Bihar State Action Plan on Climate Change

'Building Resilience through Development'

बिहार सरकार

Government of Bihar
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Abbreviations/Acronyms

Acronym	Expanded Form
ADB	Asian Development Bank
AHS	Annual Health Survey
ANC	Ante-Natal Care
ATC	Aggregate Technical and Commercial
BAPCC	Bihar State Action Plan for Climate Change
BEE	Bureau of Energy Efficiency
BEE	Bureau of Energy Efficiency
BERC	Bihar Electricity Regulatory Commission
BIADA	Bihar Industrial Area Development Authority
BIFR	Board for Industrial and Financial Reconstruction
BIGWIS	Bihar Groundwater Irrigation Scheme
BLY	Bachat Lamp Yojana
BRBN	Bihar Rajya Beej Nigam
BREDA	Bihar Renewable Energy Development Agency
BRLP	Bihar Rural Livelihoods Project
BRLPS	Bihar Rural Livelihoods Project Society
BSEB	Bihar State Electricity Board
BSFC	Bihar State Financial Corporation
BSHPC	Bihar State Hydroelectric Power Corporation Limited
BSRTC	Bihar State Road Transport Corporation
BSSC	Bihar State Sugar Corporation
BSUP	Basic Services for Urban Poor
BUIDCO	Bihar Urban Infrastructure Development Corporation
CBR	Crude Birth rate
CDM	Clean Development Mechanism
CDR	Crude Death Rate
CEA	Central Electricity Authority
CEPT	Centre for Environment Planning and Technology
CETP	Common Effluent Treatment Plant
CFL	Compact Fluorescent Lamp
COMPFED	Bihar State Co-operative Milk Producers' Federation Ltd
CSS	Centrally Sponsored Scheme
DDG	Decentralized Distribution Generation
DFID	Department for International Development, UK
DIC	District Industries Centre
DMWR	Department of Minor Water Resources
DPR	Detailed Project Report
EOC	Emergency Operations Centre
FDA	French Development Agency
FMIS	Flood Management Information System
FYP	Five Year Plan
GDDP	Gross District Development Product
GFCF	Gross State Capital Formation
GIS	Geographical Information System
GoB	Government of Bihar

Acronym	Expanded Form
GSDP	Gross State Domestic Product
HUDCO	Housing and Urban Development Corporation
IAY	Indira Awas Yojana
ICDS	Integrated Child Development Scheme
IEC	Information, Education, and Communication
IHSDP	Integrated Housing and Slum Development Programme
IMR	Infant Mortality Rate
IPP	Independent Power Producer
IPT	Intermediate Public Transport
ISDP	Integrated Disease Surveillance Programme
ITI	Indian Technical Institute
JBSY	Janani Evam Bal Suraksha Yojana
JFM	Joint Forest Management
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KCC	Kisan Credit Card
KVIC	Khadi and Village Industries Commission
MDR	Major District Road
MFC	Multi-Functional Complex
MMR	Maternal Mortality Rate
MNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MNSY	Mukhya Mantri Nari Shakti Yojana
MoEF&CC	Ministry of Environment, Forests and Climate Change
MRTS	Mass Rapid Transit System
MSME	Medium, Small, and Micro Enterprises
NABARD	National Bank for Rural and Agricultural Development
NAPCC	National Action Plan for Climate Change
NDMA	National Disaster Management Agency
NDRF	National Disaster Response Force
NGRBA	National Ganga River Basin Authority
NGRBA	National Ganga River Basin Authority
NH	National Highway
NHPC	National Hydroelectric Power Corporation Limited
NPCIL	Nuclear Power Corporation of India Limited
NPSGY	Nayi Peedhi Swasthya Guarantee Yojna
NRHM	National Rural Health Mission
NRLP	National Rural Livelihoods Programme
NSDP	Net State Domestic Product
NTFP	Non-Timber Forest Produce
NTPC	National Thermal Power Corporation Limited
NWDA	National Water Development Agency
O&M	Operation and Maintenance
PACS	Primary Agricultural Cooperative Society
PCDE	Per Capita Development Expenditure
PDS	Public Distribution System
PESU	Patna Electric Supply Undertaking
PFC	Power Finance Corporation Limited
PGCIL	Power Grid Corporation of India Limited
PHED	Public Health Engineering Department
PIM	Participatory Irrigation Management

Acronym	Expanded Form
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PRI	Panchayati Raj Institution
PURA	Provision of Urban Services for Rural Areas
R-APDRP	Restructured Accelerated Power Development and Reform Programme
R&M	Restoration and Modernisation
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RGSEAG	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls
RIDF	Rural Infrastructure Development Fund
RSVY	Rashtriya Sam Vikas Yojana
SAPCC	State Action Plan on Climate Change
SC	Scheduled Caste
SDMA	State Disaster Management Agency
SDRF	State Disaster Response Force
SGSY	Swarnajayanti Gram Swarozgar Yojana
SH	State Highway
SHG	Self-Help Group
SHP	Small Hydro Power
SIPB	State Investment Planning Board
SOP	Standard Operating Procedure
SPCB	State Pollution Control Board
SRI	System of Rice Intensification
SRR	Seed Replacement Ratio
SSC	State Steering Committee
ST	Scheduled Tribe
STF	Special Task Force
STP	Sewerage Treatment Plant
T&D	Transmission and Distribution
TFR	Total Fertility Rate
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UIG	Urban Infrastructure Governance
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United nations Children's Fund
VFMPC	Village Forest Management and Protection Committee
WALMI	Water and Land Management Institute
WDC	Women Development Corporation
WLL	Wireless in Locked Loop
WRD	Water Resources Department
WUA	Water Users Association

Introduction

Background and Context

Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons, which affects food security, and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever. Temperature increases will potentially severely increase rates of extinction for many habitats and species (up to 30 percent with a 2° C rise in temperature).

A rise in extreme events will have effects on health and lives as well as associated environmental and economic impacts. Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued. Thus adaptation should be implemented in the context of national and global sustainable development efforts.

The international community is identifying resources, tools and approaches to support this effort. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as increased sea defenses or flood-proof houses on stilts, to behaviour change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, improved risk management, various insurance options and biodiversity conservation.

The National Context

India's economy and a majority of its population are highly dependent on climate sensitive sectors such as agriculture, animal husbandry, fisheries, tourism, etc. Since climate change is expected to impact natural and human systems adversely by inducing changes these systems, India can be considered highly vulnerable.

Climate change is only likely to exacerbate India's already high physical exposure to climate-related disasters (65 percent of India is drought prone, 12 percent flood prone, and 8 percent susceptible to cyclones). As a consequence, climate change is highly likely to impact

livelihoods by disrupting social, cultural, economic, ecological systems, physical infrastructure, and human assets, accentuating health risks, and as such, posing severe risks to the development of the country. Since climate change impacts are felt at multiple levels from the global to the local, responses to climate change too need to be at multiple levels, calling for strategic interventions at local, sub-national, national, and global levels.

At the global level, India's contribution to multilateral negotiations in the United Nations Framework Convention on Climate Change (UNFCCC) has been significant and it continues to advocate for effective, cooperative and equitable global approaches based on the principle of 'common but differentiated responsibilities and respective capabilities'. At the national level, India has developed the National Action Plan on Climate Change (NAPCC), 2008, and comprising eight national missions (*see Box 1 below*) at its core, addressing various sectoral aspects of climate change.

The NAPCC seeks to promote understanding of climate change, adaptation, mitigation, energy efficiency and natural resource conservation while pursuing overall economic growth – i.e., measures that promote development objectives which also result in co-benefits for addressing climate change.

Box 1: National Missions under the NAPCC

- **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** 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 percent 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 Increased forest/tree cover on 5 m ha of forest/non-forest lands and improved quality of forest cover on another 5 m ha (a total of 10 m ha), improved ecosystem services including biodiversity, hydrological services, and carbon sequestration as a result of treatment of 10 m ha.
- **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 modelling and increased international collaboration to develop adaptation and mitigation technologies.

At the same time, recognising that the impacts of climate change will vary across states, sectors, locations, and populations, and that different approaches will need to be adopted to fit specific sub-national contexts and conditions, all Indian States have been asked to prepare State Action Plans for Climate Change (SAPCCs) in line the NAPCC. It is in this context that the Bihar State Action plan (BAPCC) for Climate Change has been prepared.

The Bihar Context

Available evidence shows that there is high probability of increase in the frequency and intensity of climate related natural hazards due to climate change and hence increase in potential threat due to climate change related natural disasters in India, and Bihar is no exception to this. It is highly vulnerable to hydro-meteorological natural disasters, with North Bihar in general being highly flood-prone, and South Bihar being highly drought prone. In the (relative) absence of state level climate models and/or vulnerability studies, as well low community awareness, Bihar is potentially more sensitive and vulnerable to the climate change and its impacts.

Bihar -- 'Building Resilience through Development'

Bihar is on an accelerated growth and development pathway, and in recent years, it has acquired considerable attention throughout the country and even abroad for its remarkable performance in the development front. For a state which had suffered stagnation for long and which had almost resigned to its perpetual backwardness, this was a turning point, leading to new hopes and aspirations. These changes were possible because of the state government's firm commitment to an agenda of development, which is both speedy and inclusive.

To fulfil this agenda, the state government had not only utilised its limited resources most prudently, but had also strengthened its administrative machinery and introduced a number of institutional reforms. The results clearly show that the past growth process of the state's economy is not a short-term phenomenon, but the beginning of a long-term stable growth process. For the 12th Five Year Plan (FYP) period, the State has adopted the motto – "Growth with Justice." The State's Approach Paper for the 12th FYP targets a 13 percent constant growth rate.

The state has constantly been emphasising on social, financial, and economic inclusion, and the Approach Paper indicates that this would continue. Additionally, all sectors have been asked to identify areas for inclusion and explore the possibilities of broad-streaming (broad-

streaming as envisaged by the State Planning and Development Department, visualises the development of sub-streams by its broadening at par with mainstreams so they may be considered as one entity; broad-streaming tries to take into account the strength and weaknesses of the community and builds upon the existing avenues keeping in view the language, tradition, culture, practices of under-privileged communities into consideration). This may be one of the effective and feasible solutions for inclusive development.

As such, in line with the motto "Growth with Justice" adopted for the Approach to the 12th FYP, this BAPCC adopts the motto "Building Resilience through Development" as the core theme that will guide implementation.

The State's developmental and growth priorities are in synch with India's national priorities. Likewise, the BAPCC and the priorities outlined herein are aligned to the imperatives of the NAPCC and the eight national sectoral Missions under it. A range of measures is already underway in the State that is complementary to the State's climate resilience agenda elaborated under this BAPCC, and spans multiple sectors. Some examples of these on-going complementary initiatives are briefly outlined below:

- Bihar is taking appropriate measures to ensure that the existing tree-cover in the State is maintained, apart from efforts to enhance it. This is evidenced from the recent stand taken by the State Government not to remove trees from the Zoological Park in the State Capital Patna despite the move by civil aviation authorities to do so on the grounds that tall trees in the Park were hindering flight operations at the Patna airport;

- Bihar has opted to implement the Bachat Lamp Yojana (BLY) of the Bureau of Energy Efficiency (BEE), in a move to save an estimated 170MW by replacing around 64 lakh conventional bulbs in the state with compact fluorescent lamps (CFLs).

- The State has also advocated an 'entitlement based planning approach' to streamline the development planning process and to have a wider impact on eradicating poverty and improve socio-economic conditions in the State;

- The Integrated Food Processing Development Scheme of the State Government has made progress with attracting investments into the State, especially in the biscuits and edible oil manufacturing sectors, opening up the scope for sowing crops such as mustard and sunflower. Recent investments under the scheme are to the tune of several hundred crores, by major private sector firms;

- JEEViKA - Bihar Rural Livelihoods Project (BRLP) has been designed to address rural poverty in Bihar through the collaboration of the poor, the Government of Bihar

(GoB) and the World Bank. The BRLP objective is to enhance social and economic empowerment of the rural poor in Bihar. This objective is sought to be accomplished by:

- Improving rural livelihoods and enhancing social and economic empowerment of the rural poor.
- Developing organizations of the rural poor and producers to enable them to access and better negotiate services, credit, and assets from public and private sector agencies and financial institutions.
- Investing in capacity building of public and private service providers.
- Playing a catalytic role in promoting development of microfinance and agribusiness sectors.
- A US $ 100 million loan from the World Bank has been approved recently to expand the initiative across all 102 blocks of six districts where it is currently in operation – Muzaffarpur, Gaya, Madhubani, Purnea, Nalanda, and Khagaria. At present, only 42 blocks of these districts are being covered. The project has also been adopted by the National Rural Livelihoods Mission (NRLP); and
- ULBs in the State, including the Patna Municipal Corporation (PMC) are currently underequipped to deal with weather events such as flooding etc.; steps are being taken to rectify this. Additionally, a City Strategic Plan has been prepared for Patna and 19 other cities/towns of the State under the National Ganga River Basin Authority (NGRBA) to deal with the sewage situation and preventing the flow of sewage from flowing into the Ganges, at an estimated total budget of nearly ` 800 crores.

BAPCC Preparation Process

Preparatory processes for formulating the BAPCC were taken up in early 2011, facilitated by the United Nations Development Programme (UNDP), India, with the formulation of a State Steering Committee (SSC), headed by the Chief Secretary, and consisting of key senior bureaucrats from various sectors, and other eminent persons. A meeting of the SSC was held on 22 June 2011, wherein it was decided that the BAPCC would focus on the following key sectors:

1. Agriculture and Animal Husbandry;
2. Forests and Biodiversity;
3. Water Resources and Disaster Management;
4. Urban Development and Transport;
5. Industries and Mining;
6. Energy; and
7. Human Health

Working Groups were then constituted for each of the focus sectors, and these were then tasked with developing initial strategy papers for the BAPCC for their respective sectors. The State Environment and Forest Department was nominated the nodal Department for coordinating inputs to and formulating the Draft BAPCC.

A two-day workshop on preparation of BAPCC was organized by the Environment & Forest Department, GoB and facilitated by UNDP India, on 11-12 November 2011 at Hotel Maurya, Patna. The Workshop was organised to discuss the issues associated with impact of climate change and to formulate an understanding of the Framework for preparation of the BAPCC.

The Hon'ble Deputy Chief Minister-cum-Minister, Department of Environment & Forest, Bihar, Shri Sushil Kumar Modi inaugurated the occasion. Dr. R. K. Pachauri, Director General, The Energy and Resources Institute, New Delhi was the chief guest. Principal Secretary, Planning & Development, Sh. Vijoy Prakash; Principal Secretary, Mines & Geology, Sh. Shubh Kirti Majumdar; Principal Chief Conservator of Forests, Bihar, Sh. Basheer Ahmed Khan; Additional Principal Chief Conservator of Forests-cum-Chief Wildlife Warden, Bihar, Dr. D K Shukla and Prof. Pradhan Parth Sarthi, Central University of Bihar officers and distinguished experts of departments concerned with identified sectors were present in the workshop. Attended by over 150 representatives various departments/organizations and about 20 resource persons, the workshop centred around the following themes relevant to preparation of the BAPCC:

- Frame work for preparation of SAPCC,
- Climate Change: Projections and Scenario for Bihar,
- Vulnerability and adaptation to climate change in:
    - Transport Sector;
    - Urban Sector;

- Agriculture Sector;
- Water resources Sector;
- Energy Sector;
- Forestry Sector;
- Industries and Mining Sector;
- Health Sector; and
- Disaster Management Sector.

Timeline of BAPCC formulation Process/Activities

Month/Dates	Process/Activity
Early 2011	Formation of State Steering Committee
22 June 2011	Meeting of key State and Departmental personnel; discussion on formulation of Working Groups
11-12 November 2011	Consultative Workshop in Patna
9 June – 12 July 2012	Consultations in Patna with various line departments
30 July 2012	Draft BAPCC developed

PART A: General and Climate Profile

1 State Profile

1.1 Location and Physiography

Bihar is located between 24°20'10" and 27°31'15"N latitude and 82°19'50" and 88°17'40"E longitude in the eastern part of the country and situated at about 52.73 m height above sea level. It is an entirely land locked state and is surrounded by West Bengal in the east, Uttar Pradesh in the West and the State of Jharkhand in the South. In the North, Bihar shares its boundary with Nepal. Humid West Bengal in the east and the sub humid Uttar Pradesh in the West provides it with a transitional position in respect of climate, economy, and culture.

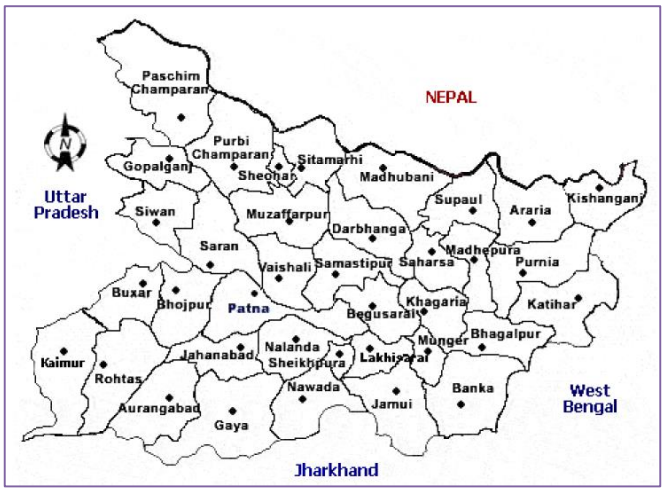


Figure 1: Bihar – Location and Districts

Table 1: Bihar - administrative divisions

Details	2001	2011
No. of Divisions	9	9
No. of Districts	37	38
No. of Sub-Districts	101	101
No. of Towns	130	199
No. of Villages	45,098	44,875
Percentage of urban population	10.46	11.30

The Bihar plain is divided into two unequal halves by the River Ganga, which flows through the middle from West to East. Close to 88 percent of the population lives in villages. Bihar state is 12th largest in terms of geographical size (94,163 sq. km) and 3rd largest by population, 10.38 crores as per Census 2011, in the country. It is also known for its abundant natural resources, perennial rivers, fertile lands, and a long glorious

history. After the division the state in 2000, Bihar retained almost 75 percent of the population, while it is left with only 54 percent of the land, thus inducing a lot of strain on the available resources. Bihar lies in the tropical to sub-tropical region. Rainfall here is the most significant factor in determining the nature of vegetation.

Bihar has a monsoon climate with an average annual rainfall of 1200 mm. The sub-Himalayan foothills of Someshwar and Dun ranges in Champaran constitute another belt of moist deciduous forests. These also consist of scrub, grass, and reeds. Here the rainfall is above 1,600 mm and thus promotes luxuriant Sal forests in the favoured areas. The hot and dry summer gives the deciduous forests. The most important trees are *Shorea Robusta* (Sal), Shisham, Cedrela Toona, Khair, and Semal. This type of forests also occurs in Saharasa and Purnia districts.

