rain water harvesting
- Introduction of Fodder preservation techniques
- Installation of Feed block machine
- Disease surveillance and monitoring cell & continuous research on emergence of newer pathogens.
- Research for development of low cost, eco-friendly housing design to mitigate heat stress.
- Changes in nutritional regime to reduce enteric fermentation.
- Massive fertility campaign

Table 7: Identified mitigation potential of proposed activities under different options proposed un Agriculture and Livestock sector

Sector	Component/identified mitigation/adaptation option	Area (million ha)	Average unit cost/ha (million Rs)	Total investment (million Rs) spread over 5 years
Agriculture	Rehabilitation of Shifting Cultivation areas by **Terraced Rice Cultivation**	0.011	0.1 per ha	1100.00
Livestocks	Enhancement of livestock production by introduction of CC adaptive measures	In all districts	7.5 per district	120.00
	TOTAL			**1220.00**

Horticulture

Horticulture department of the state has come up with elaborate proposal.

The four major strategies identified for the horticulture sector to be implemented in Arunachal Pradesh are:

- Adaptation: Identify and build on successful strategies of Adaptation by the horticultural sector to climate changes already experienced.
- Mitigation: Identify and build on successful strategies of Mitigation by the horticultural sector to climate changes already experienced.
- Institutional support for
    - Research and Development on adaptation and mitigation measures to develop best cultivation technologies for present and future horticulture in the state vis-a-vis Climate Change.
    - Dissemination of Climate Change Information.

Adaptation

Priorities identified under adaptation are:

- Identify and build on successful strategies of adaptation by the horticultural sector in the state to climate changes already experienced.
- Develop Impact Assessments for all or major horticultural crops in the state.
- Assess the Vulnerability of all current production sites as well as potential sites or area expansion under various crops.
- Long –term adaptation strategies by identifying the long-term opportunities and threats to horticultural sector and cropping systems.
- Develop (in consultation with growers and their advisors), Adaptation Strategies which are appropriate, practical, and economically sound.
- Assess the economic benefits of agro-forestry in horticulture as well as the benefits it might bring for adaptation and mitigation.
- Identify additional export opportunities for Arunachal horticultural growers.
- Identify alternative regions that may be suitable for production, to take advantage of these market opportunities.

- Develop horticulture specific forecasting tools that can be used for climate change and climate variability (especially temperature variability) related decision making at a farm and regional scale.

Mitigation

Priorities identified under mitigation are:

- Converting the Shifting Cultivation affected areas into commercial horticulture production sites.
- Wean away the shifting cultivators by assisting them in establishing commercial horticulture gardens as means of livelihood.
- Identify and promote horticulture specific Best Management Practices (BMP) which minimise clearing of vegetations/ forests for area expansion and also minimise GHG, and at the same time promote the simultaneous goals of productivity, sustainability, adaptability and abatement.
- Develop on-farm measures of GHG (indicator tools for GHG emissions), which are scientifically consistent and verifiable for measuring greenhouse gas emissions from each of the cropping systems and regions of horticultural significance.
- Assess the economic benefits of agro-forestry in horticulture as well as the benefits it might bring for adaptation and mitigation.
- Review and/or develop where necessary, Best Management Practices (BMP) for horticulture, which include adaptation and mitigation components.
- Assess the potential cost efficiencies of bio-energy and renewable energy sources for the horticultural sector.

Institutional Support

Research and Development Priorities identified by the state include::

- Constant monitoring of climate change signals/climate variability and creating meteorological database/forecasting for decision support system.
- Location specific development of adaptation and mitigation technologies on various horticultural crops including emerging new pests and diseases attributed to climate change.
- In situ / ex situ conservation of germplasm of horticultural importance/ conservation of wild relative of horticultural crops found in Arunachal Pradesh.
- Investigation on use of existing wild germplasm for developing more climate change tolerant varieties.
- Exclusive R&D on shifting cultivation in the state, its impact on climate change, documentation on loss of flora and fauna etc.

Dissemination of Climate Change Information has the following priorities setup :

- Massive awareness campaign on climate change vis-a-vis impact on horticulture.
- Communicate climate change issues to growers, policy makers and all stake holders.
- Communicate scientifically based information on observed climate trends, climate change projections and possible impacts.

Table 8: Identified mitigation potential of proposed activities under different options proposed under Horticulture (Million Rupees)

Components	2011-12	2012-13	2013-14	2014-15	2015-16	Total
Mitigation measures	1051.75	1051.75	1051.75	1051.75	1051.75	5258.75
Adaptation measures	980.0	980.0	980.0	980.0	980.0	4900.0
Institutional support for R&D & CC information dissemination	176.0	176.0	176.0	176.0	176.0	880.0
Total	2207.75	2207.75	2207.75	2207.75	2207.75	11038.75

Detailed breakups of activities are shown in Table 9.