The topography of Bihar can be easily described as a fertile alluvial plain occupying the Gangetic Valley. The plain extends from the foothills of the Himalayas in the north to a few miles south of the river Ganges as it flows through the State from the west to the east. Rich farmland and lush orchards extend throughout the state. The major crops are paddy, wheat, lentils, sugarcane, and jute (hemp, related to the marijuana plant, but a source of tough fibres for gunny bags). Also, cane grows wild in the marshes of West Champaran. The principal fruits are mangoes, banana, jackfruit, and litchis. The State is broadly divided into three agro-climatic zones as given below:

Table 2: Agro-climatic zones in Bihar

Agro climatic Zone	Districts	Area (,000 ha)	Average rainfall	Soil and Topography	Crops
Zone -I North West Alluvial Plains	Bettiah, Motihari, Gopalganj, Siwan, Vaishali, Seohar, Muzaffarpur, Samastipur, Sitamarhi, Madhubani, Darbhanga, West & East Champaran	Net Cultivated – 2281; Gross Cultivated -- 3260	1234.7	Medium acidic, heavy textured, sandy loam to clayed, flood prone. (Large area remains under water called Chaur, Maun & Tal lands)	Rice, Wheat, Maize, Arhar; Horticultural crops including Litchi, Mango, Makhana, Water Chestnut.
Zone - II North East Alluvial Plains	Purnea, Katihar, Saharsa, Madhepura, Araria, Kishanganj, Supaul, Khagaria, Begusarai	Net Cultivated – 1147; Gross cultivated -- 1677	1382.2	Light to medium textured, slightly acidic, sandy to silty loam (large area comprise of Tal and Diara lands)	Maize, Mustard, Jute, Sugarcane; Horticultural crops include Mango, Bel, Banana, Papaya, Cucurbit

Agro climatic Zone	Districts			Area (,000 ha)	Average rainfall	Soil and Topography	Crops
Zone - III South Bihar Alluvial Plains	3(a) Bhagalpur, Sheikhpura, Lakhisarai, Jamui, Munger, Banka 3(b) Bhabua, Rohtas, Aurangabad,	Net Cultivated – 241; Gross cultivated -- 3408	1102.1	Old alluvium to sandy loam.		Rice, Gram, Wheat; Horticultural crops include Mango, Guava, Banana, Bel, Jackfruit, Onion, Potato, Chillies, Marigold	

Figure 2: Map depicting Bihar's agro-climatic zones

1.2 Demographic and Human Development Profile

According to the 2011 census, the population of the state of Bihar is 103,804,637 persons, consisting of 52.2 percent males and 47.8 percent females. The average population of a district of the state is 2,731,701. The population of the state is predominantly rural, with 89 percent of the population residing in rural areas. Patna (5772804) and Sheikhpura (634927) are most populated and least populated districts of the state. Some of the important economic and development indicators of Bihar are given below:

Table 3: Economic and human development indicators

Indicators		Bihar	India
Demographic Indicators		**2011**	**2011**
1	Total Population (In Millions)	104	1210
2	% Contribution to national population	8.58	100
3	Sex Ratio (females per 1000 males)	916	940
4	Under 6 sex ratio (females per 1000 males)	933	914
Economic Indicators		**2009-10**	**2009-10**
5	Net domestic Product (at factor cost) (Rs crores) (For state)	110778	4493743
Gross Domestic Product (at factor cost) (Rs crores) (For India)			
6	Contribution of Agriculture to NSDP/GDP (%)	21.30	14.62

Indicators		Bihar	India
7	Contribution of Industry to NSDP/GDP (%)	4.63	20.16
8	Contribution of Services to NSDP/GDP (%)	74.07	65.22
9	Per Capita Net State Domestic Product (factor cost) (Rs) (for State)	11558	33731
	Per Capita Net National Product (factor cost) (Rs) (For India)		
10	NDP Growth rate (%) (for State)	9.56	8
	GDP Growth Rate (%) (For India)		
	Human Development Indicators	2007-08	2007-08
11	Human Development Index Value (HDI)	0.367	0.467
12	HDI Rank (out of 23)	21	
Gender Human Development Indices		**2006**	**2006**
13	Gender Related Development Index (GDI)	0.479	0.590
14	GDI Rank (out of 35)	35	122
15	Gender Empowerment Measure (GEM)	0.379	0.497
16	GEM Rank (out of 35)	31	
Human Development Indicators		**2011**	**2011***
17	Inequality Adjusted Human Development Index Value (IHDI)	0.303	0.343
18	Inequality Adjusted Human Development Index Rank (out of 19)	16	
19	Loss in HDI due to Inequalities (%)	32.06	32
20	Literacy Rate (%)	63.82	74.04
21	Male Literacy Rate (%)	73.39	82.14
22	Female Literacy Rate (%)	53.33	65.46
Poverty and Hunger Indicators		**2009-10**	**2009-10**
23	Poverty Headcount Ratio (%)	53.5	29.8
24	Total number of poor (in millions)	54.35	354.68
		2005	**2005**
25	Multidimensional Poverty Index (MPI)	0.479	0.283
26	Multidimensional Poverty Headcount (%)	79.3	53.7
27	Number of Multidimensional Poor (in millions)	72.3	612
		2007	2007
28	Global Hunger Index (GHI)	27.3	23.3
29	GHI Rank (out of 17)	15	
		2005-06	**2005-06**
30	Prevalence of calorie undernourishment (%)	17.3	20
31	Prevalence of Underweight Children under 5 years of age (%)	56.1	42.5

* *Values differ from India IHDI in Global HDR 2011 due to different data sources.*

Source for indicators 1-4, 20-22 -- Census of India 2011, Provisional Tables, Registrar General of India (http://www.censusindia.gov.in/2011-prov-results/prov_results_paper1_india.html); for 5-10 -- RBI Handbook of Statistics on Indian Economy and Economic Survey of India 2010-11 (http://www.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy); for 11-12 -- India Human Development Report 2011, IAMR and Planning Commission; for

13-16 -- Gendering Human Development Indices: Gendering Human Development Indices: Recasting the Gender Development Index and Gender Empowerment Measure for India, Ministry of Women and Child Development, GOI (http://undp.org.in/sites/default/files/GDI_and_GEM_Report.pdf); for 17-19 -- Inequality Adjusted Human Development Index for India's States 2011, UNDP (www.undp.org.in/sites/default/files/reports_publication/IHDI_India.pdf); for 23-24 -- Tendulkar Committee Report 2009, Planning Commission (http://planningcommission.gov.in/reports/genrep/rep_pov.pdf); for 25-27 -- MPI data and updates for 2011, OPHI (http://www.ophi.org.uk/policy/multidimensional-poverty-index/mpi-data-methodology); for 28-31 -- India State Hunger Index 2009, IFPRI (http://www.ifpri.org/publication/comparisons-hunger-across-states-india-state-hunger-index)

According to Census 2011, Bihar has recorded 25.07 percent decadal population growth. The district with highest decadal growth is Madhepura (30.65) and the district with lowest decadal growth is Gopalganj (18.83). The urban decadal growth rate (35.11) is higher when compared to rural growth rate (23.9). From the data, it could be seen that decadal growth rate of urban females (37.07) is more than urban males (33.4), whereas the decadal growth rate of rural females (23.43) is lower than rural males (24.33). This could be a pointer towards increased acceptance of girl child (reduced female foeticide/infanticide) and women empowerment in urban areas. The household size in the state of Bihar roughly stands at six members per household. The number of members per household in rural areas is about six, whereas in urban areas it is about 6.5. As per 2011 Census, the number of literates in Bihar is 54,390,254 taking the state's literacy rate to 63.82 percent. Out of these male literates are 73.4 percent and female literates are 53.3 percent. The urban literacy rate stands at 78.75 percent (male 84.42 percent and female 72.36 percent) compared to rural literacy rate of 61.83 percent (male 71.9 percent and female 50.82 percent).

1.3 Economy

The recent data on state income shows that the economy of Bihar has been showing a steady growth trend for the last 6 years. During the first 5 years after separation of Jharkhand in 2000, the economy had grown at an annual rate of 4.42 percent at constant prices. The already stagnating economy of Bihar had become even more crippled after the bifurcation, thanks to the asymmetric distribution of resources between Jharkhand and present Bihar. However, the economy witnessed a turnaround due to policies pursued by the present state government and, as a result the economy grew at an annual rate of 11.36 percent during the period 2004-05 to 2010-11. This has been made possible by the fact that the investment pattern showed a massive upsurge. From a small average annual plan size of around ` 1200 crores during the 10th Plan (2002-2007), the annual plan size climbed to more than ` 15,000 crores during the 11th Plan period (2007-2012). The investment portfolio also changed and there was a massive stress on infrastructural development and social delivery system.

Bihar faces complex economic development challenges. With an estimated population of 103.8 million in 2011, Bihar is a densely populated region, with no less than 1102 persons living per sq. km. of its area. As per the Planning Commission figures, in 2004-

05, 41.4 percent of the population lived below poverty line in Bihar. As nine out of ten people on the average live in the villages, poverty is more visible in rural areas. With the bifurcation of the state in November 2000, the newly created Jharkhand state inherited the mineral rich and forest rich parts of the state and present Bihar was left with its largely agro-based economy. However, Bihar is a part of the Gangetic plains and hence has rich soil and possesses abundant water resources, and with optimal use of its abundant agricultural resources, it is possible to enhance growth of the economy and the pace of growth of Bihar's economy in last 6 years is a vindication of such a possibility.

The share of the primary sector in the gross state domestic product (GSDP) has been declining on a continuous basis. The government is trying to stress investment in the manufacturing and infrastructure sector so that the decline in the primary sector's contribution is accompanied by productivity gains in the secondary and tertiary sector. Nevertheless, the state cannot progress without a satisfactory growth of its agricultural sector.

Agriculture would continue to play an integral part of the development process, as around 90 percent of the population still live in villages and they would continue to depend on agriculture as a prime source of their livelihood. The growth rate of Bihar's economy has not been uniform over the last decade. During the first five years since 1999-00, the economy had grown at an annual rate of only 4.42 per cent (see Table 5 below).

The economy then witnessed a turnaround and it grew at an annual rate of 11.36 percent during the period 2004-05 to 2010-11. It can be noted that the growth rate achieved during 2004-05 to 2010-11 has been one of the highest among all the Indian states. The table also shows that during the period 2004-05 to 2010-11, the sectors reporting a growth rate of more than 15 percent are — registered manufacturing (23.30 percent), construction (19.61 percent), communications (27.23 percent) and trade, hotels and restaurant (20.22 percent). During the period 1999-00 to 2004-05, the major contributors to the growth process were — construction (12.17 percent), communication (11.02 percent) and trade, hotel and restaurant (12.25 percent). In other words, the registered manufacturing has emerged as a new leading sector of growth during 2004-05 to 2010-11. It can also be noted from the table that, except for forestry and fishing both of which are rather small in size, all the sectors of Bihar economy had registered a higher growth rate during the later five years.

Table 4: Compound Annual Growth Rate (CAGR) of GSDP[1]

No.	Sector		Annual Growth Rate			
			1999-00 to 2004-05		2004-05 to 2010-11	
			Current Prices	Constant 1999-00 Prices	Current Prices	Constant 2004-05 Prices
1	Agriculture/Animal Husbandry		4.00	2.40	13.95	3.73
2	Forestry / Logging		7.91	3.96	4.36	-2.00
3	Fishing		10.92	10.18	16.46	1.79
4	Mining/Quarrying		-20.53	-19.13	16.12	13.80
	Sub-Total (Primary)		4.42	2.71	13.17	3.08
5	Manufacturing		3.31	-0.41	16.19	9.74
	5.1	Registered	-0.91	-6.53	31.30	23.30
	5.2	Un-registered	4.89	1.80	11.76	5.71
6	Construction		14.75	12.17	27.95	19.61
7	Electricity/Water Supply/Gas		5.12	-3.01	5.60	7.57
	Sub-Total (Secondary)		7.42	3.82	22.09	15.04
8	Transport/Storage/Communication		2.56	2.63	15.39	14.68
	8.1	Railways	-1.50	-2.69	12.79	7.86
	8.2	Other Transport	5.90	3.10	17.88	9.30
	8.3	Storage			14.50	7.11
	8.4	Communication	4.11	11.02	13.90	27.23
9	Trade/Hotel/Restaurant		15.93	12.25	29.68	20.22
	Sub-Total (8 and 9)		12.16	9.41	27.02	19.03
10	Banking/Insurance		10.08	5.23	16.42	16.00
11	Real Estate/Ownership of Dwelling/Business Services		12.44	4.59	18.15	9.68
	Sub-Total (10 and 11)		11.35	4.88	17.52	12.38
12	Public Administration		6.36	2.80	17.27	9.14
13	Other Services		4.22	1.47	13.89	5.38
	Sub-Total (Tertiary)		9.11	5.70	21.81	14.17
	Total GSDP		7.32	4.42	19.45	11.36
	Per Capita GSDP		**5.08**	**2.24**	**17.63**	**9.67**

In 2009-10, the Net State Domestic Product (NSDP) of Bihar was US$ 32.5 billion. The average NSDP growth rate between 2004-05 and 2009-10 was about 16.2 percent. Bihar's per capita NSDP increased from US$ 172.6 in 2004-05 to US$ 340 in 2009-10. A robust secondary and tertiary sector has helped Bihar to increase its average per capita NSDP by around 14.5 percent between 2004-05 and 2009-10.

[1] Source: Bihar Economic Survey 2011-12, Finance Department, GoB, February 2012

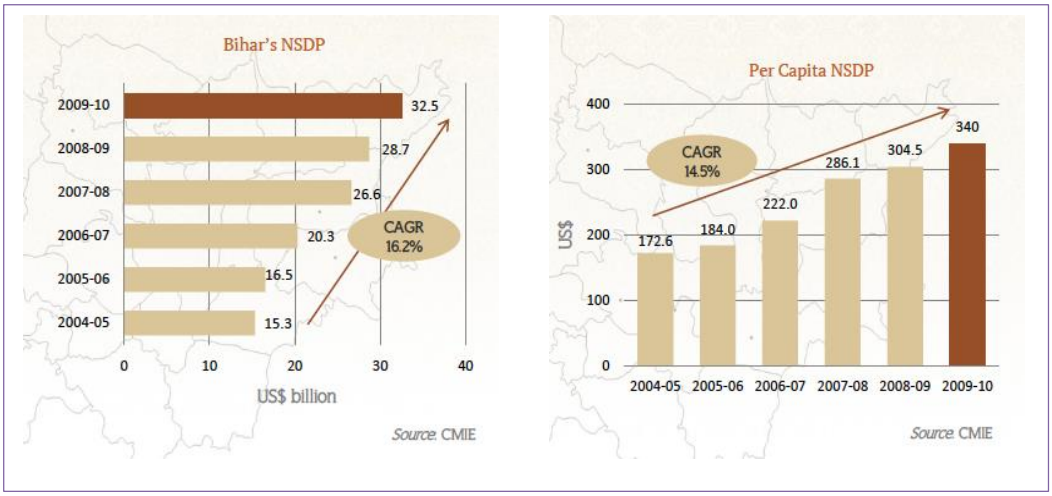


Figure 3: Bihar's NSDP and per capita NSDP

While Bihar's per capita income at current prices remains relatively low, the impact of the strong growth process in the state is reflected when one compares it with the all-India average. In 2006-07, the Per Capita Income in Bihar (` 10,055) was 32.2 percent of the all-India average (` 31,198); but in 2009-10, this ratio had increased to 34.7 percent (` 16,119 for Bihar and ` 46,492 for India) compared to the all India average of 46492 in 2009-102. However, as is the case with most states in India, these figures mask regional disparities within the State.

The latest available estimates for Per Capita GDDP (Gross District Domestic Product) relate to 2007-08 and those estimates show that Patna (` 47,293), Munger (` 13,689), and Begusarai (` 11,959) are the most prosperous districts of Bihar. On the other end of the ranking, the most economically backward districts are Seohar (` 5021), Sitamarhi (` 5479), and East Champaran (` 5575). Even if Patna is excluded since it has the State capital, the per capita income of Munger is about 3 times that of Seohar. Analyses of consumption levels of petroleum products (petrol, diesel, coal and cooking gas) show that Patna happens to be most prosperous one according to all the four indicators. Other districts, which fall among the top 3 districts with respect to at least one indicator, are — Munger, Rohtas and Bhojpur in south Bihar, and Begusarai, Muzaffarpur, Vaishali in north Bihar. The most backward districts in terms of at least on of the above four indicators are — East Champaran, Sitamarhi, Seohar, Madhubani, Nawada, Supaul, Vaishali, Darbhanga, Samastipur and Araria. It may be noted here that, except Nawada, all of these 10 districts are in north Bihar.

[2] Source: Central Statistical organization, New Delhi

Table 5: Relatively prosperous and backward districts of Bihar[3]

Criteria	Top 3 Districts	Bottom 3 Districts
Per Capita NDDP	Patna, Munger, Begusarai	E. Champaran, Sitamarhi, Seohar
Consumption of Petrol	Patna, Muzaffarpur, Vaishali	Madhubani, Sitamarhi, Nawada
Consumption of Diesel	Patna, Begusarai, Rohtas	Madhubani, Sitamarhi, Supaul
Consumption of BIT	Patna, Muzaffarpur, Rohtas	Vaishali, Darbhanga, Samastipur
Consumption of LPG	Patna, Munger, Bhojpur	Supaul, E. Champaran, Araria

The State targets under the 12th FYP are to achieve annual growth rates of 7 percent in the primary sectors, 16.30 percent in the secondary sectors, and 13.89 percent in the tertiary sectors, with an overall aggregated constant growth rate of 13 percent for the State's economy[4].

1.4 Focus Sectors

Detailed descriptions of the Focus Sectors under the BAPCC are given in Section B.

1.4.1 Agriculture and Allied Sectors

Bihar state is located in the Indo-Gangetic plains in central-north India, and its naturally fertile soil is one of the key assets of the State, and conducive to agriculture However, agriculture and its allied sectors in Bihar are beset by many challenges, and climate change and its impacts are only likely to deepen these challenges. The overall strategy of therefore under the BAPCC is therefore to transform agriculture and its allied sectors into climate resilient and vibrant production system, while developing their full potential and ensuring sustained food and nutritional security in the State.

1.4.2 Forests and Biodiversity

Forests have a critical role to play as carbon sinks, and are thus vital to climate mitigation. It also recognises that forests are essential for maintaining favourable and stable conditions needed for sustained agricultural productivity by playing roles in maintaining soil fertility, structure, and water holding capacity. Forests are also vital for maintaining the hydrological cycle and regulating water flows and sub-soil water regimes, recharging the aquifers and maintaining the flow of water in rivers and rivulets and that forested watersheds have better availability as well as quality of water than watersheds under alternative land uses.

[3] Source: Bihar Economic Survey 2011-12, Finance Department, GoB, February 2012

[4] Presentation on 12th FYP and Annual Plan 2012-13, GoB, 27 June 2012. Available on the Planning Commission of India's website.

Forests also provide a range of provisioning services, particularly fuel wood, fodder, small timber, NTFP and medicinal plants, and artisanal raw material like cane and bamboo, that are crucial to livelihood security of forest dependent communities. As such, the emphasis of the forests and biodiversity sectors under the BAPCC will be to improve forest and biodiversity management practices through multiple strategies and initiatives in the State to minimise the impacts of climate change and for the overall wellbeing of the State and its people. It aims to address climate change though enhancing carbon sinks in sustainably managed forests and other ecosystems, enhancing the resilience and ability of vulnerable species/ecosystems to adapt to the changing climate; and enabling adaptation of forest dependant local communities in the face of climatic variability.

1.4.3 Water Resources

Water is critical for all aspects of life on earth, and all human activity is dependent on this critical resource. While Bihar has abundant water resources, the spatially and temporal distribution of this valuable resource is uneven across the state; the water resources sector poses challenges and complexities at multiple levels for the State.

Increased water use by all categories of water users and increased demand due to economic and population growth are compounded by further stress by the increased pollution of existing water resources, which not only restricts potential uses of available water but also threatens future use. There is also a high degree of dependence on groundwater in the State, and this can have serious consequences in the future. The BAPCC recognises the critical importance of water resources to the State and need to safeguard these through a comprehensive multi-pronged response process.

1.4.4 Disaster Management

Bihar is prone to multiple and frequent disasters of various categories, predominantly floods and droughts. The Department of Disaster management is committed for the cause of disaster resilient state. Climate change is making extreme climate events more frequent and the incidences of landslide, flash flood, and drought are on the rise.

In the long run this is sure to adversely affect virtually all sectors of the State's economy. As a response, the State has already prepared a comprehensive Draft State Disaster Management Plan, and the strategies outlined in the BAPCC will be complementary to those in the Plan.

1.4.5 Urban Development

Although Bihar is relatively less urbanised than most other states in India, its percentage decadal growth of urban population at 35.11 is higher than the 31.80 for the country as a whole (and higher than as many as eighteen states/UTs). Bihar's urban infrastructure faces a serious deficit, and the rapid urban growth is putting immense pressure on the urban infrastructure and services resulting in degradation of the urban environment and of natural resources.

The State recognises that climate change and related extreme weather vents can critically impact Bihar's urban agglomerations, and as such, is committed to taking all necessary measures to mitigate this, through actions outlined herein under the BAPCC.

1.4.6 Transport

The rapid growth of vehicles numbers in the State has been accompanied by concomitant problems including congestion and traffic snarls, lack of adequate parking spaces, high accident rates, environmental vehicular pollution rise, and inadequacy of road space for efficient public transportation. The Transport Department has to not only cater to the public transportation needs of the State's population in general and also especially but also the growing demands of urban agglomerations.

1.4.7 Energy

Bihar has adopted a blend of thermal and hydel sources. Bihar currently has only 493 MW of installed capacity for power, with thermal plants accounting for nearly 89 percent of the total installed power generation capacity, with the remaining 11 percent being contributed by the hydel plants. Of late, emphasis is also being laid on the development of non-conventional energy sources, i.e., solar, wind and biomass energy. Even though Bihar has a very lowest annual per capita consumption of electricity, considering the limited generation in the State, there is an acute shortage of power not only for peak demand, but even the base demand in the state.

The CEA has anticipated nearly 65 percent deficit in peak demand in 2012. This scenario, while dismal from the standpoint of energy availability, also represents significant opportunities for holistic and planned approaches to the energy sector, including integration of various climate concerns.

1.4.8 Industries and Mining

Bihar today (after the separation of Jharkhand) has virtually no large industries, and most industrial activity is in the medium, small, and cottage sectors. Nevertheless, Bihar is proactively promoting the state as an attractive investment destination, and with initiatives such as the Industrial Incentive Policy 2011, industrial growth is likely mushroom across a range of sectors in the coming years. This represents an

opportunity for the State to take cognisance of climate change and its impacts on industry, as well plan a range of adaptation and mitigation interventions.

1.4.9 Human Health

While the status of health services in Bihar is still inadequate, substantial improvements have been recorded in this sector in recent years owing to increase in expenditure for health services on one hand and better monitoring of the health services on the other. Health indicators for the state have also shown significant improvement more recently. The State has developed a Health Sector roadmap, and has planned substantial investments in the sector under the 12th FYP.

However, climate change and its impacts pose a set of additional risks, and could potentially impact the State's well-laid plans.

2 Climate Profile of the State

2.1 Introduction

Bihar is situated at the eastern part of the country which lies midway between the humid West Bengal, in the east and the sub humid Uttar Pradesh, in the west. It is bounded by country Nepal in the north and by the state of Jharkhand in the South. The Bihar plain is divided into two unequal halves by the river Ganga which flows through almost in the middle from west to east. Bihar occupies geographical area of 94,163 sq. km and is extended for 483 km from east to west and 345 km from north to south.

Geologically, Bihar represents the northern front of Indian sub- continent. The geographical and geological feature of Bihar includes the belt of Himalayan foothills in the northern fringe of Paschim Champaran, the vast Ganga Plains, the Vindhyan (Kaimur) Plateau extending into Rohtas region and the small Gondwana basin outliers in Banka district. Nearly two third of Bihar is under cover of the Ganga basin composed of alluvium and masks the nature of basement rocks.

The state has a tropical monsoon climate with three distinct seasons-winters, summer and rainy. The state can be divided into two climate zones; the Sub-Himalayan and the Ganga plain. The winter season exists from December to February, January being the coldest month when temperature falls below 10°C. The winter season is characterized by fog, cold wave and western disturbances. Winter rainfall is received by western disturbances in the state.

The summer season covers the period from April to June, May is the hottest month in the greater part of the area and the maximum temperature some time reaches above 45°C and causes the heat waves of the state. The monsoon season normally starts in the third week of June and lasts up to end of September and downpour accumulated seasonal rainfall of 120-150 cm throughout the state. The rainfall is also triggered by monsoon depression which formed in Bay of Bengal, entered in Bihar and produced wide spread rainfall. During monsoon season, the state experienced flood and drought in almost every year and affect the water resources and agriculture of Bihar.

Rainfall and temperature are two main climatic variables which affect agriculture, water, forest, health and other sectors; therefore it is necessary to understand its observed and future projected scenarios in Bihar.

2.2. Climate Change Scenarios

The observed rainfall and surface temperature (resolution of 10x10) for the period of 1961-2000 of India Meteorological Department (IMD) is used. For future climate projection, Climate Model Intercomparision Project Phase 5 (CMIP5) data is used. The Representative Concentration Pathways (RCPs) 2.6 4.5, 6.0 and 8.5 experiments is considered for future time periods while the Historical experiment is for past time periods. In the Historical experiment in CMIP5, models are integrated from 1850 to 2012 with external forcing changing with time.. The simulated ISMR in RCPs experiment is considered for the period of 2006-2050. Here, Future change in annual surface temperature (^{o}C) and percentage change in JJA rainfall (mm/day) in Representative Concentration Pathways (RCP) 4.5 experiment are analysed for the period of 2006-2050 with respect to Historical experiment for the period of 1961-2005 in CESM1(CAM5) model.

2.2.1 Observed temperature

(Based on temperature time-series for 1951-2010)

Annual Mean temperature = **0.01^{o}C increase**,
- Mean temperature in monsoon = **0.01^{o}C, increase**
- Mean temperature in post monsoon = **0.02^{o}C, increase**
- Mean temperature in winter and summer = **No trend**

Annual Tmax = **No trend**
- Mean Tmax in winter = **- 0.01^{o}C, decrease**
- Mean Tmax in summer = **- 0.02^{o}C, decrease**
- Mean Tmax in monsoon = **0.01^{o}C, increase**
- Mean Tmax in Post Monsoon = **0.01^{o}C, increase**

Annual mean temperature = **0.01^{o}C, increase**
- Mean temperature in monsoon = **0.01^{o}C, increase**
- Mean temperature in post monsoon = **0.02^{o}C, increase**
- Mean temperature in winter and summer = **No trend**

Annual Tmax = **No trend**
- Mean Tmax in winter = **- 0.01^{o}C, decrease**
- Mean Tmax in summer = **- 0.02^{o}C, decrease**
- Mean Tmax in monsoon = **0.01^{o}C, increase**
- Mean Tmax in post monsoon = **0.01^{o}C increase**

2.2.2 Observed Rainfall

Based on rainfall time-series for 1951-2010

- Monsoon season rainfall (0.59 mm/year) shows significant trend, although negative trend is found in winter (-0.06 mm/year) but not significant.
- Based on rainfall date for the period of 1984-2012, Heavy rainfall frequency is more in the month of July in Patna while Purnea shows more heavy rainfall frequency in compare to Patna for June-July-August-September
- Meteorological Drought and flood years during 1872-2010 over Bihar are 26 and 24 respectively.

2.2.3 Projected temperature[5]

Future projected change in maximum surface temperature (0C) during 2011-2040 with respect to 1961-1990 in simulation of GISS-E2-H-rcp4.5, GISS-E2-H-CC-RCP8.5 climate models shows that

Western Bihar = 0.6°C to 1°C, increase
Eastern Bihar = 0.2°C to 0.4°C, increase

Future projected change in minimum surface temperature (^{0}C) during 2011-2040 with respect to 1961-1990 in simulation of GFDL-CM3-RCP4.5, GFDL-CM3-8.5, MRI-CGCM3-RCP8.5, and MRI-esm1-RCP8.5 climate model shows that

Southern Bihar=1.2°C to 2.0°C
North Bihar=1.0°C to1.6°C

2.2.4 Projected rainfall [6]

Future projected change in JJA rainfall (cm) during 2011-2040 with respect to 1961-1990 in simulation of CCSM-RCP4.5, CCSM-recp8.5, CESM1-CAM5-rcp4.5 and CESM1-CAM5-rcp8.5 climate model shows that

EASTERN & CENTRAL BIHAR:	5-10 % surplus
SOUTH & WESTERN BIHAR:	5 % deficit

2.3 Key Conclusions

- Tmin increase of 0.6 to 1.5°C in December-January during 1971-2000 in different pockets of Bihar

[5] CUB, Patna
[6] Ibid

- Tmax decrease of -3.0 (Southwest) to -1.4^{0}C (Northeast) in April-May during 1971-2000
- Tmin increase of 0.1^{0}C is observed in the month of December during 1971-2000
- No significant change in June-July-August (JJA) rainfall (cm) during 1871-2002 although decrease (southwest) or increase of rainfall is observed in different pockets
- Future projected change in annual temperature (^{0}C) during 2011-2040 with respect to 1961-1990 in RCPs of 8.5 shows changes of 0.8-1.9^{0}C
- Future projected change in Tmin (^{0}C) in December-January during 2011-2040 with respect to 1961-1990 shows changes of 0.2-1.0^{0}C
- The 5-10% change (positive or negative) in mean JJA rainfall (cm) is noticed over Bihar in RCPs of 4.5 and 8.5 scenarios

Based on temperature and rainfall time-series for 1951-2010

- Annual Tmax does not show any trend while mean Tmax in winter (-0.01^{0}C/year), Summer (-0.02^{0}C/year), Monsoon (0.01^{0}C/year), and Post Monsoon (0.01^{0}C/year) shows significant tend.
- Tmin in annual (0.02^{0}C), winter (0.02^{0}C/year), Summer (0.01^{0}C/year), and Post Monsoon (0.02^{0}C/year) shows significant tend, while Monsoon season does not show any trend
- Annual mean temperature (0.01^{0}C), mean temperature in monsoon (0.01^{0}C) and post monsoon (0.02^{0}C) show significant trend while no trend is found in winter and summer season.
- Mean Diurnal temperature range shows significant negative trend in annual (-0.02^{0}C), winter (-0.04^{0}C) and summer (-0.03^{0}C), other seasons do not show significant trend.
- Monsoon season rainfall (0.59 mm/year) shows significant trend, although negative trend is found in winter (-0.06 mm/year) but not significant.
- Based on rainfall date for the period of 1984-2012, Heavy rainfall frequency is more in the month of July in Patna while Purnea shows more heavy rainfall frequency in compare to Patna for June-July-August-September

Part B: Climate Change Strategy

3 Overarching State Framework

3.1 State Vision and Commitment

The State has articulated climate concerns in its Approach Paper for the 12th FYP, and as such, is committed to fostering an integrated approach to inclusive, sustainable, and climate resilient growth and development. The GoB's vision will be achieved through pursuing (a) broad streaming of climate concerns into all aspects of development policy and implementation, (b) integrating low carbon and climate resilient development models into its growth strategy, and (c) ensuring complementarity with and contributing to the national agenda on climate change.

Keeping in mind the overall motto of Bihar Action Plan of Climate Change (BAPCC) – 'Building Resilience through Development', these approaches will be supported by the strategies and actions outlined in this report, and by all other necessary actions by the State Government for the achievement of the Vision.

3.2 Overall Approach, Principles, and Strategies

The approach of the BAPCC is to create and define an overarching climate response framework at the State Government level to reduce vulnerability; reduce hazards and exposure; pool, transfer, and share risks; prepare and respond effectively; and increase capacity to cope with unforeseen events, while articulating flexible sector specific response strategies and actions keeping in mind the overall Vision.

The State recognises that it has several existing vulnerabilities (ecological, economic, social and cultural), and that climate change is likely exacerbate these further if not addressed adequately and holistically. Therefore the climate response strategy of Bihar has key elements such as accelerating inclusive economic growth, promoting sustainable development, securing and diversifying livelihoods, and safeguarding ecosystems. Further, the strategy is not to be viewed as a standalone action; instead it will be integrated into the regular developmental planning process, keeping with the convergence principles articulated in the State's 12th FYP Approach Paper.

Adaptation will be the predominant philosophy and component of the climate response strategy of Bihar, while at the same time leveraging opportunities for mitigation co-benefits. The state lays equal emphasis on both 'hard' and 'soft' adaptation approaches – where 'hard adaptation options' include options that have physical attributes (e.g. infrastructure and engineering structures) and 'soft adaptation options' include the

development of skills, processes, institutions, social systems, policies and programmes. Flexibility (within livelihoods, economic, social, cultural, ecological and institutional systems), diversification (involving multiple independent flows to livelihood and natural systems), learning and education (from events at both individual and institutional levels and knowledge base required to develop new systems when existing ones are disrupted), mobility (an attribute of flexibility), operational techniques (for risk reduction before and following disruptions), convertible asset and innovation (designing new systems and options) will be the key elements of the climate response strategy for Bihar.

Specific elements of the overarching climate response framework at the State Government level are articulated below (additional elements will be added as and when necessary). The state will develop action oriented operational plans and budgetary frameworks for these by end 2012. It has also been ensured that all actions to be undertaken as part of the BAPCC have broad conformity to the NAPCC and the eight National Missions under it.

3.2.1 Scientific Knowledge, Evidence Base, and Understanding of Climate Change

The previous section has already outlined the fact that the currently available knowledge base vis-à-vis climate change vulnerability and its impacts on the State, its economy, and its various sectors and communities is limited or virtually non-existent. As such, the BAPCC seeks to fulfil the following outcomes (which are linked to the overall knowledge management Strategy under the BAPCC)

- Development of detailed climate vulnerability and risk analyses covering all districts, as well as specific analyses pertaining each of the sectors addressed in the BAPCC;
- Improved scientific evidence base and coordination mechanisms between scientific research and academic institutions (including both national and state level agencies) for build scientific data and evidence base for the State; and collation of available scientific information and data on climate change pertaining to the State
- Review of the sectoral strategies under the BAPCC based on the vulnerability and risk assessments; and
- Documentation (on an on-going basis) of people's perceptions on community change and its impacts, and where appropriate, establish if these have scientific bases and validity.

To fulfil the above outcomes, the State will take all necessary steps including initiating (as one of the highest priority agendas) processes for carrying out detailed climate

vulnerability analyses and developing a climate vulnerability atlas, which will be updated on an on-going basis. Centre for Environmental Science, Central University of Bihar, Patna may be proposed for climate modelling activities.

Centre for Environmental Sciences arrange dialogue among academic institutions and coordinate climate change research. These will then be used to foster processes for specific basic and applied research initiatives that may be required to support the implementation of BAPCC. Central University of Bihar will also foster dialogue and collaboration between scientific and academic research organisations elsewhere as part of the above processes.

Climate modelling activities have been started at Centre for Environmental Sciences (CES), Central University of Bihar (Founded by GoI under Central Universities Act, 2009) at Patna. The Regional Climate Model, PRECIS (UK Met Office) is being used to conduct the experiment for base line (1961-1990) and A1B scenario (2011-2040) at surface horizontal resolution of 50x50km^2 over India, apart from various other studies using IPCC climate model data and in the next phase, CES is expanded climate modelling activities on a high speed computing facility by government funded research projects on Monsoon Rainfall, Droughts, Floods, Western Disturbances and Climate Change Impacts on Agriculture and Water Resources. Considering that Centre for Environmental Sciences, Central University of Bihar is the only academic institution who is working on modelling of climate change, the State proposes to mandate CES with the role of Centre for Climate Change, and to task it with the role of anchoring all climate change and impact related research activity specific to the State and also build State capacities for understanding and tackling climate change through appropriate adaptation and mitigation actions.

3.2.2 Governance Mechanisms, Institutional Decision Making, and Convergence

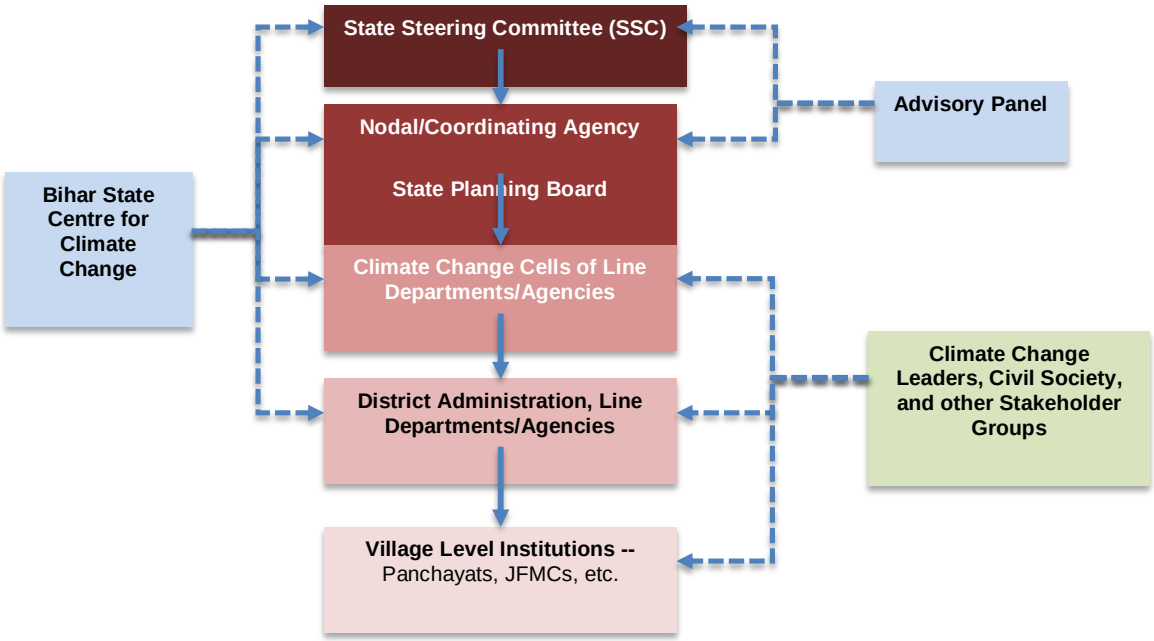
As indicated in an earlier section, Bihar is already implementing a range of steps/programmes that are climate-friendly/neutral (there are described in Section 4 below under each sectoral subsection). While continuing to foster such initiatives, the State will seek to fulfil a range of outcomes including:

- Developing and putting into place overarching institutional and governance mechanisms at the State level to oversee and implement the BAPCC;
- Review of all state policies and revise these as necessary to articulate and integrate climate concerns;
- Articulation and integration of climate change considerations into development strategies, plans and programmes;

- Strengthening of institutional decision-making mechanisms and processes (including monitoring & evaluation) to ensure cross-sectoral coordination related to climate change;
- Development and adoption of appropriate management approaches including regulatory, incentive, and innovation based approaches to encourage appropriate adaptation and mitigation measures; and
- Development and strengthening of institutional capacity for climate related disaster risk reduction and management.

The overarching State level institutional architecture is given in Figure 4 below.

Figure 4: State level architecture for BAPCC implementation



In order to provide an overarching governance framework and guidance to the State's climate agenda, the State has already constituted the State Steering Committee under the Chair of the Chief Secretary and consisting of key senior bureaucrats from various sectors, and other eminent persons.

The SSC, which was mandated the apex role of overseeing all aspects of the State's preparations and initiatives to address climate change and its impacts, will be activated, and a specific terms of reference will be developed for it, including periodic mandatory meetings, and outlining other key responsibilities including review of all State policies and programmes and identify gaps, risks, opportunities, and possible corrective actions towards achieving the above outcomes.

The Department of Environment and Forest will act as the Nodal Agency for coordinating and overseeing all operational aspects of the BAPCC implementation and coordination at the State level, with oversight support from the Chief Secretary, the Development Commissioner, and the Principal Secretary, Planning and Development. All sectoral line departments and other key agencies in the state will set up Climate Change Cells in their respective departments/agencies. These Cells will coordinate and oversee all aspects of BAPCC implementation in their respective sectors, as well as liaise/coordinate with the State Planning Board and other line departments as required.

The State will also put together and co-opt an Advisory Panel comprising of academic and practitioner experts to advise and work with the State SSC and the State Planning Board in carrying out their respective mandates. It is anticipated that the Advisory panel would co-opt new members as and when required or a case-by-case basis. While this BAPCC focuses on sectoral interventions across a selected set of government line departments/agencies, this will by no means exclude the role of other line departments/agencies, and these will be co-opted to support BAPCC implementation processes from time to time.

3.2.3 Capacity Development, Education, and Awareness

The State recognises that overall awareness of climate change and its impacts in Bihar is limited. Therefore, the BAPCC seeks the fulfilment of the following outcomes:

- Capacities of government line departments and agencies at all levels to analyse, plan, converge, implement and monitor programmes addressing climate change and its impacts; and
- Significantly improved awareness of climate change and its impacts in government at all levels as well as in communities, civil society, and the private sector in the State.

The State will initiate and foster a range of on-going awareness and capacity building measures aimed at targeting government departments and agencies at various levels, to improve overall awareness levels. It is proposed that Centre for Environmental Sciences, Central University of Bihar will develop climate modelling centre and deploy capacity building modules to train personnel from the Climate Change Cells of various line departments, who in turn can train and build capacities of their respective departmental personnel to actively engage the climate agenda.

The State will also put into motion a process of building awareness on climate change and its impacts among the population and communities in general and also develop and widely disseminate sets of actions that the citizens of the State can take to support the BAPCC. In addition, the State will examine the possibility of incorporating climate

change related modules into the educational curriculum across various levels, including the development of specific academic programmes on climate change at University levels.

Appropriate external agencies in coordination with Centre for Environmental Sciences, Central University of Bihar will be co-opted as necessary to support the awareness and capacity building processes. The State will additionally seek to build and support a network of Climate Leaders – who can come from either government or elsewhere – to help foster and champion the climate agenda in the State.