Table 9: Identified adaptation measures, locations and tentative area requirement

Crop	Adaptation measures	Districts	Current area (ha)	To be covered under current adaptation plan (2011-12 to 2015-16) (ha)
A. Climate Change oriented cultivation practice				
Apple	Low chilling , disease and pest resistant and drought tolerant Cultivars, use of MI & RWH, organic cultivation, HDP etc	Tawang, West Kameng, some pockets of other districts.	12308	2500
Kiwi	Low chilling , disease and pest resistant Cultivars, MI & RWH, organic cultivation	-do-	250	1000
Other temperate crops	-do-	-do-	4575	1000
Khasi Mandarin/ citrus	Use of nuclear seedlings from highly tolerant local cultivars with high productivity and longevity, drought tolerant and use of MI&RWH, Organic cultivation etc.	All Siang districts, Lohit, LDV,P/Pare, Upper Subansiri, East Kameng, Tirap and Changlang	29750	6000
Pineapple	HDP with improved cultivation management, use of MI& RWH, Organic cultivation etc.	-do-	10225	1500
Other sub-tropical fruits	-do-	do-	11800	1500
Ginger	Use of rhizome rot and other disease tolerant varieties, improved cultivation management, use of MI& RWH, Organic cultivation etc	-do-	2282	1000
Large Cardamom	Replacing the higher altitude requiring varieties with mid- and low hill varieties, disease and pest resistant verities and other measures shown above.	-do-	12452	1500
Other Spices	-do-	All districts	550	
Medicinal and aromatic crops	Multi cropping, inter-cropping and as component of agro-forestry.	All districts	1000	1000

Crop	Adaptation measures	Districts	Current area (ha)	To be covered under current adaptation plan (2011-12 to 2015-16) (ha)
Vegetables	Use of drought and disease resistant cultivars, use of use of MI& RWH, Organic cultivation etc	All districts	15000	3000
TOTAL (A)				20000
B. Micro Irrigation and Rain Water Harvesting System (MI& RWH)				
All crops	To be installed in all cultivated areas for judicious use of Water. WRH to tap the surface run off by rain water and also for artificial recharge of ground water	All districts		12000
TOTAL (B)				12000

Table 10: Mitigation measures to be implemented under National Mission for a Green India

Sub-mission of National Mission for a Green India	Categories under the Sub-Missions	Area (Million Ha)
Sub-Mission 2: Ecosystem restoration and increase in forest cover	Rehabilitation of Shifting Cultivation areas.	0.02
	Restoration of scrublands, ravine reclamation.	0.005
Sub-Mission 3: Enhancing tree covers in Urban and per-urban areas	Nutritional gardens for households/institutional areas etc.	0.00135
Sub-Mission 4: Horti-forestry	Farmer's land including current fallows, shelter belt plantations etc.	0.02
	TOTAL	0.04635

Table 11: Dissemination of Climate Change Information – Institutional Support

Component	Identified areas	Number/projects location
Research and Development	Infrastructure support for R&D activities on climate change effect on horticulture	4 Agro-climatic Zones
	Data base on Climate Change information	All 16 districts
	Development of adaptation technologies	All 16 districts
	Development of mitigation technologies	All 16 districts
	Jhum cultivation	All 16 districts
	Germplasm conservation/biodiversity conservation	All 16 districts
Dissemination of Climate Change information	Seminar/Workshop/Training/Film show	All 16 districts

Enhanced Energy Efficiency Mission

Proposal of Schemes under Enhanced Energy Efficiency Mission: Department of Power, Government of Arunachal Pradesh.

Justification:

- The existing transformers have outlived their span of normal life and damaged due to wear and tear and required to be replaced for reducing losses and therefore it is proposed for installation of amorphous core transformers or energy efficient transformer which use high grade.
- The existing size of conductor is required to be upgraded with appropriate size of conductor due to over loading on the line to reduce losses and to replace the time barred conductors.
- The existing distribution system on LT line is required to be converted to high Voltage Distribution System to reduce losses.
- Existing defective meters are to be replaced and providing Meters to un-metered consumers.
- Providing low cost light emitting diode base lamps for space lighting.

Table 12: Mitigation projects proposed under the Enhanced Energy Efficiency Mission - Consolidated

Head	Activity	Estimated Cost(M Rupees)
SUB-HEAD – I	Overloaded old transformer	
	Adoption of HVDS	11.29
	Replacement	175.99
	Up gradation	268.83
SUB-HEAD – II	Upgradation/replacement of ASCR conductor of ht/lt line with appropriate sizes	434.86
SUB-HEAD – III	Adopting high voltage distribution system	89.44
SUB-HEAD – IV	Replacement of defective energy meters system consumer meters i/c providing meter to unmetered consumers	547.7
SUB-HEAD – V	Replacement of old reflector of existing street light	5.07
SUB-HEAD – VI	Providing low cost CFL to BPL under Bajat Yojana lamp	23.14
	Total	1556.33

Table 13: Mitigation projects proposed under the Enhanced Energy Efficiency Mission - Detailed

Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
SUB-HEAD – I						
Up gradation AND REPLACEMENT OF OVERLOADED OLD TRANSFORMER						
1	16 KVA,11/0.415 KV	16	No(s)	97147.63	1554362.08	Adoption of HVDS
2	25 KVA,11/0.415 KV	28	No(s)	110933.78	3106145.84	Adoption of HVDS
3	63 KVA,11/0.415 KV	13	No(s)	255383.85	3319990.05	Adoption of HVDS
4	100 KVA,11/0.415 KV	10	No(s)	331200.00	3312000.00	Adoption of HVDS
				Total	11292497.97	

1	10 KVA,11/0.415 KV	10	No(s)	65738.37	657383.70	Replacement
2	16 KVA,11/0.415 KV	22	No(s)	97147.63	2137247.86	Replacement
3	25 KVA,11/0.415 KV	50	No(s)	110933.78	5546689.00	Replacement
4	63 KVA,11/0.415 KV	51	No(s)	255383.85	13024576.35	Replacement
5	100 KVA,11/0.415 KV	79	No(s)	331200.00	26164800.00	Replacement
6	150 KVA,11/0.415 KV	15	No(s)	445280.00	6679200.00	Replacement
7	200 KVA,11/0.415 KV	45	No(s)	478725.05	21542627.25	Replacement
8	250 KVA,11/0.415 KV	28	No(s)	592756.66	16597186.48	Replacement
9	250 KVA,33/0.415 KV	1	No(s)	1424665.97	1424665.97	Replacement
10	315 KVA,11/0.415 KV	17	No(s)	647122.48	11001082.16	Replacement
11	500 KVA,11/0.415 KV	14	No(s)	1455000.00	20370000.00	Replacement
12	630 KVA,11/0.415 KV	3	No(s)	1294244.96	3882734.88	Replacement
13	1.0 MVA,33/11KV	2	No(s)	1350000.00	2700000.00	Replacement
14	2.5 MVA,33/11KV	2	No(s)	18711780.00	37423560.00	Replacement
15	3.15 MVA,33/11KV	2	No(s)	3420000.00	6840000.00	Replacement
1	16 KVA,11/0.415 KV	4	No(s)	97147.63	388590.52	Up gradation
2	25 KVA,11/0.415 KV	102	No(s)	110933.78	11315245.56	Up gradation
3	25 KVA,33/0.415 KV	1	No(s)	110933.00	110933.00	Up gradation
4	63 KVA,11/0.415 KV	182	No(s)	255383.85	46479860.70	Up gradation
5	63 KVA,33/0.415 KV	12	No(s)	332000.00	3984000.00	Up gradation
6	100 KVA,11/0.415 KV	132	No(s)	331200.00	43718400.00	Up gradation
7	100 KVA,33/0.415 KV	3	No(s)	954031.43	2862094.29	Up gradation
8	125 KVA,11/0.415 KV	3	No(s)	490000.00	1470000.00	Up gradation
9	150 KVA,11/0.415 KV	11	No(s)	445280.00	4898080.00	Up gradation
10	200 KVA,11/0.415 KV	33	No(s)	478725.05	15797926.65	Up gradation
11	250 KVA,11/0.415 KV	31	No(s)	592756.66	18375456.46	Up gradation
12	250 KVA,33/0.415 KV	2	No(s)	1424665.97	2849331.94	Up gradation
13	315 KVA,11/0.415 KV	40	No(s)	647122.48	25884899.20	Up gradation
14	315 KVA,33/0.415 KV	2	No(s)	842000.00	1684000.00	Up gradation
15	350 KVA,11/0.415 KV	5	No(s)	939000.00	4695000.00	Up gradation
16	400 KVA,11/0.415 KV	3	No(s)	1355000.00	4065000.00	Up gradation
17	500 KVA,11/0.415 KV	15	No(s)	1455000.00	21825000.00	Up gradation
18	630 KVA,11/0.415 KV	12	No(s)	1294244.96	15530939.52	Up gradation
19	630 KVA,33/0.415 KV	1	No(s)	2432618.53	2432618.53	Up gradation
20	800 KVA,11/0.415 KV	1	No(s)	1682000.00	1682000.00	Up gradation
21	1.0 MVA,11/0.415 KV	3	No(s)	1755000.00	5265000.00	Up gradation
22	1.6 MVA,33/11 KV	3	No(s)	2070000.00	6210000.00	Up gradation
23	2.0 MVA,33/11KV	1	No(s)	1565155.00	1565155.00	Up gradation
24	3.15 MVA,33/11KV	5	No(s)	3420000.00	17100000.00	Up gradation
25	5 MVA,33/11 KV	2	No(s)	4320000.00	8640000.00	Up gradation
SUB-HEAD – II						
UPGRADATION/REPLACEMENT OF ACSR CONDUCTOR OF HT/LT LINE WITH APPROPRIATE SIZES						
Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
1	ACSR Conductor 6/1/2.11	679.7	Km	32509.42	22096652.77	Replacement
2	ACSR Conductor 6/1/2.59	2119.86	KM	40931.44	86768922.40	Up gradation
3	ACSR Conductor 6/1/3.35	2883.22	KM	72246.56	208302726.72	Up gradation
4	ACSR Conductor 6/1/4.09	1297.79	KM	90683.36	117687957.77	Up gradation
SUB-HEAD – III						