3.2.4 Connecting Science, Policy, and Practice

As an extension of the overarching principles actions on improving scientific knowledge and evidence base articulated above, the State is committed to supporting processes that connect science to policy and practice. The following outcomes are envisaged towards this end:

- Data/research needs to support BAPCC implementation and related policymaking identified (on an on-going basis, as needs evolve);
- Mechanisms to foster dialogue with and between scientific research and academic agencies; and
- Specific mechanisms to adopt and implement practical approaches and solutions based on basic and applied research to support BAPCC implementation.

As such, under the BAPCC, the State seeks to actively consult and dialogue with relevant scientific organisations and academia in the formulation of state policies, to develop a culture of evidence-based policymaking. It also similarly will support similar consultation and dialogue in the formulation of developmental and sectoral programmes by the various line departments and agencies, through their Climate Change Cells as has been proposed in the BAPCC. On an immediate basis, specific emphasis will be given to practical approaches and solutions (technological and otherwise) that have already been developed by universities/research organizations in the state.

3.2.5 Integrating Poverty, Livelihoods, and Equity Issues

The State already places emphasis on inclusive development, as has been articulated in its Approach Paper to the 12th FYP. By extension, the State also recognises that since climate change can disproportionately impact the poor, women, children and the aged, and can also impact livelihoods, sectoral planning under the BAPCC needs to explicitly integrate poverty, livelihoods and equity concerns.

The State also recognizes the different roles that men and women play in society and because of the unequal power relations between them. While a large number of poor, rural women depend on climate-sensitive resources for survival and their livelihoods, they are also less likely to have the education, opportunities, authority, decision-making power and access to resources they need to adapt to climate change. Women's vulnerability to climate change differs from men and climate change interventions that are not gender-responsive often result in deepening the existing gender divide[7].

As such, the state will take the necessary steps towards fulfilling the following (but not be limited to) outcomes:

a) Reduced intra-state inequity between the various regions of Bihar as also reduced inter-district inequality, especially in infrastructure and service provision as these have a bearing on livelihoods and thus adaptive capacity as well;
b) Mainstreamed use of explicit gender-responsive language, data, and analysis in the detailed implementation plans to be developed under the BAPCC and integration of gender and equity elements components in programming such as setting gender-specific indicators in programmes and schemes, carrying out gender-focused monitoring and evaluation, including gender-sensitive audits of adaptation programme and schemes, building capacities of women and men to implement participatory schemes at the village-level; building capacities on gender and adaptation within all governance institutions at all levels from Panchayati Raj Institutions (PRIs) to the State[8];
c) Partnerships and collaborative arrangements with relevant agencies (to be identified) to help build capacities within the Departments to work with gender and climate change adaptation; and
d) Partnerships and collaborative arrangements with the Panchayati Raj Department to help Gram Panchayats develop participatory and gender-just local action plans on adaptation (LAPAs) at the Panchayat level, in addition to their mandate of developing and implementing the Village-level Development Plans.

It is expected that these actions will significantly enhance and contribute to equitous adaptive climate resilience in the State.

[7] Fourth Assessment Report (2007) of the Inter-governmental Panel on Climate Change (IPCC), Chapter 17, especially pages 729-730

[8] Aditi Kapoor, Engendering The Climate For Change: Policies and practices for gender-just adaptation. Alternative Futures and Heinrich Boll Foundation (HBF), 2011

3.2.6 Private Sector and Financial Institutions

The private sector already plays a role in contributing to the State's economy in the secondary and tertiary sectors. A range of PPP initiatives and projects are already underway in the State in various sectors. Such PPP models can be useful for pooling resources and expertise and for up-scaling climate change adaptation (especially in terms of climate resilient infrastructure and low carbon goods and services) and mitigation initiatives by way of explicit incorporation of climate concerns into project frameworks.

Private Sector has great potential and competency for bringing innovative solutions and scale to the various models for climate change adaptation shaped by the civil society and/or government institutions however their primary thrust thus far has been limited to clean development mechanism (CDM) and related projects.

Increasingly, there is a huge potential and need private sector to play critical roles sectoral initiatives in the primary sectors as well – brining in new management practices, technologies and technology transfer, innovation, capital and investments, capacity building, etc. In this direction, the BAPCC will seek to fulfil the following outcomes:

- A roadmap for exploring the potential role of private sector across the various focus sectors of the BAPCC especially in the primary sectors such as agriculture (with special emphasis on rain-fed mountain agriculture and extension), forestry, etc.;
- Review of existing initiatives by the private sector including CSR to examine possibility of incorporating climate agendas;
- Review of existing policy frameworks governing the private sector including the draft State PPP Policy with the objective of exploring the incorporation of climate change concerns into PPP projects in the state;
- Outlining of necessary enabling frameworks and regulatory mechanisms for involvement of the private sector.

As in the case of the private sector, increasingly, the financial sector and financial institutions will have critical roles to play in sectoral initiatives – brining in new financial practices, products, and innovation, capital, investments, climate risk transfer mechanism, etc. As such, the BAPCC envisages the following outcomes:

- Developing a roadmap for exploring the potential role of the financial sector and financial institutions across the various focus sectors identified in the BAPCC (and in other sectors as appropriate/necessary); and

- Outlining the necessary enabling frameworks and regulatory mechanisms for involvement of the financial sector.

3.2.7 Role of Civil Society

Civil society and voluntary organizations have played critical roles in shaping the development landscape of not only Bihar, but also across the nation. These will continue to have vital roles in the context of climate change, and have the potential to deliver programmes and services to communities and to bridge the roles of not only the government and community but also bridge the roles of scientific research institutions and the private sector with government and the community.

As such, the BAPCC envisages the following outcomes relating to the role of civil society:

- Developing a roadmap for exploring and articulating the potential role of civil society organisations (including non governmental organisations [NGOs] and NGO Networks, community based organisations [CBOs] and CBO networks, etc.) in BAPCC implementation including capacity building at various levels especially at district and sub-district levels, inputs to the BAPCC on poverty, equity and livelihood concerns, outreach and extension and bridging roles, documentation of community perceptions and best practices, participatory research, knowledge networking, and contributing to expanding the available evidence base on climate change, etc. and
- Identifying appropriate civil society organisations and their networks at various levels who can who can partner BAPCC implementation at various levels including state, district, block and at the grassroots.

3.2.8 Role of International/External Support Agencies

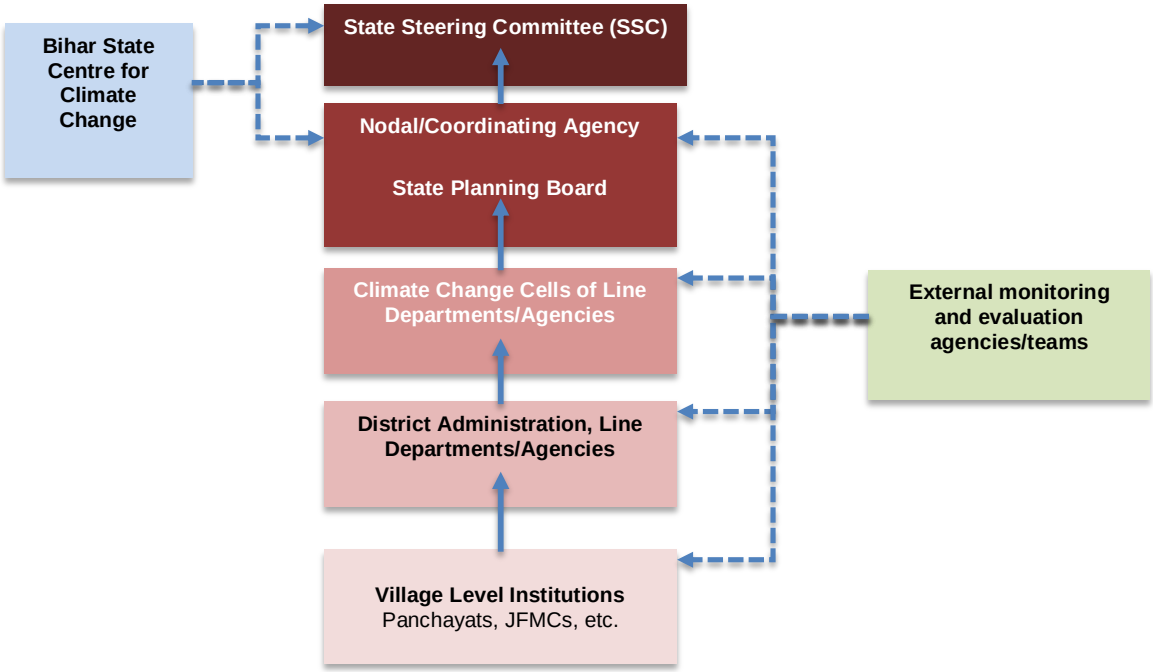
Likewise, international/external agencies play significant roles in supporting developmental initiatives and bringing in technical assistance to the State. A range of international organisations, including multilateral, bilateral and other agencies have supported and continue to support significant development projects across government departments as well as civil society.

As such, it is envisaged that international organisations will also play a significant role in supporting various aspects of BAPCC implementation; the State will therefore proactively seek opportunities for collaborative partnerships with such organisations especially in the context of external support for financial support, technical assistance and advisory services, bringing in international best practices, knowledge management and networking, inter-state and regional dialogues on climate change, etc.

3.2.9 Monitoring Framework

A tentative and indicative outline of a monitoring and reporting framework is given in Figure 5 below.

Figure 5: Tentative and indicative monitoring framework for the BAPCC



The state is committed to ensuring that BAPCC implementation is complemented by a robust framework and mechanisms for monitoring and evaluation not only as a means of ensuring that the detailed operational plans that will be developed under the BAPCC are implemented as planned, but more importantly, as a tool for systematic review and programme improvement as the needs of the State evolve with implementation.

The reporting will take place on a quarterly basis at all levels, internal reviews of implementation progress and performance on a half-yearly basis. Likewise, considering that this BAPCC broadly covers implementation plans over a five year period, implementation of the, an external third-party evaluation during mid-2014 to critically examine implementation and recommend course corrections, and another similar external evaluation will be carried out during end 2017.

A detailed and robust monitoring framework will be developed including specific methodologies, protocols, and templates for monitoring and reporting as part of the process of developing detailed work plans under the BAPCC.

3.2.10 Knowledge Management, Sharing, Learning, and Dialogue

The BAPCC recognises that knowledge creation, management, and dissemination/ exchange will be critical and central to the successful implementation of the SAPCC. The BAPCC also recognises that Bihar does not exist in an independent developmental vacuum; it exists in the developmental context of the central-north Indian region and also in the larger context of India. Therefore the BAPCC will seek to fulfil the following outcomes in this regard:

- Develop protocols for new knowledge creation and documenting emerging best practice across sectors and at all levels, as well as documenting and sharing people's perceptions on climate change and its impacts on an on-going basis;
- Develop mechanisms and partnerships for sharing knowledge base and emerging experiences including best practice not only within the State at all levels but also with other states in the region and across India and elsewhere.

As such, it is envisaged that the BAPCC outcomes knowledge management will be crosscutting and also closely connected to the envisaged outcomes on capacity building. Additional elements of Knowledge Management may be taken up from time to time during BAPCC implementation as required.

Linkages with the NAPCC and the National Mission on Strategic Knowledge for Climate Change

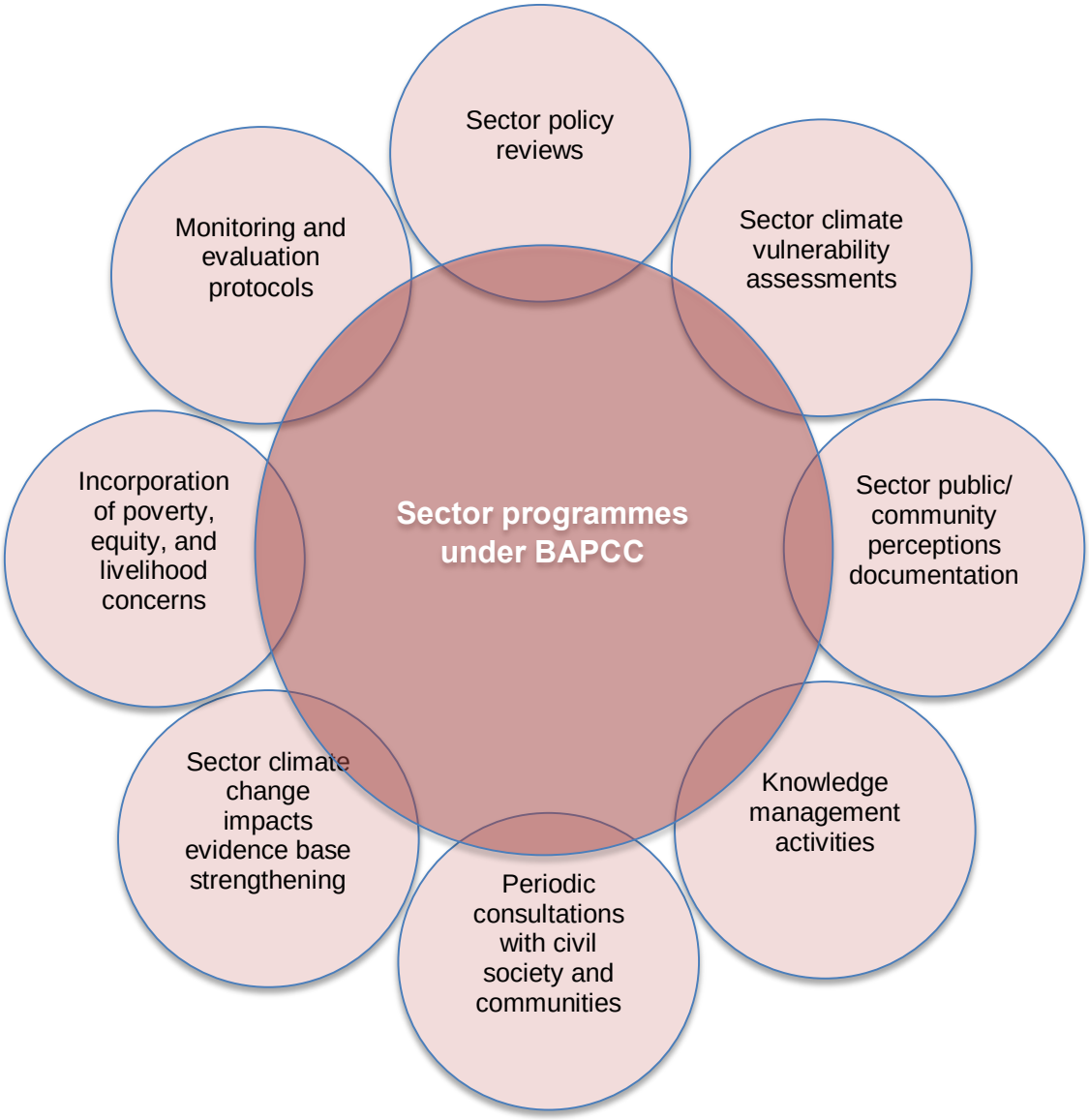
The above sub-sections, and in particular, those on -- Scientific Knowledge, Evidence Base, and Understanding of Climate Change; Capacity Development, Education, and Awareness; Connecting Science, Policy, and Practice; and Knowledge Management, Sharing, Learning, and Dialogue – are consistent with and complement imperatives outlined in the NAPCC in general and in particular, those under the National Mission on Strategic Knowledge for Climate Change.

4 Sectoral Implementation Approaches

4.1 Overall Common Implementation Framework

It is envisaged the BAPCC implementation under the various sectors of the State will be governed by a common implementation framework[9] as in Figure 6 below:

Figure 6: Common framework elements for sectoral implementation under the BAPCC



[9] Since these will be common across sectors, in order to avoid repetitiveness, will not appear in the descriptions of each sectoral programme

The common elements will include:

- *Sector policy reviews*: Each sector will undergo a policy review, and where appropriate, explicit articulation of climate change concerns and sectoral responses will be articulated;
- *Sector climate vulnerability assessments:* Sectoral climate vulnerability and risk assessments will be carried out as part of a larger vulnerability and risk assessment for the State, and where appropriate, sectoral programme elements will be re-framed based on the findings;
- *Sector climate change impacts evidence base strengthening:* Each sector will put into motion a process of building the evidence base on climate change and impacts to the sector;
- *Forecasting and early warning systems:* Each sector will put into motion systems for adoption forecasting and early warning systems for adverse climate impact installation for improved resilience and adaptation;
- *Participatory qualitative methods and quantitative models:* Each sector will seek to adopt and foster quantification of cost and benefit analysis of adaptation options for sector performance improvements and outcome optimisation;
- *Locally specific adaptation plans*: To increase resilience, locally specific adaptation plans will be made; enabling the exchange of case studies and good practices will facilitate the development of robust solutions;
- *Leveraging Co-benefits:* Each sector will proactively seek to identify and leverage opportunities for co-benefits arising out of BAPCC implementation;
- *Sector public/community perceptions documentation:* Each sector will carry out periodic documentation of public/community perceptions on climate change and its impacts relevant to the sector;
- *Periodic consultations with civil society and communities:* Each sector will carry out periodic consultations with civil society and communities to gauge adaptive resilience needs;
- *Incorporation of poverty, equity and livelihood concerns:* Each sector will, where appropriate, incorporate and explicitly articulate poverty, equity and livelihood concerns in their policies, plans and budgetary processes;
- *Monitoring and evaluation protocols:* Each sector will, in line with the overarching State level framework, develop and deploy monitoring and evaluation processes and protocols to guide effective programme implementation; and

- *Knowledge management activities:* Each sector will, in line with the overarching State level framework, carry out KM activities, and contribute to the State level processes on an on-going basis. Under the BAPCC, an appropriate organisation will be identified to carry out the role of a knowledge aggregator, and become a clearinghouse of all data/information on existing and planned research projects and initiatives relating to climate change in the Bihar context. Towards this, the identified organisation will provide the following inputs:
    - Hosting of geo-portal on climate change;
    - Host-hub for knowledge/information sharing related to climate change;
    - Knowledge repository;
    - Identification of potential research and development domains concerned with climate change issues in the state; and
    - Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change.

Additionally, efforts will be made to explore the options for participation of and leveraging the private sector and financial institutions in each sectoral programme. Likewise, where appropriate, suitable external support agencies will be leveraged/sought to bring in additional implementation support or technical assistance.

5 Agriculture and Allied Sectors

5.1 Overview, Characteristics and Status

Bihar's Economy is dominated by the agricultural sector. Around 90 percent of the population still live in rural areas where agriculture, along with animal husbandry, has been the mainstay of their livelihood. Agriculture is sure to play the most important role for the development of the state. Bihar is rich with fertile land resources. The area under cultivation as a proportion of the total reporting area is as high as 60 percent, as compared to only 47 percent for the country as a whole. Nearly 81 percent of the State's population is employed in agriculture production system, which is much higher than the national average.

In Bihar, based on soil characteristics, rainfall, temperature, and terrain, there are three main agro-climatic zones, which have been briefly described in earlier section. Each zone has its own unique characteristics in terms of the crop production. Agro climatic zone I and II is located south of the river Ganges whereas the Zone III (A and B) is located south of the river Ganges. Zone I is situated in the north-western part of the state whereas zone II is located in the north-eastern part. Zones I and II are flood prone whereas zone III is drought prone.

The soil texture in the state varies from sandy loam to heavy clay and majority type belongs to loam category, which is good for crop cultivation. Soil PH varies from 6.5 to 8.4. The annual precipitation varies from 990 to 1200 mm although major precipitation is received during the month of July to September. The changing temporal and spatial pattern of rainfall and temperature will adversely affect these agro climate zones. There are three crop seasons - Kharif, Rabi and Zaid. Kharif crops are sown in May-June and harvested in September– October.

The important Kharif crops are cotton, rice, sugarcane, maize, jowar, and bajra. Rabi crops are sown in October–November and harvested in February–March. The important Rabi crops are wheat, grams, barley, rapeseed, and mustard. Zaid crops are produced in the short duration between Rabi and Kharif crop season, mainly from March to June, are called Zaid crops e.g. Muskmelon, Watermelon, gourd and etc. Rice, wheat, and pulses are grown in all the districts however the choice of the crop and crop rotation varies across the agro climatic zone.

The principal crops are rice, wheat, pulses, maize, potato, sugarcane, oil seeds, tobacco, and jute. Rice, wheat, and maize are the major crops. Although the state has attained self-sufficiency in food grains production, barring maize and pulses, productivity of other farm

produce in Bihar is much below the national average. Bihar is rich in water resources, which can be utilized for inland fishery.

5.1.1 Land Use Pattern

Table 6 presents the land use pattern of the state from 2006-07 to 2008-09.

Table 6: Land utilization pattern in Bihar (2006-07 to 2008-09; area in '000 hectares)[10]

Land use	2006-07	2007-08	2008-09
Geographical area	9359.57 (100.0)	9359.57 (100.0)	9359.57 (100.0)
(1) Forests	621.64 (6.6)	621.24 (6.6)	621.64 (6.6)
(2) Barren and Unculturable Land	436.06 (4.7)	432.09 (4.6)	431.77 (4.6)
(3) Land put to Non-agricultural use	1646.89 (17.6)	1652.66 (17.7)	1670.45 (17.8)
Land Area	1285.98 (13.7)	1292.11 (13.8)	1312.94 (14.0)
Water Area	360.91 (3.9)	360.55 (3.9)	357.51 (3.8)
(4) Culturable Waste	45.65 (0.5)	45.59 (0.5)	45.43 (0.5)
(5) Permanent Pastures	17.33 (0.2)	16.47 (0.2)	15.87 (0.2)
(6) Land Under Tree Crops	240.52 (2.6)	240.96 (2.6)	242.86 (2.6)
(7) Fallow Land (excluding current fallow)	119.97 (1.3)	119.35 (1.3)	122.30 (1.3)
(8) Current Fallow	566.39 (6.1)	568.61 (6.1)	655.17 (7.0)
Total Unculturable Land (1 to 8)	3694.45 (39.5)	3697.36 (39.5)	3805.48 (40.6)
Net Sown Area	5665.12 (60.5)	5662.20 (60.5)	5554.08 (59.4)
Gross Sown Area	7718.95	7764.65	7670.95
Cropping Intensity	1.36	1.37	1.38

Seven districts where more than 70 percent of the area are under cultivation, are Nalanda (77.0 percent) Bhojpur (79.3 percent), Buxar (77.4 percent), Siwan (74.4 percent), Sheikhpura (72.6 percent), Gopalganj (72.6 percent), and East Champaran (70.6 percent). On the other hand, there are five districts that have less than 50 percent of net sown area, viz., Banka (42.3 percent), Jamui (16.9 percent), Munger (37.1 percent), Gaya (34.5 percent) and Nawada (42.1 percent). The cropping intensity is the lowest at 1.16 in Jamui and Patna.

5.1.2 Cropping Pattern

Table 7 shows the cropping pattern of various crops.

Table 7: Cropping Pattern in Bihar 2001-02 to 2009-10)[11]

Crops	Percentage of Area								
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Food grains	94.3	94.4	94.4	94.2	94.4	94.3	94.4	94.7	94.3

[10] Source: Directorate of Economics and Statistics, GOB

[11] Source: Department of Agriculture, GoB

Crops	Percentage of Area								
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Cereals	--	--	85.2	84.8	85.8	85.9	86.5	86.7	86.3
Pulses	--	--	9.2	9.4	8.6	8.4	7.9	8.0	8.0
Oilseeds	1.9	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.9
Fibre Crops	2.1	2.3	2.4	2.2	2.1	2.1	2.1	2.0	1.9
Sugarcane	1.5	1.4	1.4	1.4	1.5	1.6	1.4	1.5	1.6
Total Area	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

5.1.3 Production and Productivity

Table 8 below shows the productivity of major crops in the State.

Table 8: Productivity (Kg/ha) of major crops in Bihar[12]

Crops	Triennium Average (2000- 03)	2007-08	2008-09	2009-10	Triennium Average (2007-10)	% Change between trienniums
Total Cereals	1732	1799	1941	1595	1778	3
Total Rice	1457	1288	1651	1120	1353	-7
Autumn Rice	1247	1396	1324	947	1222	-2
Aghani Rice	1488	613	1712	1132	1152	-23
Summer Rice	1758	1729	1643	1736	1703	-3
Wheat	2036	2334	2205	2084	2208	8
Total Maize	2384	2823	2724	2341	2629	10
Kharif maize	1765	1221	1478	1772	1490	-16
Rabi Maize	2934	4001	3845	2660	-	-
Summer Maize	2765	3762	3096		-	-
Total Coarse Cereals	979	924	2642	2277	1948	99
Barley	1186	1202	1245	1118	1189	0
Jowar	923	1096	1044	1040	1060	15
Bajra	861	1103	1208	1108	1140	32
Ragi	879	605	687	812	702	-20
Small Millets	681	739	786	760	761	12
Total Kharif Pulses	901	1024	1034	1125	1061	18
Arhar	1215	1383	1357	1513	1417	17
Urad	682	782	845	892	840	23
Bhadai Moong	529	607	598	656	620	17
Kulthi	788	929	940	962	944	20
Other Kharif Pulses	544	657	671	810	713	31
Ghaghra (Cow Pea)	564	899	737	938	858	52
Total Rabi Pulses	806	781	902	796	826	3

[12] *ibid*

Crops	Triennium Average (2000- 03)	2007-08	2008-09	2009-10	Triennium Average (2007-10)	% Change between trienniums
Gram	1001	990	1157	1014	1054	5
Lentil	886	796	931	880	869	-2
Pea	947	1077	1027	1009	1038	10
Khesari	847	839	1062	944	949	12
Summer Moong	596	600	656	510	588	-1
Other Rabi Pulses	662	742	743	744	743	12
Total Oilseeds	818	1015	938	1034	996	22
Castor seed	944	950	957	963	957	1
Safflower (Kusum)	802	750	802	769	774	-4
Sesamum	629	795	806	766	789	26
Sunflower	1401	1390	1506	1405	1434	2
Mustard & Rapeseed	799	992	861	996	950	19
Linseed	712	825	848	846	840	18
Ground Nut	716	719	557	1650	975	36
Total Fibre Crops	7131	9416	8162	9148	8909	25
Jute	7317	9442	1361	1637	4147	-43
Mesta	6858	9260	1669	1701	4210	-39
Sunhemp	727	-	-	-	-	-
Sugarcane	43586	37624	37624	43430	39559	-9

5.1.4 Production and Productivity of Vegetables and Fruit

Bihar produces a variety of vegetables and fruits. In terms of vegetable production, the state is proud to be holding the topmost position in the country in recent times. Although, Horticulture (Fruits, vegetables, spices, honey, medicinal and aromatic plants) occupies 15 % of land area but income generated from horticulture is much higher. The state has a monopoly in production of litchi and makhana and continues to grow various fruits, vegetables, spices and floriculture is catching the imagination of people, reflected in their growing interest, across the state, ion diversification of horticulture. The productivity of potato increased from 2008-09 to 2009-10. The productivity of onion and cauliflower is increased from 2008-09 to 2009-10.

5.1.5 Area and Production of Flowers

Patna, Muzaffarpur, Vaishali, Samastipur, and Gaya are major flower producing districts in the state. In 2010-11, the production levels of important flower crops were – rose (86.52 tonnes), marigold (5120 tonnes), Jasmine (307.46 tonnes), and tuberose (522 tonnes).

5.1.6 Animal Husbandry

Livestock and dairy is one of the key sectors for creation of livelihood and employment opportunities in the rural sector. Since 90% of state's population is rural, animal husbandry

is extremely important for providing gainful employment to population living in rural areas. The production of milk has increased from 26.32 lakh tonnes in 2001-02 to 65.00 lakh tonnes in 2010-11. During the same period, the production of eggs has increased to 110.10 crores in 2009-10 from a production level of 74.00 crore in 2001-02. But, in 2010-11, the production level fell to 74.40 crores leading to an annual growth rate of 3.25 percent. The production of wool now stands stagnated at a level of 2.50 – 2.60 lakh kgs.

5.1.7 Fisheries

Fisheries sector of the state is an important, most promising and fast growing food farming sub-sector accounting 7.97% annual growth rate. The availability of immense aquatic resources of the state not only satisfies the demand of fish but also plays an important role in gainful employment generation, food and nutritional security, poverty alleviation, state income growth and finally socio-economic up-gradation of the rural community. To meet the challenge of the global climatic change and its impact on fisheries of Bihar, the Department of Fisheries, State govt. will strategically ensure end-to-end holistic approach covering production, input and resource enhancement, renovation of existing resources, post harvest management to assure sustainable returns to the producers. To meet draught challenge, Renovation of Infrastructure such as ponds and tanks developments is required.

5.2 Key Issues

Though endowed with good soil, adequate rainfall, and good ground water availability Bihar has not yet realized its full agricultural potential. Its agricultural productivity is one of the lowest in the country, leading to rural poverty, low nutrition, and migration of labour. Vagaries of rainfall influence agriculture productions; recurrent floods and droughts severely affect the outputs. Weak agriculture extension systems have led to poor transfer and adoption of modern efficient technologies.

Problems of flood and drought severely affect the agricultural income on an annual basis, and intra-state disparities are significant in many sub-sectors. Beginning with 2005-06, the achievement level of total credit targets has been around 80% till 2009-10. The achievement level came down to around 70 % 2010-11. The estimated green fodder production from forests, permanent pastures, grazing lands and cultivated areas has declined from 13.77 lakh tonnes in 2000-2001 to 13.46 lakh tonnes in 2002-03.

Dry fodder production (crop residue of cereals, pulses and oil seeds) over the same period declined from 195.23 lakh tonnes to 156.12 lakh tones. The area under pastures and grazing lands is extremely scarce (0.18 percent of the total geographic area). Gaya has the maximum area under pastures and grazing lands at 2192 ha. Of all rural households owning

cattle and/or buffalo in Bihar, more than three-quarters are either landless or have less than 1 hectare of land. Sheep and goats tend to be even more concentrated among landless and marginal rural households.

5.3 Priorities

Bihar's priorities have been identified in the State Agriculture Roadmap, which aims to trigger processes of development in agriculture and allied sector. Given the substantial yield gaps of most agricultural commodities on the one hand and low farmers' income and widespread rural poverty on the other, and also taking into account the richness of natural resources and high level of peoples' aspirations, a gradual approach for liberating the people of Bihar from twin traps of hunger and poverty will neither be economically sound not socially expedient. The proposed road map of agriculture, with defined goals and time frame gives a humanitarian dimension to agriculture apart from addressing the important question of food security.

The State's agriculture development in the 12th Five Year Plan will emphasize on:

(i) Broad based agriculture growth – benefits of raising productions and productivity will be ensured to diverse crops, i.e., food grains (rice, wheat, durum wheat, maize, Madua), pulses, oilseeds, horticulture crops, cash crops like sugarcane, Jute, Paan and others through specific strategies;

   a. Making agriculture gainful and raising incomes of farmers; stress will be on:
   b. Removing constraints in procurement and market linkages;
   c. Promoting cost effectiveness, reducing insecurities and expansion of processing capacities;

(ii) Encouraging sustainable agriculture development in the state by reducing fluctuations and uncertainty in productions due to floods, droughts and water logging, and by promotion of environment friendly techniques like organic farming, improvement of soil health, reuse of wastes and by- products;

(iii) Rapid expansion in supply of inputs (seeds, mechanization, fertilizers, credit and others) and quality assurance will play a major role. Impetus to agriculture credit will be a major thrust area to meet essential requirements of farmers;

(iv) Substantial augmentation of warehousing and storage facility will be carried out for agriculture growth and food security. Marketing of agriculture produces will be promoted through involvement of multiple agencies and innovations in institutional structures. Rapid expansion in infrastructure will be ensured through increased investments;

(v) Triggering rapid growth in traditional agriculture systems will require institutional changes and realignments. Vastly expanded, strengthened, and modernized extension network would ensure benefits of broad based development to farmers of the entire state. To realize the goals the agriculture development plan must accompany establishment of strong information/data base systems and growth of education and research;

For Animal Husbandry and Dairy, the major thrust points will be the following:

(i) Production and productivity will be raised through improved breed management. Impetus will be given to augmentation of processing facilities (milk and milk products);

(ii) Rapid expansion of extension network up to the Panchayat level will be carried out. Government aims to act as facilitator for livestock entrepreneurship development in rural areas. Development plan will involve strengthening of veterinary and dairy services network; and

(iii) Establishment and strengthening of institutions for human resource development and promotion of education, training, and research will play a major role in the growth of the sector.

Development and management of fisheries will aim for a major jump in fish production and productivity by the end of the 12th FYP. The major thrust will be as follows:

(i) Infrastructure facilities will be expanded for availability of quality inputs. Institutional strengthening will be carried out for improved extension services, training and skill development and infusing professional management practices.

5.4 Perceived Climate Impacts[13]

The spatial and temporal distribution of Indian Summer Monsoon Rainfall (ISMR) during June-September is largely affect agricultural yields. The departure in minimum and maximum temperatures from average values influences plant physiological conditions viz., respiration, water requirement, and growth, thereby affecting yields. Extreme weather conditions such as floods, droughts, heat and cold waves, flash floods, cyclones, hail storms, etc. are constant hazards for agricultural production. Potential risks to the agricultural system from changing climatic conditions can be identified at multiple levels.

[13] Adapted from the National Mission for Sustainable Agriculture: Strategies for Meeting the Challenges of Climate Change. Department of Agriculture and Cooperation, Ministry Of Agriculture, New Delhi, August 2010.

Climatic variability directly impacts yields at crop level and also affects soil quality; water resources; brings in pests, diseases and weeds, etc. further aggravating the impact on the cropping system, thereby reducing the yield per hectare of land or per unit of livestock at the farm level. The adverse impact of climatic variability on agriculture production at farm level gets aggregated to the level of the food system in terms of food shortages and rising prices, which can also endanger food and livelihood security.

At the crop level, in the short term, increase in carbon dioxide (CO_2) concentration is likely to compensate the negative effect on yields due to increase in temperature, but as temperature increases further, it would result in yield losses. Most crop simulation studies have predicted a decrease in the yield of crops with an increase in temperature. Further, adverse temperature and moisture conditions affect the quality of food grains.

Climate change may have significant effect on the quality of plantation and cash crops such as fruits, vegetables, tea, coffee, aromatic & medicinal plants, etc. Change in climate is likely to bring about a change in the population dynamics, growth and distribution of insects and pests thereby, upsetting crop-pest balance. Drought conditions would increase pathogen and insect survival rate due to change in plant nutrient level and decrease in plant defence system. These changes could lead to enormous crop losses in altered environment.

An increase in temperature also leads to increased evapotranspiration, thereby lowering groundwater table and adversely affecting irrigation potential. At some places, increased surface temperature coupled with reduced rainfall may lead to accumulation of salts in upper soil layers.

Impacts of climate change on livestock will be felt in the form of elevated body temperatures, increased respiration rates, decrease in feed intake, etc. Indirect impacts will be observed in the form of reduction in grazing land and water availability, decline in available cattle feed, emergence of new diseases, etc.

Thermal or heat stress would impact animal production and profitability in dairying due to lower feed intake, milk production, and reproduction. Severe drought conditions are likely to affect livestock due to decline in feed and fodder availability and serious water shortages. The impact of climate change induced decline in pastoral land would further aggravate the severe constraints on livestock farming.

It has already been observed that the breeding of Indian major carps as well as the distribution of important fish species and plankton has been affected due to changes in temperature and rainfall patterns over the catchments of the Ganga.

5.4.1 Wheat, Rice, Maize

Production of crop is greatly influenced by weather phenomena and therefore any change in climate will have major effect on crop yield and productivity. The temperature, air movement, solar radiation, humidity and soil moisture are major climatic factors influencing the crop phenology. The projected increase in temperature is less in Kharif season that that of in the Rabi.

In Bihar, under scenarios of increase in atmospheric CO_2 concentration, the climate change impact on wheat and winter maize shows that simulated yield of wheat is possible to decrease in 2050s and 2080s by 3.6% and 14.1% respectively, for Pusa. At Madhepura, decline in yield is possible by 5%, 13% and 21% for during 2020s, 2050s and 2080s respectively. Patna and Sabour shows decrease in simulated yield around 40% for 2080s. Crop duration shows maximum decline at Madhepura by 26 days. Number of grains increased marginally for Pusa and Patna during 2020s; otherwise a decrease is noticed for other time periods from the baseline. The agroclimatic zones I and II showed lesser decline in the number of grains and more or less constant weight of grains than zone III. However, zone III shows decrease in both number and weight of grains during different time-periods, thus indicating suitability of North Bihar (zones I and II) for wheat cultivation. Simulated yield of winter maize showed an increase in the range of 8.4–18.2%, 14.1–25.4% and 23.6–76.7% during 2020s, 2050s and 2080s respectively.

Maximum increase is observed in Sabour for all the three time-periods Maize with increased CO_2 and consequent rise in temperature shows a decrease in duration and days from the baseline. TDM, grain weight and grain number shows an increase from the baseline to 2080s. The decrease in duration is probably well compensated by increased growth rate with better temperature regimes resulting in increased number of grains and grain weight leading to overall increase in biomass. Increase in grain number and TDM is an indicator of increased net photosynthesis, as the net rate of photosynthesis is more in full sunlight and also photo-respiratory losses are almost negligible in case of C4 plants compared to C3 plants (Abdul Haris et. al. 2012).

Table 9: Simulated impact of climate change on growth parameters of wheat

	Duration (days)	Maximum CGR (kg/ha/day)	Maximum LAI (kg/ha/day)	TDM (kg/ha)	No. of grains/ha	Weight of grains (g/1000 grains)
PUSA						
Baseline	123	257	3.66	13,796	114,699,833	37.306
2020s	117	249	3.54	13,197	116,578,283	37.471
2050s	108	246	3.34	12,106	107,897,132	37.7
2080s	100	273	3.05	11,238	96,575,358	37.7
MADHEPURA						
Baseline	111	284	3.58	13,510	136,776,467	35
2020s	100	293	3.49	12,394	120,584,333	38
2050s	91	290	3.39	11,178	107,761,030	38
2080s	85	272	3.16	10,455	98,064,733	38
PATNA						
Baseline	97	134	2.88	5,399	37,508,229	36
2020s	92	130	2.93	5,186	42,182,533	38
2050s	87	128	2.71	4,526	37,961,153	34
2080s	79	122	2.26	3,893	29,137,213	30
SABOUR						
Baseline	107	229	3.41	10,883	108,409,826	33
2020s	100	209	3.30	9,742	92,359,979	34.6
2050s	92	197	3.08	8,570	84,163,695	31.2
2080s	86	188	2.83	7,642	71,424,974	29.8

Based on the Tmax, Tmin, drought and flood severity, available water capacity, population density, average yield, net shown area, cropping intensity, percentage area irrigated, livestock density and many others, a vulnerability index map is prepared which shows Kishanganj of Bihar is most vulnerable with vulnerability index of 4.687.