ADOPTING HIGH VOLTAGE DISTRIBUTION SYSTEM						
Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
1	HVDS (New 11 KV Line)	138	KM	648144.00	89443872.00	
SUB-HEAD – IV						
REPLACEMENT OF DEFECTIVE ENERGY METERS SYSTEM CONSUMER METERAS I/C PROVIDING METER TO UNMETERED CONSUMERS						
Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
1	Trivectometer 33KV with CT PT	97	No(s)	350000.00	33950000.00	
2	Trivectometer 11Kv with CT PT	448	No(s)	260000.00	116480000.00	
3	Trivectometer LT with CT	1740	No(s)	15000.00	26100000.00	
4	Energy Meter 3 Phae HT	133	No(s)	18000.00	2394000.00	
5	Energy Meter 3 Phase 4 Wire	13513	No(s)	12000.00	162156000.00	
6	Energy Meter Single Phase 2 Wire	93917	No(s)	2200.00	206617400.00	
SUB-HEAD – V						
REPLACEMENT OF OLD REFLECTOR OF EXISTING STREET LIGHT						
Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
1	Street Light Reflector	11274	No(s)	450.00	5073300.00	
SUB-HEAD – VI						
PROVIDING LOW COST CFL TO BPL UNDER BAJAT YOZNA LAMP						
Sl	Description of Item	Quantity	Unit	Rate	Amount	Type
1	Low Cost CFL Fitting	77135	No(s)	300.00	23140500.00	

Jawaharlal Nehru National Solar Mission

Proposal submitted under this mission are

- DPR submitted for 100KWp Solar Power Plant at 2nd IRBn, Seijosa, East Kameng District – Rs.28.4 million
- DPR submitted for 100KWp Solar Power Plant at 2nd IRBn, Diyun,Changlang District – Rs.28.4 million

Policy Frameworks that isrequired to be implemented in Arunachal Pradesh should have the following major components:

- The state has no established State Electricity Regulatory Commission (SERC) who would frame Power Policy where in mandatory purchase of power from renewable energy could be made. Due to lack of such a regulatory body, there is no proper policy to diffuse the use of renewable energy in the state.
- 0.25% Renewable Purchase Obligation (RPO) from renewable, out of the total power requirement of the state under National Tariff Policy needs to be implemented.
- Mandatory use of Solar Water Heater initially in the government building could be incorporated in the state's Building Bye-Laws.

- The state Renewable Energy Agency needs to be upgraded to a fully fledged Renewable Energy Department to look after the Renewable Energy Sector headed by CEO of IAS/Chief Engineer.
- Priority should be given to National Solar Mission.
- State Solar Policy needs to be framed to give more trust on its use.
- There should be more policy approach to the CDM.
- As being done in the other states, policy needs to be framed to earmark a marginal amount in paisa from the cess/surcharge of revenue collected from the electricity consumers being the contribution for promotion of use of energy from the renewable sources and energy conservation.

National Mission on Sustainable Habitat

Activities proposed under different sub-sectors are:

Urban Transport

- Metro Cable System: - To reduce the Traffic Congestion, Noise Pollution, Air Pollution the department is proposing metro Cable system within all townships.
- JnNURM Buses
  - new buses under JnNURM.
  - introduce C.N.G Buses in the State
- Solid Waste Management
  - Extend existing 4 to 22 urban town of the State
- Road
  - urban roads improvements by widening, re-carpeting, blacktopping and construction of drain, storm water drain and pedestrian path etc
  - Avenue Plantation is proposed on both sides of all urban roads.
- Other scheme
  - working women Hostel, unemployed women Hostel, Shopping Complex, Parking Place (Solar heating)

Urban Mapping

- Preparation of Master Plan (Green City concept)
  - Land Use Assignment Zoning Plan that determines the use of each land parcel in the development area.
  - Structural Road Network Plan that guides laying of trunk infrastructure in the development area.
  - Development Control Regulations that determine the built form in the development area
- Create Master Plan Preparation Cell under Department of Town Planning for preparing base map and Development Plan of notified centre
  - Enabling preparation of Master/ Zonal plans.
  - Creating a database at Urban Local Body level for monitoring and management of at least relevant functions enlisted in the 12th schedule of 74th CAA.