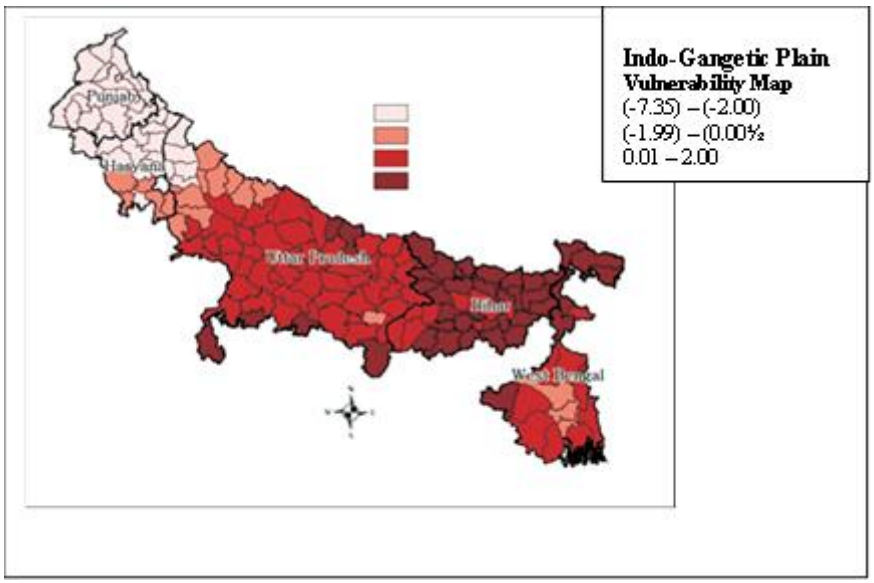


Figure 7: Indo-Gangetic Plain Vulnerability Map

Based on the modelling study, it is found that wheat yield may decrease by 5-6 % in Bihar state due to change in maximum temperature alone by 2080s (Arvind Kumar et al. 2011). It is found Sarjoo-52 Rajshree, MTU-7029, Satyam, Rajendra Mahsuri-I and others are most suitable rice for direct dry seeding of rice with subsequent aerobic soil conditions avoiding water requirement during land preparation and reduces overall water demand

Table 10: Simulated impact of climate change on growth parameters of maize

	Duration (days)	Post-anthesis duration	Maximum CGR (kg/ha/day)	Maximum LAI (kg/ha/day)	TDM (kg/ha)	Grain weight (g/100 grains)	No. of grains (grains/ha)
PUSA							
Baseline	157	26	216	2.58	13,544	114.3	34,108,353
2020s	152	26	223	2.62	13,582	115.6	36,404,873
2050s	143	25	244	2.58	13,475	114.3	38,772,077
2080s	135	26	284	2.52	14,262	122.8	39,685,550
MADHEPURA							
Baseline	159	28	238	2.77	15,555	120.1	39,556,007
2020s	154	27	249	2.80	15,639	121.7	41,386,080
2050s	145	27	291	2.81	15,608	121.2	43,266,460
2080s	135	27	340	2.53	16,392	124.3	44,248,780
PATNA							
Baseline	150	22	351	4.79	16,556	90.8	43,590,337
2020s	146	22	347	4.75	16,785	94.7	45,289,700
2050s	138	22	411	4.65	16,383	93.9	46,697,863
2080s	128	23	524	4.54	17,365	100.2	49,212,777
SABOUR							
Baseline	150	21	195	2.56	11,468	82.34	29,869,011
2020s	145	21	201	2.66	11,720	84.63	31,253,789
2050s	137	22	237	265	11,604	86.25	35,699,926
2080s	130	23	246	2.56	12,597	101.5	37,796,805

5.4.2 Livestock and animal husbandry

Bihar is rich in livestock resources. The total livestock in the state has decreased from 53.742 million to 42.990 million between 1997 and 2003 showing a decrease of 20%. Impacts of climate change on livestock will be felt in the form of elevated body temperatures, increased respiration rates, decrease in feed intake, etc. Indirect impacts will be observed in the form of reduction in grazing land and water availability, decline in available cattle feed, emergence of new diseases, etc.

Thermal or heat stress would impact animal production and profitability in dairying due to lower feed intake, milk production, and reproduction. Besides being susceptible to increased heat stress from climate change, livestock is also exposed to the risks associated with extreme events. Severe drought conditions are likely to affect livestock due to decline in feed and fodder availability and serious water shortages.

The impact of climate change induced decline in pastoral land would further aggravate the severe constraints on livestock farming. A rise of 2-6 °C due to global warming (time slices 2040-2069 and 2070-2099) projected to negatively impact growth, puberty and maturity of crossbreds and buffaloes and time to attain puberty of crossbreds and buffaloes will increase by one to two weeks due to their higher sensitivity to temperature than indigenous cattle.

5.4.3 Fisheries and aquaculture

Bihar is blessed with vast and varied fisheries and aquaculture resources. However, despite such natural resources and fish as highly preferred food item, aquaculture and open water fisheries resource remain highly underutilized. The major schemes taken up include production and supply of fish seed, development of Maun/Chaur besides centrally sponsored schemes for development of aquaculture and welfare of fishers.

The total fish production in the state is about 2.66 lakh tones with average productivity of about 2.2 tonnes per ha per annum. It contributes about 1.6 % of Bihar GDP.

Changes in the climate would also affect the fisheries sector in many ways. Climate change would also indirectly affect aquatic habitats (quantity and quality), ecosystem productivity, distribution and abundance of aquatic competitors and predators/disease thereby affecting the livelihood and food security of fishing communities. It has already been observed that the distribution of important fish species and plankton has been affected due to changes in temperature and rainfall patterns over the catchments of the Ganga.

The fishes cannot maintain a constant body temperature like mammals and their body maintain the same temperature where they are living in. Fishes can live in very cold or very hot water and prefer to stay in the preferred range of temperature. In very cold water, their metabolism slows down and they become lethargic. In other side, if the surrounding water is relatively warm, their metabolism speeds up and they digest food more rapidly, grow more quickly, and eventually have more energy for reproduction. At the same time, fishes need more food and more oxygen to support this higher metabolism.

The changing pattern of rainfall and temperature will have direct implications on natural stock of fish populations as well as will have direct implication to livelihood option of fisher folk. The Gangetic River system (Uttar Pradesh, Bihar and West Bengal) contains about 265 species of freshwater fish. The water problems due to climate change in the Ganga River basin will increase and may be critical in terms of the ecosystem goods and services derived from the inland water bodies via fisheries. The breeding period of majority of fishes of the Ganga River system is June-August due to their dependency on seasonal floods.

The monthly data of rainfall from the middle stretch of the river at Allahabad from 1979–2009 revealed that the percentage of total rainfall in the peak breeding period (May–August) declined by 7% whereas it increased by 4% in the post- breeding period when resorption of eggs of IMC sets in (M. K. Das et al., 2014)

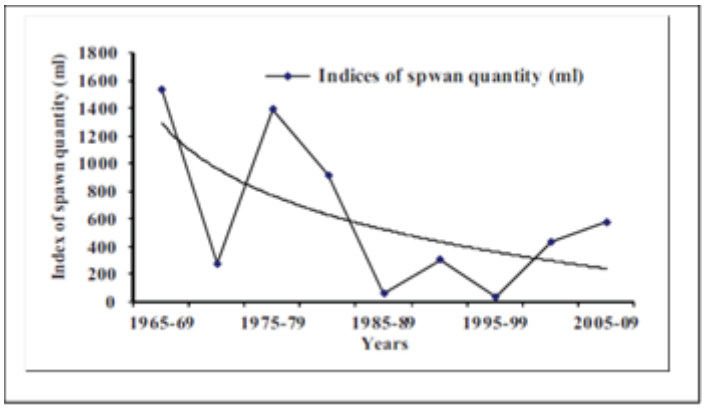


Figure 8: Indices of spawn quality in middle stretch of the River Ganga from 1965-2009

5.4.4 Dairy

The Present milk production of the state is 6516 thousand MT per year. It has been targeted to take this production level up to 10035 Thousand MT per year by 2017 and to 14867 Thousand MT per year by 2022. However, milk productivity level in the State is still very low. Global warming is likely to lead to a loss of 1.6 million tonnes in milk production by 2020 and 15 million tons by 2050 in business as usual scenario.

Based on temperature-humidity index (THI), the estimated annual loss in milk production at the all-India level by 2020 is valued at about Rs. 2661 crores at current prices. The economic losses may be highest in UP followed by Tamil Nadu, Rajasthan and West Bengal. Stressful THI with 20th or more daily THI-hrs (THI >84) for several weeks affects animal responses.

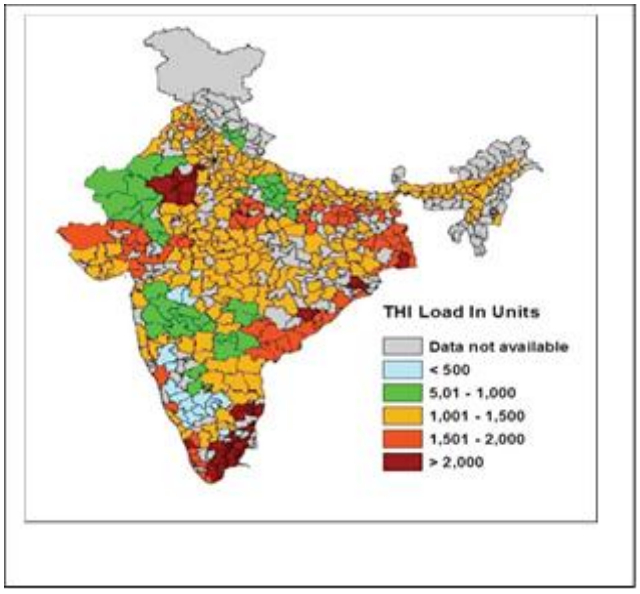


Figure 9: Annual THI load on livestock

The economic losses may be significant in Bihar producing crossbred cows and buffaloes will be affected more by climate change. Under climate change scenario, increased number of stressful days with a change in temperatures and probable decline in availability of water may further impact animal productivity and health.

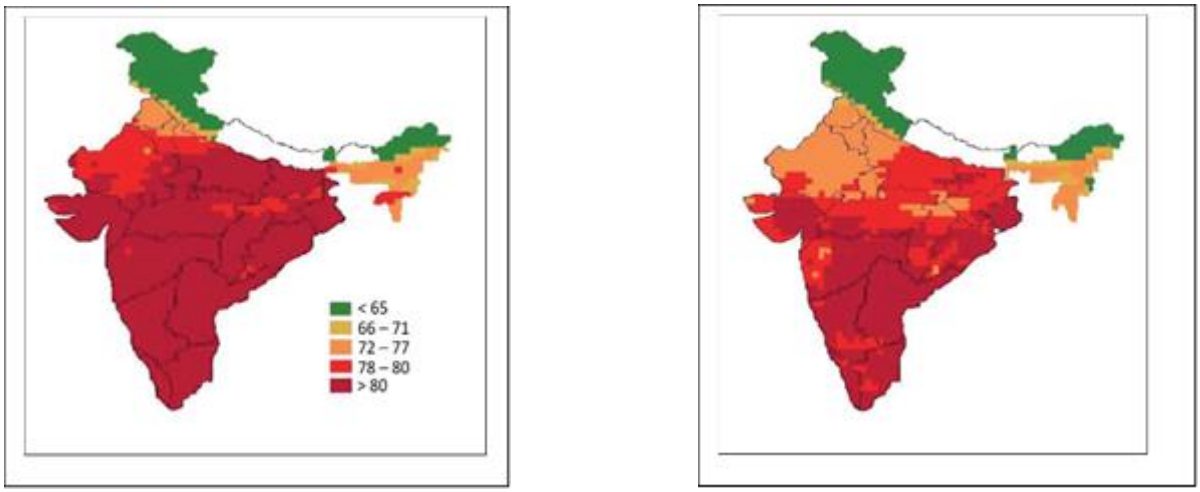


Figure 10: THI load in baseline (left) and in 2030s scenario (right) during March

5.4.5 Horticulture

Fruits, vegetables, spices, honey, medicinal and aromatic plants occupy 15% of land area but income generated from horticulture is much higher in Bihar. The state has a monopoly in production of litchi and makhana and continues to grow various fruits, vegetables, spices. Floriculture is getting more importance in the state. The agro-climatic conditions are eminently suitable for whole range of vegetables; a variety of roots and tubers crops; perennial fruit crops like mango, litchi, guava, and limes; annual fruit crops like banana,

pineapple and papaya and spices like ginger, turmeric and chilly, of late, floriculture is also showing excellent prospects. The state thus has possibilities for growing a diversified basket of vegetables, fruits, spices, tubers and flowers and medicinal and aromatic plants.

Fruits

Major fruits grown in the state are Mango, Litchi, Guava, Pineapple, Citrus, Banana, Papaya and Ber. Mango is grown all over the state, main growing areas are Muzaffarpur, Vaishali, Bhagalpur, Darbhanga, Madhubani, Sitamarhi, Patna and West Champaran. Litchi is mainly grown in Muzaffarpur, Vaishali, Sitamarhi, East and West Champaran and Darbhanga of North Bihar region. Pineapple is grown in north- eastern part of the state particularly in Kishanganj, Purnea, Araria, Katihar and Saharsa districts.

Vegetables

Bihar ranks 3rd in vegetable production in the country and produces a variety of traditional and non-traditional vegetables. Climatic and soil conditions of the state are congenial for production of different types of vegetables in the state. However, it lacks the basic infrastructure for storage, packaging, transportation, organized marketing system and post harvest handling facilities. Seed is the most important input which influences the output of vegetables crops. Vegetable production programme could be strengthened only if its seed production programme is strengthened. Thus, seed production programme should be strengthened to give a boost to vegetable production.

In future climate scenarios warming may ease the chilling conditions in these regions to favour potato productivity, while in other regions with cooler winter season the warming from current levels may prove detrimental. Based on INFOCROP-POTATO model (Singh et.al. 2005), It is found that potato production in 2020s and 2050s, will be decrease by 3% and 11% over Bihar.

Spices

A variety of spices are produced in Bihar. At present Bihar produces about 20 thousand tonnes of spices annually from an area of nearly 15,081 ha. The important spices are Ginger, Turmeric, Chilly, Coriander, and Garlic. Chilli accounts for 47.6 percent of the area under spices and 39.5 per cent of the production followed by turmeric, which occupies 26.3 per cent of the area under spices and accounts for 36.4 per cent of the production in the state.

5.5 Strategies

The State has already developed a comprehensive Road Map covering agriculture and its allied sectors. State will undertake the several measures that will be complementary to Agriculture Road Map and are specifically designed to enhance resilience. These will indicatively include (but not be restricted to):

1. Building institutional linkages with Indian Council on Agricultural Research (ICAR) and its participating organisations including Central Research Institute for Dry land Agriculture (CRIDA), Indian Agricultural Research Institute (IARI), Indian Institute of Horticultural Research (IIHR), Central Institute of Agricultural Engineering (CIAE), National Dairy Research Institute (NDRI), Central Marine Fisheries Research Institute (CMFRI), Central University of Bihar (CUB) and other collaborating centres for technical advice, capacity building, and research support including State and sector specific vulnerability analyses
2. Developing strategic plans at the agro-climatic zone level so that action plans are contextualized to regional scales in the areas of research and development, technology and practices, infrastructure and capacity building;
3. Collating, disseminating and follow best management practices including those for conserving resources and increase input use efficiency, bridging the yield gaps, and through customized interventions such as use of bio-technology to develop improved and diversified varieties of crops (including flood and drought tolerant varieties) and livestock, promoting efficient irrigation systems, demonstration of appropriate technology, capacity building and skill development;
4. Facilitating access to information and institutional support by expanding Automatic Weather Stations (AWS) networks to the Panchayat level and linking them to existing insurance mechanisms including Weather Based Crop Insurance Scheme (WBCIS) and National Agriculture Insurance Scheme (NAIS), scaling the returns at that level;
5. Implementing measures to minimize soil and water losses through resource conservation technologies such as agroforestry, integrated watershed management and water harvesting through check dams, renovation of existing ponds, etc. and building new ones;
6. Improving irrigation efficiency including developing processes for adopting/ promoting improved energy pricing and water pump efficiency;
7. Promoting adoption of solar and wind power systems for irrigation and other uses;
8. Strengthening weather services and early warning systems through enhanced agro-met systems;
9. Integrated nutrient and pest management and promotion of conservation agriculture; and
10. Capacity building of stakeholders by synergizing traditional knowledge, agricultural heritage and modern technology and research.

11. Promote capacity building and Human Resource Development at production and marketing level.
12. Promote R&D technologies for conservation, production, processing and marketing.
13. Enhance productivity through — adequate input supply (i.e. seed), resource renovation & enhancement, intensification, diversification of aquatic crops.
14. Adopt coordinated approach and promotion of public private partnership (PPP)
15. Generate computerize data base regarding resource availability, existing production, potential production, demand of fish as well as mitigate socio-economic problems of fisher folk.
16. Capacity building of Fishermen/Fisherwomen/Officers

Specific and additional emphasis will also be placed on the role of women in agriculture and its allied sectors – which is high in the State and likely to be most adversely affected by the impacts of climate change. In these contexts, responsibility for adaptation is likely to fall on their shoulders – including finding alternative ways to feed their family.

However, statutory and/or customary laws often restrict women's property and land rights and make it difficult for them to access credit and agricultural extension services, while also reducing their incentive to engage in environmentally sustainable farming practices and make long-term investments in land rehabilitation and soil quality. Despite these obstacles, recent evidence demonstrates that women who are already experiencing the effects of weather-related hazards –such as erratic monsoon patterns, flooding and extended periods of drought – are developing effective coping strategies, which include adapting their farming practices. Therefore, efforts will be made to further recognize and support women's role in adaptation, including promoting women's involvement in decision-making processes and implementation. Also, given women's key role in agriculture, efforts will be especially made so that gender disaggregated data becomes available to enable gender specific planning and interventions.

5.6 Institutional Linkages and Stakeholders

A range of institutional linkages, convergence potential, and partnerships is envisaged under the BAPCC[14]. While these have largely been identified in the State Agriculture Roadmap, these will indicatively include State institutions such as the National Food Security Mission, Bihar; Bihar Rajya Beej Nigam Limited; Bihar Agricultural Management & Extension Training Institute (BAMETI); Bihar State Seed Certification Agency (BSSCA); the Bihar State

[14] This is not meant to be an exhaustive list; rather, it gives some examples of possible linkages under the BAPCC.

Horticultural Mission; Animal & Fisheries Resources Department (and related institutions); State Water resources Department; State Directorate of Rice Development; State Energy Department; BREDA; State Forest Department; State Food and Consumer Protection Department, etc. Additional linkages with be built with National and State agricultural research institutes/centres and universities such as Central University of Bihar (CUB); Bihar Watershed Development Society; various international development agencies, private sector and financial institutions, civil society, community based organisations, and agriculture and allied sector dependant communities in general, are the primary stakeholders.

5.7 Linkages with the NAPCC

While the strategies outlined in the State Agricultural Roadmap and herein are consistent with the sectoral imperatives of the NAPCC and the National Mission For Sustainable Agriculture under it, the State will also take specific care to ensure that specific action plans developed under the BAPCC are also consistent with the same. The strategies under the agriculture and allied sectors under the BAPCC also additionally have linkages with the National Mission on Water, National Mission for a Green India, National Mission for Enhanced Energy Efficiency, National Solar Mission, and the National Mission on Strategic Knowledge on Climate.

5.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

6 Forests and Biodiversity

6.1 Overview, Characteristics and Status[15]

6.1.1 Ecology of Bihar

Bihar has diverse landforms ranging from plains of Ganga and other rivers to high elevation forests in the Shivalik range covering West Champaran, while Vindhyan range in the southern districts adjoining Jharkhand. The state can be divided into three zones based on the geological and climatic variation, namely Eastern Himalayan region, Middle Gangetic plain and South Eastern plateau and hill region. The north western and southern parts of the state are the mountainous regions.

The region is biologically very rich harbouring large number of economically important and medicinal plants, which are unique to the region. Further the seasonal variations in the form of dry and moist months influence the phenological types representing high degree of biological diversity. Bihar is divided into two major ecoregions, namely North Bihar and South Bihar; the brief salient features of these regions are as follows.

North Bihar: North Bihar region is the northern most section of the state and is mostly covered by the Shivalik ranges. This region lies in the foothills of central Himalayas and on the north of Gangetic plain. River Gandak and Masan are the perennial rivers cutting the topography. These rivers along with their tributaries bring in the water and soil in lower part of the region.

Due to constant erosion and depositional rhythm along the course, the river Gandak changes its path and some of the abandoned portion in the region has given a way for unique system of water logged areas consist of ecologically important swamp forest, swamp grassland and ox-bow lakes. These areas have given refuge to few of the important species such as Indian One horn Rhino, Royal Bengal Tiger, Great Pied Hornbill, Sarus Crane, etc. The forests in the region are restricted to the hilly tracts of the Shivaliks and lower Himalayas.

Table 11: Rainfall, climate, soil group, altitude, and zones in North Bihar

Rainfall (mm)	Climate	Soil group	Zone	Altitude
1461-2035 mm	Damp, humid and moist 8°C-36°C	Piedmont Swamp Soil, Terai Soil and alluvial plains	Shivalik ranges and Terai belt	125-880 m

South Bihar: South Bihar region is the southernmost section of the state, which lies south to the Gangetic plain in the eastern part of Vindhyan range. This region is represented by

[15] All statistical data in this section are sourced from the Forest Survey of India Report 2011.

unique ecological systems. River 'Sone' is most important to this region. The forests in the region are restricted to the hilly tracts of the Kaimur hills, Rajgir hills, and Kharagpur hills.

The region also consists of some of the important conservation zones and Wild Life Sanctuaries like Bhimbandh Wildlife Sanctuary, Gautam Buddha Wildlife Sanctuary, Kaimur Wildlife Sanctuary, Nagi Dam Wildlife Sanctuary, Nakti Dam Wildlife Sanctuary and Pant Wildlife Sanctuary, Rajgir. The rainfall, climate, soil group, zone, altitude are given in the Table 12.

Table 12: Rainfall, climate, soil group, altitude, and zones in South Bihar

Rainfall (mm)	Climate	Soil group	Zone	Altitude
1000-1100 mm	Hot and dry with Average Temperature 40^{o}C	Gangetic Alluvium, sandy loam	Gangetic plain and Eastern Vindhyan range	300-500 m

6.1.2 General Description of Vegetation of Bihar

Vegetation of the state is classified under climatic, serial and edaphic types. The climatic forest types are broadly classified into dry deciduous and moist deciduous types. Besides the deciduous forest, the vegetation types also include Sal, gregarious forests, bamboo forests, canebrakes, and grasslands, covering relatively less area.

Sal mixed dry deciduous forests (northern dry mixed deciduous forests) occupy major proportion under natural vegetation cover and predominantly found in Kaimur, Rohtas, Aurangabad, Gaya, Nalanda, Nawada, Jamui, Banka and Munger districts.

Dry deciduous forests are found in both, the plains and the peninsular region in the southern districts. Sal mixed moist deciduous forests (northern moist Sal bearing forest) are distributed mainly in West Champaran and partly in the valleys of Kaimur, Rohtas, Aurangabad, Gaya, Nalanda, Nawada, Jamui, Banka and Munger.

Dry Siwalik Sal forests are mainly distributed in the Shivaliks range in the West Champaran district. Moist mixed deciduous forests (West Gangetic moist mixed deciduous forest) occur mostly in West Champaran district, also in the valleys in the valleys of south Bihar hills. Canebrakes (tropical seasonal swamp forests) are predominantly found in the West Champaran district.

Table 13: Dominant tree/plant species

Forest Type	Dominant Species
Moist deciduous	Shorea robusta Gaertn.f; Mallotus philippensis (Lam.) Muell. -Arg.; Terminalia elliptica Willd; Syzygium cumini (L.) Skeels; Haldina cordifolia (Roxb.) Ridsd; Buchanania lanzan Sprengs; Lannea coromandelica (Houtt.) Merrill; Acacia catechu (L.f.) Wild; Terminalia bellirica (Gaertn.) Roxb; and Litsea monopetala (Roxb.) Pers.
Dry Siwalik Sal	Shorea robusta Gaertn. f.; Terminalia crenulata Roth; Litsea monopetala (Roxb.) Pers.; Lannea coromandelica (Houtt.) Merrill; Holarrhena antidysenterica (Heyne ex Roth) Wall .ex DC; Lagerstroemia parviflora Roxb; Grewia tillifolia Wahl; Garuga pinnata Roxb; Acacia catechu (L.f.) Willd; and Terminalia bellirica (Gaertn.) Roxb
Sal mixed dry deciduous	Shorea robusta Gaertn.f; Madhuca indica Gmelin; Buchanania latifolia Roxb; Lannea coromandelica (Houtt.) Merrill; Terminalia crenulata Roth; Diospyros melanoxylon Roxb; Aegle marmelos (L.) Corr.; Anogeissus latifolia (Roxb. Ex DC.) Guillemin & Perottet; Acacia catechu (L.f.) Wild; and Lagerstroemia parviflora Roxb.
Sal mixed moist deciduous	Shorea robusta Gaertn. f.; Terminalia crenulata Roth; Lannea coromandelica (Houtt.) Merrill; Syzygium cumini (L.) Skeels; Mallotus philippensis (Lam.) Mull. -Arg.; Litsea monopetala (Roxb.) Pers.; Bambusa arundinacea (Retz.) Wild; Lagerstroemia parviflora Roxb; Un identified-60; and Holarrhena antidysenterica (Heyne ex Roth) Wall .ex DC.
Dry Deciduous	Madhuca indica Gmelin; Lennea coromandelica (Houtt.) Merrill; Diospyros melanoxylon Roxb; Shorea robusta Gaertn. f.; Anogeissus latifolia (Roxb. Ex DC.) Guillemin & Wall. Ex DC; Lagerstroemia parviflora Roxb; Buchanania latifolia Roxb; Holarrhena antidysenterica (Heyne ex Roth) Wall .ex DC; Aegle marmelos (L.) Corr.; and Cassia fistula L.
Tropical seasonal swamp	Syzygium cumini (L.) Skeels; Mallotus philippensis (Lam.) Mull. -Arg.; Trewia nudiflora L.; Ficus hispida L.f.; Drypetes roxburghii (Wall. Hurusawa); Dalbergia sissoo Roxb. Ex DC; Grewia tillifolia Wahl; Lennea coromandelica (Houtt.) Merrill; Streblus asper Lour; and Ficus racemosa L.

The highest number of species in Bihar State has been recorded for dry deciduous forests with 305 species including two parasites, followed by moist deciduous type having 184 species. Whereas the Sal mixed dry deciduous, Sal mixed moist deciduous, Dry Siwalik Sal forest and tropical seasonal swamp forest types have 138, 68, 180 and 80 species, respectively.

6.1.3 Recorded Forest Area, Classification, and Forest Cover

The recorded forest area of the state is 6,473 km^2, which is 6.87% of its geographical area. Reserved Forests constitute 10.70%, Protected Forests 89.28% and Unclassed Forests 0.02 % of the total forest area. The forest cover in the state, based on interpretation of satellite data of November 2008 - January 2009, is 6845 km^2, which is 7.27 % of the state's geographical area. In terms of forest canopy density classes, the state has 231 km^2 very dense forests, 3280 km^2 moderately dense forest, and 3334 km^2 open forest. The forest cover of the state is shown in Figure 11 below.

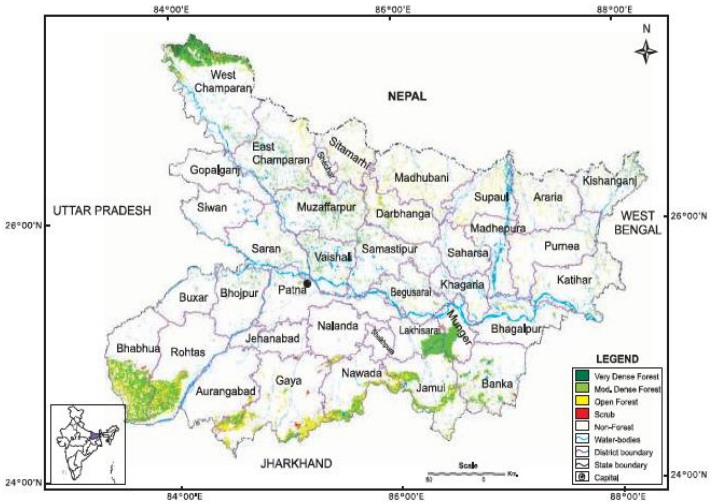


Figure 11: Bihar's forest cover

District-wise forest cover in different canopy density classes along with the changes compared to 2009 assessment and scrub are given in Table 14.

Table 14: District-wise forest cover in the state (km^2)

S.No.	District	Geographical area	Very dense forest	Mod. Dense forest	Open forest	Scrub	Total
1	Araria	2830	0	16	74	0	90
2	Aurangabad	3305	0	54	97	13	164
3	Banka	3022	0	111	110	12	233
4	Begusarai	1918	0	20	23	0	43
5	Bhabhua	3381	0	555	507	20	1082
6	Bhagalpur	2567	0	29	13	0	42
7	Bhoipur	2390	0	16	3	0	19
8	Buxar	1708	0	2	1	0	3
9	Darbhanga	2279	0	41	144	0	185
10	Gaya	4976	0	124	506	46	676
11	Gopalganj	2033	0	2	2	0	4
12	Jamui	3107	0	383	249	2	634
13	Jahanabad (including Arwal district)	1569	0	2	1	5	8
14	Katihar	3057	0	18	44	0	62
15	Khagaria	1486	0	2	6	0	8
16	Kishanganj	1884	0	26	49	0	75
17	Lakhisarai	1356	0	180	14	2	196
18	Madhepura	1788	0	6	20	0	26
19	Madhubani	3501	0	18	118	0	136
20	Munger	1347	0	251	14	7	272
21	Muzaffarpur	3172	0	82	74	0	156
22	Nalanda	2367	0	5	23	6	34

S.No.	District	Geographical area	Very dense forest	Mod. Dense forest	Open forest	Scrub	Total
23	Nawada	2494	0	187	323	10	520
24	Pashchimi Champaran	5228	231	520	162	0	913
25	Patna	3202	0	13	3	0	16
26	Purbi Champaran	3968	0	76	88	0	164
27	Purnea	3229	0	6	41	0	47
28	Rohtas	3832	0	321	385	11	717
29	Saharsa	1680	0	2	9	0	11
30	Samastipur	2904	0	39	18	0	57
31	Saran	2641	0	38	17	0	55
32	Sheikhpura	612	0	0	0	0	0
33	Seohar	572	0	2	17	0	19
34	Sitamarhi	2071	0	18	64	0	82
35	Siwan	2219	0	1	1	0	2
36	Supaul	2432	0	8	93	0	101
37	Vaishali	2036	0	74	12	0	86
Total		**94163**	**231**	**3248**	**3325**	**134**	**6938**

Table 15: Forest cover change matrix (area in Km^2)

2009 Assessment	2011 Assessment					Total 2009
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	231	0	0	0	0	231
Moderately Dense Forest	0	3,239	5	0	4	3,248
Open Forest	0	6	3,312	4	3	3,325
Scrub	0	2	2	130	0	134
Non-Forest	0	33	15	0	87,177	87,225
Total 2011	**231**	**3,280**	**3,334**	**134**	**87,184**	**94,163**
Net Change	**0**	**32**	**9**	**0**	**-41**	

The change matrix given in Table 15 reveals that there has been no change in very dense forest whereas there is an increase of 32 km^2 in the moderately dense forest and nine km^2 in open forest. Forest type groups are given in Figure 12.

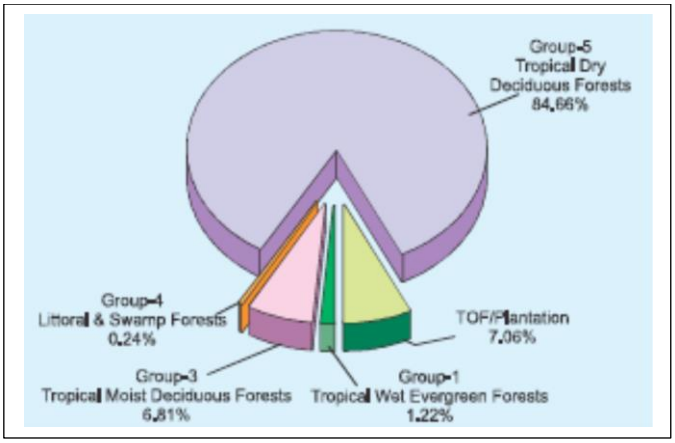


Figure 12: Forest type groups

The forest and tree cover of the state is presented in Table 16.

Table 16: Forest and tree cover

Category	Area	% of Geographical Area
Tree Cover	2,369	2.52
Forest Cover	6,845	7.27
Forest & Tree Cover	9,214	9.79

The growing stock in the recorded forest area has been estimated on the basis of the current forest cover map, forest type map and forest inventory data. For TOF, the same has been estimated using TOF inventory data. It is presented in the Table 17 below.

Table 17: Growing Stock (million cum)

Forest	TOF	Total
35.186	47.195	82.381

The extent of bamboo bearing area in the forests of the state is 739 km2. Density-wise details, number of culms by soundness and equivalent green weight are given in following table.

Table 18: Bamboo bearing area by density in recorded forest area (Area in km2)

Recorded Forest Area	Pure Bamboo	Dense bamboo	Scattered bamboo	Clumps hacked	Bamboo regeneration	No bamboo
6,473	1	239	393	75	31	5,734

6.1.4 Protected Areas

Table 19: Protected areas in Bihar

S.No.	Name	District	Legal Status	Date of Notification	Area (in km^2)
1	Valmiki National Park	W. Champaran	N.P.	2.8.89	335.6
2	Valmiki Vanya Prani Sanctuary	W. Champaran	S	4.5.76	880.78
3	Bhimbandh Sanctuary	Monger	S	27.5.76	681.99

S.No.	Name	District	Legal Status	Date of Notification	Area (in km^2)
4	Pant Vany Prani Sanctuary	Nalanda	S	20.5.78	36.84
5	Kaimur Sanctuary	Rohtas	S	25.7.79	1342
6	Gautam Budha Bird Sanctuary	Gaya	S	14.9.71	259.5
7	Udaypur Vany Prani Sanctuary	W. Champaran	S	29.4.78	8.87
8	Nagi Dam Bird Sanctuary	Jamui	S	14.7.87	7.91
9	Nakti Dam Bird Sanctuary	Jamui	S	15.7.87	3.32
10	Vikaramshila Gangetic Dolphin Sanctuary	Bhagalpur	S	28.8.90	0.5 Km in length
11	Kanwar Jheel Bird Sanctuary	Begusarai	S	20.6.89	63.11
12	Baraila Jheel Salim ali Jhbba Sahni Bird Sanctuary	Vaishali			
13	Kusheshwar Sthan Bird Sanctuary	Darbhanga			

6.1.5 Salient Features of Bihar's Forests

The hill ranges at Rhotas, Kaimur, and Bhabhua have good quality Sal gregarious forest, whereas the deep valleys provide habitat for dense moist deciduous forests. The forest along the periphery of the hill range are mostly open to degradation due to constant and anthropogenic pressure, however, the hill tops are relatively in better condition in the places with steep slope and rocky terrain. The forests in Gaya, Aurangabad, and Nawada owing to their small areas are most into poor state of tree density. The Sal mixed dry deciduous forest range at Munger-Lakhisarai-Jamui is one such forest which is in better condition for both diversity and density, comprising of well grown trees mainly of Shorea robusta and Terminalia elliptica. The ground vegetation is also quite diverse.

In North Champaran the high Shivaliks range provides a good habitat for the wide range of flora and fauna. The old bamboo plantation in the Govardhana range is very well established and provides ideal habitat for the Tiger in the region. The loss of forest every year due to change in the path of river Gandak is considered as one of the most crucial threats to the forest in the region. This change in the path has been attributed to the manoeuvring to the banks of river Gandak along the Indo-Nepal border.

6.1.6 Wetlands

Area estimates of various wetland categories for Bihar have been published in the National Wetlands Atlas of India, Bihar Section, by the Space Applications Centre, Indian Space Research Organisation. Total wetland area estimated is 403209 ha that is around 4.4% of the geographic area. The major wetland types are river/stream accounting for about 74% of the wetlands (298408 ha), natural waterlogged (34878 ha) lakes/ponds (20281 ha), and ox-bow lakes/cut-off meanders (16172 ha). However, the small wetlands (< 2.5 ha) accounts for about 4.5% assuming that each is of one ha. There is a significant reduction in the extent

of open water (about 34%) from post-monsoon (224655 ha) to pre-monsoon (148382 ha). It is reflected in all the wetland types except reservoir/barrage (Table 21).

Table 20: Area estimates of wetlands in Bihar

S.No.	Wetland Category	Number of Wetlands	Total Wetland area	% of wetland area	Open Water	
					Post-monsoon area	Pre-monsoon area
Inland Wetlands - Natural						
1	Lakes/Ponds	514	20281	5.03	11506	6345
2	Ox-bow lakes/ Cut-off meanders	989	16172	4.01	10130	5264
3	High altitude wetlands	-	-	-	-	-
4	Riverine wetlands	200	2118	0.53	1664	777
5	Waterlogged	1300	34878	8.65	21185	9507
6	River/Stream	238	298408	74.01	168984	118481
Inland Wetlands - Man-made						
7	Reservoirs/Barrages	90	8612	2.14	7587	6005
8	Tanks/Ponds	1067	4822	1.20	3363	1870
9	Waterlogged	18	336	0.08	236	133
10	Salt pans	-	-	-	-	-
	Sub-Total	4416	385627	95.64	224655	148382
	Wetlands (<2.25 ha)	17582	17582	4.36	-	-
	Total	**21998**	**403209**	**100.00**	**224655**	**148382**

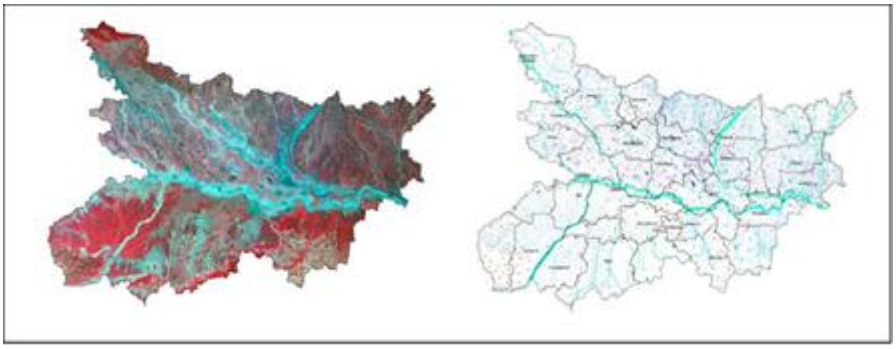


Figure 13: Wetlands areas of Bihar

6.2 Key Issues

The key threats to forests in Bihar include extreme poverty and overdependence of local population on depleted forest resources, uncontrolled livestock grazing, and recurrent droughts in South Bihar, and floods (and water logging) in North Bihar districts. Many of Bihar's wetland areas too are in urgent need of conservation and protection, as these are

important habit areas for a range of species, especially avifauna. All aquatic plants are good sources of organic fertilizer hence they will be well utilized as such in and around wetland.

6.3 Priorities

Considering the limited forest resources in the State and the threats to these, there are several key priority areas. Proposed initiatives during the 12th FYP period are briefly outlined below:

- It is proposed to increase tree cover in the state by plantation in non-forestlands. A robust social forestry program is being proposed to encourage farmers to plant trees on their lands. A pilot project for introducing Poplar in Vaishali district has yielded encouraging results and it will be replicated in 24 other districts of the state at an estimated cost of 260 crores during the 12th FYP period. To achieve 15 percent forest/tree cover Social Forestry and Agro Forestry as well as schemes under MNREGA need to be intensively and extensively implemented. Farm nurseries in the private sector need to be promoted and encouraged as the Environment and Forest Department cannot by itself fulfil the needs of the State.
- The State has taken a very important decision to free 10 species of trees from transit rules, which will act as an incentive for the farmers to grow trees, as they will be freed from procedural hassles for disposing off their produce.
- The rehabilitation and enrichment of these forests will be done with the cooperation of the local people through Joint Forest Management (JFM). JFM will be strengthened by doubling the number of Village Forest Management and Protection Committee (VFMPC) in the state.
- Intensification of Forest Management Schemes during the 11th Plan has given a fillip to strengthening of infrastructure like communication, roads, free surveillance etc. in the forests. However, there is a need to change the mode of funding under the scheme. Currently the scheme is constrained by the guidelines of Ministry of Environment and Forests (MoEF) and each of the items of work needs the sanction of MoEF.
- 50 % of forest area of the State is notified as Protected Areas (Sanctuaries and National Parks); management of these areas needs special emphasis and specialized approach. The State has taken up preparation of the management plans for these areas. These management plans will provide the necessary baseline date for finalizing the management practices to be adopted for wildlife and biodiversity conservation.

- Protection mechanism of protected areas is being upgraded by providing more vehicles and communication systems. The firepower of staff engaged in protection, needs enhancement through provision of arms and requisite training to use them effectively. Protection of wildlife and its habitat will be done with the active participation of people through eco-development committees.
- Man-animal conflict issues need redressal. The State has enhanced the compensation packages for damage by wild animals and for the first time has introduced a compensation package for crop damage. Relocation of habitations of Valmiki Tiger Project on lines of the recommendations of the Tiger task Force is desirable. Where this is not possible, an effective co-existence plan will be put in place.