- Use modern data sources such as Satellite data, total Station, GIS software, and other hardware & Soft ware procured under NUIS scheme, to generate a comprehensive 3-tier GIS database in the scale of 1:10,000 for Master Plan and 1:2,000 for detailed town planning Schemes and 1:1000 for Utilities planning.
- Prepare Master Plans of all the urban centres on pilot basis using latest technology.
- Integrate conventional data sources with modern data sources to develop GIS database.
- Use standards adopted under NUIS Scheme as well as NUDB&I with regard to database, methodology, equipment software, data exchange format etc.
- To create a town level repository of urban database through National Urban Databank and Indicators (NUDB&I) Unit which would also assist development of urban indicators for National Urban Observatory (NUO) on pilot basis.
- Providing training and Capacity building among town planning professionals so that they can use latest technique for preparation of master Plan.

- Microzonation and risk assessment of the landslide affected areas is an important aspect which needs attention.
  - Establish a Geotechnical Laboratory at Itanagar, Arunachal, Pradseh
  - Conduct Microzonation and risk assessment study using GIS and Remote Sensing Techniques @ of Rs 5 M Rs per town

The activities proposed and the fund requirements are given in Table

Activity	Funds (Million Rupees)
Urban Transport	
Metro Cable System	1000.0
JnNURM, CNG Buses	660.0
Solid waste management	880.0
Roads improvement	660.0
Other Schemes	300.0
Urban Mapping	
Master Plan Preparation	90.0
Master Plan Preparation Cell	13.0
Microzonation and risk assessment	145.8
Total	3748.8

Rural Roads

Using cold mix has advantages over using conventional hot mix with regard to checking pollution and warming. Over the past 2 years 1200 km of road with 20 mm thick seal coat using cold mix was laid. Also roads are being designed in such a way so as to reduce carbon foot print. Use of cold mix also ensures faster connectivity to remote areas.

National Water Mission

The activities proposed and the fund requirements are given in Table

Mitigation

- to take up sustainability schemes to augment and share the water resources in order to enhance the service efficiencies in the sector
- source protection, gully plugging, check dam, catchment area protection, contour trenching, impounding reservoirs and artificial recharge
- to protect and enhance the drinking water sources by prevention of forest cover loss due to anthropogenic reasons such as jhumming etc
- watershed protection by afforestation

Activity	Funds (Million Rupees) over 5 years
Sustainability scheme	
Roof top rain water harvesting schemes, source protection, gully plugging, check dam, catchment area protection, contour trenching, impounding reservoirs and artificial recharge	1500.0
Note: the Labour cost of any recharging system/surface water impounding structures should be met from Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and Integrated Watershed Management Programme (IWMP)	

Adaptation Projects with investment (including capacity development projects)

Adaptation will call for adjustments in human and natural systems, in response to actual or expected climate stimuli or their effects, thus moderating/ harm or exploiting opportunities. Adaptation reduces vulnerability to impacts Climate Change impacts through a behavioural change. Therefore Adaptation and Mitigation are complementary strategies. Adaptation is a complementary risk management strategy to mitigation.

Proposed Adaptation option

- **Conjunctive use of water:** conjunctive use from several sources, viz., surface ground water, and rainwater harvesting including recharge/roof water collection and bulk transfer through pipelines
- **Plantation to incentivise Jhum to reduce fallow period:** Jhumming is a way of line and cannot be banned due to individual periodical occurrence in or community rights of ownership over the forest land and non availability of other livelihood options. Plantation of permanent cash crops like cardamom, banana orange, apple or any fruit bearing tree as per soil suitability in around the water supply source to stop removal of the vegetation coverage for Jhum cycle. This could be done in collaboration with horticulture department.
- **Afforestation and protection of forest** in catchment of water sources as convergence measures under programmes such as MGNREGAS, IWMP etc.
- **Capacity Development** through training may be imparted to all the stake holders and affected community to

  - Sensitise the importance of Climate Change and its interlinkages with development options
  - Importance of "Adaptation" in policy making, planning and programming
  - learn about systematic steps aiming at defining concrete adaptation options at national, sector, local and project level, and accord support of necessary institutional capacities to facilitate carry out a change process
  - learn about relevant climate information
- **Optimum use of water**: advocacy through support activities like awareness campaign involving all water users especially women, and through mass media in rural and urban sectors
- **To adopt non water consuming Eco-San toilets** in villages of selected districts like Tawang, West Siang etc. Some 7500 Eco-San toilets will cost about 112.5 million rupees.
- **Re-use of water:** advocacy and awareness building to implementation where feasibile
- **Water pricing**: Introduction of Reasonable pricing of water and Swajaldhara/NRDWP guidelines should be practised in rural areas as much as possible, so that sense of ownership and belongingness develops in public mind. This could lead to the conservation and judicious use of water in the rural areas.
- **Rationing:** Could be introduced in rural areas where 24 hours water supply is being practised to avoid over extraction of the water source.
- **Wise Water Use Programme**. "The Water, Use it wisely" campaign is a year round water conservation program to educate and encourage residents in the rural and urban sectors to use their drinking water wisely. The campaign offers homeowners and businesses simple water savings tips and techniques through school based education, public and private outreach events, business partnerships, as well as through paid and PSA (Public Service Announcement) media advertisement.

Activity	Funds (Million Rupees)
Sustainability scheme	
7500 Eco-San toilets	112.50
Awareness, campaign, Capacity Building	
Afforestation and plantation with GIM and Horticulture mission	

Chapter 7

Cross Cutting Issues and Integrated Approach

Chapter 7 - Cross Cutting Issues and Integrated Approach

Sectoral Policy and Barrier analysis for M&A project design, implementation and Monitoring

The State has already recognized a large number of issues critical to the management of climate change. Some of the critical areas recognised and the areas of research that need to be taken up under the Strategic Knowledge Mission have been identified as below.

Critical Areas:

While dealing with Climate Change challenges some of the critical issues that are spread across the sectors and domains could be:

- Identification of species tolerant to climate change.
- Identification of alternative livelihood options.
- Identification of technology options for handling industrial and domestic sewage.
- Handling of municipal solid wastes.
- Handling of air pollution from industrial, domestic, transportation sources.
- Alternative energy options
- Documenting traditional practices, local knowledge and folk traditions.
- Minimizing time lags in Lab to field transfer of technologies.
- Utilization of CDM benefits.
- Creating data base and identifying trends and Climate responses.
- Strengthening the nodal agencies and creation of human resource.

Areas of research:

Priority areas for research should include:

- Promote research in multi disciplinary aspects of environmental pollution as well as waste utilization.
- Undertake carrying capacity assessments in critical/aquatic stretches and air polluting areas.
- Prepare and upgrade environmental status reports with special emphasis on climate change.
- Develop effective and low cost technology for pollution control.
- Conduct EIA of development projects critical to climate change i.e. power, housing, cement etc.
- Document biodiversity status and traditional and folk knowledge.
- Create climate change related databases and identify responses to climate change.
- Research into identification of alternative means of livelihood.
- Research into low and alternative energy options.
- Preparing communication strategies.

The above intent is not an easy affair and needs a strategic planning and implementation to get the desired results. The major players that influence the policy which in turn influences the various intended systems can be grouped into two categories with respect to the scale at which they operate. The main players from this angle are the organizations/departments involved in planning, implementation and management of the big projects which have widespread influence. Most of these projects be they a major irrigation project, a hydropower project or national highway project, have been in the realm of the government or at the most public sector domain. It is only recently that the private sector started participating, once the government policies were changed to woo private participation.

The second kind of players are those who work at the local scale for programmes that are again run by the central and state government departments but involve agencies that are either NGOs or Gram Panchayats. At this scale there are more inherent problems than the earlier situation where one is concentrating on a single project. In this case, the programmes are invariably widespread. However the policies are made with a view to have minimum variability, in order to get uniformity of implementation. For some sectors such uniformity of implementation might not have any problem but on the contrary there are other sectors that are very sensitive to the environment and need special handling. Water and agriculture are two such sectors and need special understanding and handling. Some of the programmes that have faced problems on account of independent actions are:

- The National Drinking Water Mission which has seen a very large number of hand pumps becoming defunct after installation
- Watershed management programme which has created problems for downstream people in many cases
- The rejuvenation of old tanks programme that has limited success due to over-doing the watershed development activities in the catchment area of the tank.

Need for Integrated approach

As mentioned above, the water resources sector is the core sector to which all the other sectors are connected in a very complex way. If the climate change adaptation has to be adequately and comprehensively addressed then the interconnectivity of other sectors has to be understood with the water resources. For such an intent use of an integrated approach becomes essential. Integrated watershed/water resources management does not merely imply the amalgamation of different activities to be undertaken within a hydrological unit. It also requires the collation of relevant information so as to evaluate the cause and effect of all the proposed actions. The watershed is the smallest unit where the evaluation of man-induced impacts upon natural resources becomes possible with respect to the water balance approach. As the impacts resulting from actions taken at the watershed level will be experienced at a higher level within the drainage basin, the assessment of these impacts will require the availability of a framework which enables the mapping of such units to the higher catchment level in the hierarchy of River Basin at the highest level of drainage system. Such a framework will need regular maintenance and updating to reflect fully the most accurate ground-truthed data of the infrastructure requirements for planning and management of the natural resources collected by the relevant departments. This framework, once available, could be used by all the line departments and updated by the relevant departments which have designated areas of

jurisdiction over the data entry. Such a framework shall also be used to enumerate the freshwater ecosystem services each system is serving and need to be preserved.

The policy, being an intent put together by domain experts and policy makers, is invariably a very good document that addresses all the concerns of a very wide cross-section of stakeholders. The same situation occurs with the National/State Water and Environment policies. These are very good documents in their own right. However there are few issues that are either not adequately addressed or are altogether missing. Some of these issues are briefly discussed below.

- The National Water Policy (NWP) and State Water Policies (SWPs) do emphasize on a river basin approach to manage the water resources effectively. It somehow does not explicitly emphasize that the same drainage area based approach should also be continued for the sub-areas of the basin, namely catchments and watersheds that shall make it possible to address the equity and externality issues effectively under the present and future situations
- There is no provision in the NWP/SWPs for a feedback mechanism on the implications of actions taken in the policy instruments of other sectors such as Environment, Forest, Agriculture, Watershed Development, Energy, etc.
- The NWP/SWPs do not attempt to tackle equity issues and other societal issues connected with water. These only stop at providing rehabilitation to those people uprooted by big projects but no attempt is made to quantify the impact of local level interventions that are potentially capable of creating bigger impacts.
- Even with the National Water Mission (NWM) that has been put together for tackling climate change impacts, many of the above concerns still remain intact. It is very important to take stock of these concerns if the objectives set forth under the NCCAP/SCCAPs are to succeed.

It is not true that our policy makers at the national and state level are not aware of these issues; the present situation is more on account of lack of initiative and also many times due to difficulty in handling the complexity of these issues. To help bridge the apparent gap between the policy and research communities it is important to incorporate advocacy and promotion techniques to connect and disseminate new knowledge of the biophysical and socio-economic outcomes of land and water interventions to policy makers through a number of mechanisms. These would include peer-to-peer networking of policymakers, the use of interactive workshops and the use of innovative media including e-fora and websites.

Data and Information infrastructure, Modelling

Another segment that shall require maximum research and development initiative is to create infrastructure that shall be able to encapsulate the majority of issues described above and which shall act as a facilitator to provide a framework for integration, planning, monitoring and assessment. A typical framework can revolve around water sector by incorporating the Integrated Water Resources Management Cycle and shall include the following methodologies which can be operated in conjunction with support tools. Formulation, implementation and maintenance of such a framework is truly in the realm of research and must be taken up at the earliest at the state level.

Some of the components and functionalities of such a system are:

- Hydrological assessment of all water uses and users within a catchment
- Catchment Stress Assessment to determine to what extent the catchment is not meeting aquatic ecosystem requirements
- Strategic Environmental Assessment to identify the economic returns and employment opportunities that arise or potentially could arise from water use in the catchment
- Methodologies for contextual analysis (forest and water narratives, beliefs underlying policy)
- Web and GIS based dissemination tools, incorporating Blue and Green water integrating methodologies
- An 'Allocation Equity Guide', providing guidelines to support stakeholder negotiations
- Environment impact assessment methodologies, primarily in relation to biodiversity and water quality
- Poverty reduction impact assessment methodologies, addressing the questions: who are the winners and losers of these policies? Will the outcomes of the policy instruments benefit key poor and vulnerable groups?
- Monitoring and evaluation. The impact assessment methodologies outlined above will also provide the basis for monitoring and evaluating the socio-economic, poverty and water resource outcomes of manmade interventions
- Such a framework should be able to effect convergence of scales to encompass the interventions being made at various levels. The effective adaptation measures to climate change impacts shall only be possible through reliable simulation of the future conditions which such a common framework offers.

Linking mitigation and adaptation

The development of Information Systems is logical response to meet the specific information needs of the various line departments dealing with various sectors. These systems may be domain specific to certain extent for managing the sector specific information but need to have cross linkages to tackle the interdependence of these sectors.

A hydrologic information system consists of a hydrologic database coupled with tools for acquiring data to fill the database and tools for analyzing, visualizing and modeling the data contained within it. The IIT Delhi and INRM has taken an initiative in this direction and formulated a GIS portal (http://gisserver.civil.iitd.ac.in/natcom), for the general users, providing Web Mapping Application for accessing Hydrological Information based on the SWAT hydrological modeling and other web based interface applications. This interface also provides the outputs of the NATCOM Phase I and Phase II projects quantifying the climate change impact assessment on the river basins of Indian. This has provided a base framework that can be improved upon to cater to the information needs of the diversified users and sectors. However this serves as an example that has demonstrated that such systems are useful for serving the present needs of integration of information across the sectors and space for comprehensively tackling the issues of mitigation and adaptation.

Institutional arrangements for mitigation and adaptation programmes - Forestry

The institutional arrangement proposed for mitigation and adaptation programmes to address climate change proposed under the State Climate Change Action Plan is given in the box below.

Activities		Institution
Research	Carbon mitigation projects	SFRI, Itanagar and Research Institutes
	Impact and vulnerability modelling	SFRI, Itanagar and Research Institutes
	Adaptation projects	SFRI, Itanagar, IISc and Department of Forestry, NERIST, Nirjuli, Itanagar.
	Long term monitoring	
Monitoring	Carbon stocks	
	Biodiversity	
	Growth rates	
	Socio-economic aspects	
Implementation	Overall the implementation of mitigation and adaptation programmes under GIM would constitute an additional programme implementation responsibility along with the regulatory and developmental responsibilities that the Department of Environment and Forests, Arunachal Pradesh discharges at present. Forest Department does not have enough staff strength especially at lower levels to shoulder enhanced targets. Neither is the present set of staff adequately trained for a qualitative and people oriented joint working. At the department level, the works in the notified forest areas will be taken up through territorial wing of the department while those outside notified forests would be implemented through a separate Directorate of Social Forestry that will be assisted at Circle/Division level by subject matters specialist like Sociologist, Economist, Extension and Training Experts, etc for enhanced effectiveness. While the overall programme implementation will be facilitated, supervised and monitored by the, the Department of Environment and Forests, Arunachal Pradesh Village Forest Committees and Eco-development Committees will have a greater role in implementation of works at field level with involvement of NGOs and other village level thematic groups like Self Help Groups under linkage with Gram Panchayats. Research, modeling, GIS and monitoring personnel need to be outsourced or engaged on contract basis or on deputation to have continuity of term so as to enable running of these facilities on professional lines. Such professional support is very essential to assist the Research, Working Plan and Evaluation Wings in the department	

Capacity building

Capacity building is a very critical segment for the success of mitigation and adaptation. The capacity building has many segments; enhancing the technical capacity of the concerned departments to handle the climate change impact assessment and adaptation capability, monitoring, awareness creation and financial management. Some of the activities under capacity building are given in the following Table.

Activity	Capacity development needed
Mainstreaming climate change in developmental programmes	• Training the Officials of State Development Departments on the steps and approaches to handle the climate change impacts on various sectors and to build scientifically the adaptations options to be considered by the policy makers and the society • Establish Centers of Excellence in Colleges/ Universities/ Institutions
Integrate climate change agenda with National Green Corps activities and District Plan activities	Train the individuals involved in these activities

Activity	Capacity development needed
Finalize sate environmental policy	Strengthen Climate Change Nodal Cell
Monitoring of the mission projects	Select Research institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections
Awareness	• Train school and college teachers on climate change, impacts, adaptation and mitigation • Organize seminars, conferences and workshops on Climate Change • Create Climate Change awareness centers at National Parks, Sanctuaries, Zoo and other public places • Publicity through print and electronic media
Financing	• Create corpus of fund for climate change • Make Banks, Government Departments to seek funding from national Climate change Missions and international mechanisms on climate change

In the state of Arunachal Pradesh forest sector is the most critical and dominant sector and therefore needs special capacity building efforts in the areas related to the forest sector. Some of these needs have been recognised below.

Need of Research and Development in Horticulture Sector:

To find out most suitable adaptation and mitigation measures.

Horticulture crops are very sensitive to temperature, humidity and other climatic factors. For example raise in temperature of few degrees in certain location makes Apple not suitable for cultivation. Alternate lower chilling required crops like Kiwi has to be recommended in place of Apple.

Change in temperature and humidity also determines occurrence of destructive pests and diseases and its distributions

Therefore, there is requirement of constant monitoring of variation in temperature, rainfall, humidity, and other climatic factors which will influence, the production and suitability of crops, pest and disease incidences etc. Therefore, to find out most suitable crops and cultivation practices including new pests and disease occurrence to adapt to changing agro climates and probable change in climate in near future, constant Research is need of the hour without which recommending for location specific mitigation and adaptation measure to farmers will be impossible.

There is also urgent need of research on most judicious methods of water utilisation in horticulture through micro-irrigation, Rain Water Harvesting etc on location specific basis by utilising locally available materials (say bamboo). This is necessitated because water sources to horticulture gardens are drying up.

In order to achieve this, Horticulture Department should be given support for

- Establishment of computerised Weather Stations/ weather forecasting units in all key areas.
- Infrastructures like laboratories for plant disease analysis, fruit qualities, soil and water testing etc in four (4) Agro climatic Zones where department has big farm and nursery set ups. These farms can be set up as Centre for research and development in horticulture

Conservation of local germplasms of horticultural importance:

There are more than 500 species of medicinal plants recorded indigenous to the state. More than 425 species of Orchids have been reported from Arunachal Pradesh. Numerous varieties of edible mushrooms are available in wild form. Many wild relatives of cultivated crops like wild Apple, wild Kiwi, wild Mango, wild Bananas, wild Citrus, wild Mangosteen, wild Cherry, wild Litchi, wild nuts, wild Cardamom and so many others are found luxuriantly growing in natural form in the forest which constitutes rich floral bio-diversity of the state. These plants indigenous to the state is an important gene pool which is very important for future use.

However, these plant resources are now threatened to be permanently extinct because of shifting cultivation and burning down of forest.

Therefore, there is urgent need conserved them as follow:

- In situ / ex situ conservation of germplasm of horticultural importance/ conservation of wild relative of horticultural crops found in Arunachal Pradesh.
- Investigation on use of existing wild germplasm for developing more climate change tolerant varieties.

Exclusive R&D on shifting cultivation in the state:

- To investigate the possibility of economic use of already available plants in forest as alternate livelihood for shifting cultivation.
- To enhance the availability of these economic plants in its natural ecosystem so that it can be utilised in sustainable manner as livelihood.
- To investigate exact extant of magnitude, damages to environment, and socio-economic implications on people of Arunachal Pradesh.