6.3.1 Intensification of Forest Conservation

- Enhance soil moisture/water conservation efforts;
- Integrate watershed management/catchment area treatment schemes;
- Total ban on mining in and around natural forest areas/protected areas including ecologically fragile areas;
- Livestock management in villages near the natural forests - phasing out unproductive cattle folk by providing productive (better quality) cattle - incentivizing stall feeding to reduce/minimize grazing pressure on forests;
- Undertaking studies on dependence of local communities on forests, especially for fuel wood and non-timber forest produce (NTFPs);
- Provide alternative fuel resources to villagers near forests (LPG/fuel wood production incentives etc.) to reduce fuel wood dependence on forests, promoting the use of non-conventional energy resources;
- Water harvesting and ground water recharging tanks and other rural development schemes in and around the villages near forests with focus on forest conservation objectives - involving the forest officials and Panchayat Raj institutions (PRIs);
- The sustainable development of wetlands depends on proper utilization, management and conservation of diverse natural resources to ensure the fulfilment of human needs, that continue to do so far for the future generation without hampering the natural resources; and

- Providing occupational rehabilitation to people around the protected areas by promoting eco-tourism and also utilizing their services in wildlife and biodiversity conservation efforts.

6.3.2 Greening in Other Areas (Outside Forests)

- Institutionalized plantation efforts - Road side, canal side, flood protection, embankments and community lands to be strengthened;
- More nurseries for production of quality planting materials for agroforestry and farm forestry;
- Incentivize agro-forestry propagation and promotion through aggressive campaigning and extension services;
- Linking isolated wetlands for effective drainage through rivers/ rivulets after proper research/ study of their habitat potentials (of aquatic and avian flora/ fauna); creation of green shelterbelts around wetlands with focus on avian habitat management; and scientific water & fisheries management through PRIs;
- Survey and appraisal of flora and fauna in areas out of forests and wildlife management outside forest areas in active collaboration with PR institutions;
- Evolving a "green code" with Urban/Rural Development/Industries Department providing for and regulating;
- Development and Management of Parks, greening of roads in urban and semi urban areas;
- Industries, commercial establishments and housing schemes to have mandatory greening tasks/ components; and
- Shelterbelt/green cover around drainage/sewer and treatment facilities (oxidation ponds etc.)

6.3.3 Strengthen Infrastructure for Implementation, Research Training, Monitoring and Enforcement

- Forest Department and the State Pollution Control Board (SPCB) to be strengthened sufficiently to carry out the required tasks; and
- Create a separate multi-disciplinary facility/wing in the Environment and Forest Department for research and monitoring of climate change action plan and inter departmental co-ordination

6.3.4 Others

- Cultivation of plants those are most friendly to climate change such as which emits higher oxygen
- Protect and enhance forest cover to increase the capacity to sustain climate change related stress
- Improvement of quality of forest to increase biodiversity and sustainability of forest system
- Promote social forestry in rural and horticulture in urban area in agreement with traditional wisdom
- Study of effect of climate change on wild life should and prevention measures to check loss of diversity

6.4 Perceived Climate Impacts

There is no in depth study of impact of climate change on forest per say in the state. In general, climate change is likely to make the State's meagre forest resources more vulnerable on account of possible shift of the species of forest ecosystems and also on account of increased occurrences of fire, pest /diseases, invasive species, change in species assemblage/forest type, forest die-back and loss of biodiversity. It is also almost certain that forest dependant livelihoods may get severely affected, increasing the vulnerability of local communities in and around forests in the State.

6.5 Strategies

The overarching approach to the forests and biodiversity sector will be to foster an integrated approach that treats forests and non-forest public lands as well as private lands simultaneously, while identifying and leveraging opportunities for mitigation and adaptation measures that enhance ecosystem goods and services, particularly carbon stocks, water, and meet biodiversity conservation and livelihood security needs at the unit/landscape or sub-landscape/watershed or sub-watershed levels.

The BAPCC will focus on restoration of native bio-diverse species mix while at the same time enhancing carbon sink in forests and other ecosystems, while being informed by sensitivity to the ecological nature and value of resources, for instance avoiding dense plantations in grasslands which have other values like fodder, watershed etc.

Research studies will be undertaken to categorise vulnerability and potential as criteria for intervention, and intervention priorities and selection of project areas/sub-landscapes/sub-watersheds will be formed formulated based on the analyses from these studies.

Drivers of degradation, such as firewood needs and livestock grazing will be addressed using inter sectoral convergence (e.g. livestock, forest, agriculture, rural development, energy etc.). The BAPCC will ensure a key role for local communities in project governance and implementation. Gram Sabha and its various committees/groups including JFMCs, etc. will be strengthened as institutions of decentralized forest governance, and capacity building for adaptive forest management and livelihood support activities e.g. community based NTFP enterprises will be accorded high priority. Key Interventions in different forest classes will include the following.

Interventions in very dense forests: The entire 231 km2 of very dense forests are situated in the West Champaran district, and is part of the Valmiki Tiger Project. Forests of all ages and types of this class have remarkable capacity to sequester and store carbon. As such, interventions will focus on enhancing storage and reducing emissions by ensuring full stocking, maintaining health, reducing losses due to tree mortality, natural calamities, wildfires, insects and diseases, and stand density management by prudent tree removal. It is envisaged that this will provide a renewable source of products including timber, engineered composites, paper, and energy even as the stand continues to sequester carbon. These forests will continue to be protected rigorously against all threats.

Moderately dense forests: It is proposed to improve the condition of these forest areas through:

- Better protection by increased strength of frontline staff and improved/enhanced infrastructure;
- Improved/enhanced fire management through prevention, detection and control measures as well as improvement of infrastructure;
- Regulated grazing;
- Eradication of invasive species;
- Soil and moisture conservation through watershed management; and
- Gap plantation adopting indigenous species.

It is envisaged that sustainable management of these forests would lead to increase in stocking density, enhanced biomass and carbon sinks.

Open forests: The Forest Department proposes to improve these forests through:

- Large-scale gap plantation of indigenous species;
- Regeneration of rootstock;
- Soil, and moisture conservation, run off reduction, and integrated watershed management;
- Consultation with communities and plantation of multi-purpose and fast growing small timber yielding and other tree species to fulfil the requirement of local people such as fuel wood, fodder, NTFPs, agricultural implements, etc.;
- Constitution/re-vitalisation of forest protection committees/JFMCs and capacity building of these to develop community conserved areas and similar local protection regimes;
- Provision/promotion of efficient cook-stoves among local village households; and
- Development and deployment of other innovative incentive based conservation measures involving local communities.

Scrub Forests: The Forest Department aims to improve the condition and productivity of these forests through:

- Planting small timber producing plants/trees;
- Fodder, fuel wood producing plants;
- Developing grass land and pasture land for local people within the carrying capacity of the scrub forest areas;
- Constitution/re-vitalisation of forest protection committees/JFMCs and capacity building of these to develop community conserved areas and similar local protection regimes to encourage re-generation of trees;
- Provision/promotion of efficient cook-stoves among local village households; and
- Development and deployment of other innovative incentive based conservation measures involving local communities.

Key interventions in the Valmiki Tiger Reserve and National Park will include (but not be limited to):

- Improved protection through capacity building of relevant personnel, increased strength of frontline staff and improved/enhanced infrastructure including those for enhanced mobility, rapid response, and anti-poaching units;
- Fencing of strategic areas to protect wildlife and control encroachments;
- Appropriate zonation of the National Park into multiple use categories including core, buffer, tourism zones, etc.;
- Development/improvement/augmentation of visitor facilities and nature/wildlife interpretation and promotion of the National Park and Tiger Reserve as a favoured wildlife and eco-tourism destination;
- Control of invasive species including weeds;
- Treatment of catchment areas where required; and
- Exploring opportunities for transboundary conservation and cooperation with the Royal Chitwan National Park in Nepal

Key interventions wetland areas to be taken up for interventions in the immediate short term would include the notified wetland areas including Kabar Lake Bird Sanctuary, Barailla Lake Bird Sanctuary, Kusheshwara Asthan Bird Sanctuary, Udaipur Sanctuary, Nagi/Nakti, and Vikramshila Gangetic Dolphin Sanctuary. Interventions in these would include (but not be limited to):

- Protection measures on a priority basis including fencing, training/capacity building of relevant personnel, increased strength of frontline staff and improved/enhanced infrastructure;
- Treatment of catchment areas, support to compatible land use practices, water quality monitoring, and other measures infrastructure and equipment needed to ensure sustained water balance, optimal wetland hydrology, and all-season water availability;
- Extensive community education/awareness building on the importance of these wetland areas and the need to protect/conserve them and formation of community conserved zones around these wetlands for enhanced protection; and
- Capacity building for, promotion of, and supporting infrastructure provision/ enhancements for enterprise linked community conservation efforts such as eco-tourism, birding, and bird photography, especially during migratory bird seasons.

Over the medium to long-term, the Forest Department will identify and take up other non-notified areas for similar protection and conservation using community based approaches. Just over two million ha of lands -- 22.25 percent of the total geographical area in the State are not available for cultivation. A part from this, 129000 ha are fallow lands that can be treated and brought under plantation.

Presently the percentage of forest and tree cover is 9.21 percent, implying that for increasing the forest and tree cover to 15 percent, 542000 ha of additional land has to be brought under tree cover or alternatively about 338 million trees/plants have to be raised outside forest area. The Forest Department aims to achieve this by undertaking a range of interventions including the following.

Urban and peri-Urban areas (including institutional lands): Urban forests are an exciting opportunity to (a) mitigate climate change; (b) ameliorate air and dust pollution; (c) help in improving overall water regime; and (d) nurture bio-diversity in urban environments. As such, the Forest Department will leverage all opportunities for urban greening by various interventions categorizing urban forest in following broad categories:

- Recorded or notified forest patches: In urban areas where large or medium forest patches are available, it will be notified as protected forest and fenced;
- Open spaces/green spaces like parks/wood lots: Open Spaces/Green spaces such as parks/wood lots should be raised on municipal lands to enhance the vegetative cover;
- Avenue plantations: In urban areas road side avenue plantations will be raised at least in two rows on both sides of the road where land is available; and
- Plantation on institutional lands: In urban areas, many government institutions have large open campuses. Sufficient land is available in these -- where suitable species of trees/plants can be raised.

Agro-forestry and Social Forestry: Social forestry and agroforestry have immense potential in Bihar, which is pre-eminently an agricultural State. Farmers are eager to raise plants on the bunds of the farmland. Poplar and Eucalyptus trees are suitable for farmers for agroforestry plantations. Farmers are eager to raise fruit-bearing trees on their raiyati lands.

As such, the Forest Department, in coordination with the Agriculture Department and other appropriate agencies will plan and undertake agroforestry initiatives including development of large-scale nurseries of high quality tree/plant material; distribution of plants free of cost to farmers, making available extension and support services through research and other initiatives such as training for post plantation care, visits by forest department staff, agroforestry specialists/scientists from institutions such as the National Research Centre for

Agroforestry (NRCAF) and other centres/universities; support for planting trees on non-agricultural rural lands such as homesteads, school yards, compounds of various offices, public spaces, roadsides, canal sides, private/public bunds etc. Plantations along canals and river embankments: The State has about 3430 Kms of river embankments. The Forest Department will examine the possibility of raising plantations on these embankments by using suitable species especially bamboo, which is a strong soil binder. In addition to these river embankments there are 10000 Kms of canal embankments that can be brought under plantation. A tentative physical projection of various interventions for increasing green cover is given below:

Table 21: Tentative target for green cover augmentation in forest/non-forest areas

Type of area and the density class	Extent of area (in ha)	Area likely to be treated under existing program/ schemes of Green Bihar till 2016-17 (ha)	Areas to be treated under the Climate Change Action Plan (ha)
Moderately dense forest (40.70%)	324800	173860	150940
Open Forests (10.40%)	332500	178200	154300
Scrub/Grasslands	13400	10720	2680
Non Forests land	2212000		560000
Waste land	46000		46000
Agro - forestry	6222000		1476700
Total	**9150700**	**362780**	**2390620**

A range of other interventions will also be undertaken. These will include:

1. Extensive measures to be taken by using both traditional as well as modern inputs to contain forest fires -- with increase in temperatures, forests are likely to be more prone to fires. Hence, wildfire management will to be taken up at a priority basis to combat increased frequency and intensity of wildfires in future;
2. Examination of the possibility of leveraging opportunities such clean development mechanisms (CDM), reducing emissions from deforestation and forest degradation (REDD+), etc.;
3. Activating the State Biodiversity Board and transforming it into a fully functional institution undertaking the full range of activities to survey, identify, catalogue, document, protect, and improve/enhance the status of biodiversity in the State including producing, in a time-bound manner, flagship publications on Bihar's biodiversity;
4. Developing and implementing a proactive and on-going programme of research and documenting studies relating to forestry and wildlife in the state including for example (but not limited to):

a. Studies on indigenous trees species to assess their vulnerability to climate change;
b. Assessing and documenting additional threats to biodiversity and wildlife.
c. Population dynamics and movement of wildlife;
d. Obtaining access to updated knowledge on climate change science and policy developments; and
e. Monitoring carbon stock and biodiversity at regular intervals etc.

Additionally, the Forest Department recognises that the private sector can play a role in many forestry related activity in incentivizing collection and value addition of NTFPs, growing of medicinal plants by people, promoting agro-forestry, and thus enhancing livelihood opportunities. As such, the Forest Department will actively examine the creation of enabling mechanisms for increased roles for the private sector in selected operations/activities.

6.6 Institutional Linkages and Stakeholders

A range of institutional linkages, convergence potential, and partnerships is envisaged with, indicatively, the State Agriculture Department, State Energy Department; BREDA; Bihar Watershed Development Society; State Water Resources Department, Central University of Bihar (CUB) and other agencies as necessary for enhancing green cover or achieving the imperatives under the BAPCC. Additional linkages with be built with National forestry research institutes/centres and universities; various international development agencies, private sector and financial institutions, civil society, community based organisations, and forestry and allied sector dependent communities in general.

6.7 Linkages with the NAPCC

The initiatives outlined above are consistent with the NAPCC and National Mission for Green India. Additionally, the strategies and imperatives under the forestry and biodiversity section of the BAPCC also have linkages with the National Mission on Sustainable Agriculture, National Water Mission, National Mission for Enhanced Energy Efficiency, National Solar Mission, and the National Mission on Strategic Knowledge on Climate, and the National Mission on Sustainable Habitat.

6.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

7 Water Resources

7.1 Overview, Characteristics and Status

7.1.1 River Basins and Rivers

Bihar is a landlocked state, yet it is rich with ample natural water resources. The most important river Ganga, flowing from west to east, divides the state into north and south Bihar. The state is almost fully covered under the lower Ganga basin, with a small part in the west of the State under the upper Ganga basin. The Lower Ganga basin is further divided into several sub-basins. Broadly divided into the eight major rivers – the Ghagra, Gandak, Budhi Gandak, Bagmati, the Adhwara group of rivers, Kamla, Kosi, and Mahananda spread are across North Bihar. The major rivers of South Bihar are Karamnasha, Sone, Punpun, Kiul-Harohar, Badua, Falgu, Morhar, Chandan, and Bilasi, having their origins in Jharkhand, Madhya Pradesh, and Uttar Pradesh. Most of the rivers in north Bihar originate in Nepal flowing through the plains of Bihar before draining into the river Ganga.

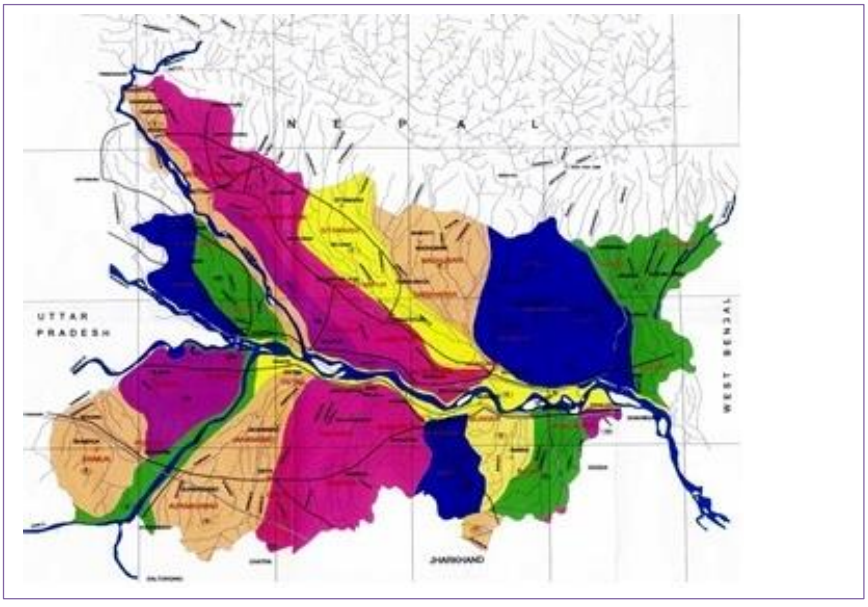


Figure 14: River basins and sub-basins in Bihar

Bihar is one of the worst flood-affected states in India. About 68.8 lakh hectares of its total geographical area of 94.16 lakh hectares are flood prone. In addition, nearly 9.41 lakh hectares (8.32 lakh ha in north Bihar and 1.09 lakh ha in south Bihar), i.e., 10% of the total geographical area of the state is water logged. There are multiple reasons behind waterlogging which include: spilling of silted small rivers, encroachment of

drainage channels, embankment induced waterlogging and the prevalence of saucer type depressions in the topography of the land.

7.1.2 Hydrogeology and Groundwater

Hydro geologically, the State can be grouped as unconsolidated/ alluvial formation, semi-consolidated formations, and consolidated/fissured formations. The main alluvial tract covers entire north Bihar and a sizeable area south of the Ganga River. These alluvial formations constitute prolific aquifers where the tube well can yield between 120-247 m^3/hr. The potentiality of these aquifer decreases due south in the marginal tracts. Auto flow conditions occur in the sub-Tarai region of Madhubani, Sitamarhi, and West Champaran districts. In the hard rock areas of South Bihar, bore wells located near lineaments/fractures can yield between 10-50 m^3/hr.

Table 22: Groundwater resources in Bihar

Dynamic Ground Water Resources	
Annual Replenishable Ground water Resource	29.19 BCM
Net Annual Ground Water Availability	27.42 BCM
Annual Ground Water Draft	10.77 BCM
Stage of Ground Water Development	39 %
Ground Water Development & Management	
Over Exploited	NIL
Critical	NIL
Semi- critical	NIL
Ground Water User Maps	38 districts
Artificial Recharge to Ground Water (AR)	• Area identified for AR: 1650 sq. km. • Quantity of Surface Water to be Recharged: 574 MCM • Feasible AR structures: 891 Percolation Tanks, 2260 Check Dams, 1630 Recharge Shaft, 1303 Contour Bunding, RWH in Urban Areas

Despite the fact that Bihar has ample ground water resources, these are also beset with several quality problems, including arsenic, fluoride, iron, and nitrate concentrations in many districts.

7.1.3 Irrigation

There are six major sources of irrigation—surface canals (major), surface canals (minor), tanks (including *ahars* and *pynes*), tube wells, other wells, and other sources. Tanks and other sources are becoming less important over time, leaving the other four sources for providing irrigation facilities.

In 2009-10, canals (major, medium and minor) provided 27.5% wells provided 61.4%percent of total irrigation. Tube wells continue to be an extremely important source of irrigation, providing more than 50% of the total irrigation in 30 districts. However, irrigation from surface canals (major, medium and minor) continues to play an important role in districts – Rohtas, Kaimur, Bhojpur, Buxar, Aurangabad, Banka, and Lakhisarai, all of which are notable rice producing districts of Bihar.

The ultimate irrigation potential is to be created by the major and medium irrigation. At present, schemes like Western Kosi Canal Project, Durgawati Reservoir Scheme, Kund Ghat, Barnar Reservoir Scheme, Bateshwarsthan Ganga Pump Canal, North Koel Reservoir Scheme, Tilaiya Diversion Scheme, Punpun Barrage Scheme, Batane Reservoir Scheme, Mandai Weir Scheme, Uderasthan Barrage Scheme, Lower Morhar and Lower Kiul irrigation schemes are under execution. The year-wise irrigation potential created until 2010-11 under major and medium schemes, actual areas irrigated, along with the utilization efficiency are presented in Table 23.

Table 23: Water utilization efficiency of major and medium irrigation schemes (Figures in '000 ha)[16]

Year	Irrigation Potential created	Total Irrigation	Efficiency (%)
2001-02	2482.43	1656.21	66.72
2002-03	2509.43	1598.36	63.69
2003-04	2574.00	1721.24	66.87
2004-05	2619.00	1528.23	58.35
2005-06	2637.00	1660.91	62.98
2006-07	2833.00	1684.73	59.47
2007-08	2863.00	1679.82	58.67
2008-09	2873.00	1666.04	57.99
2009-10	2880.00	1202.45	41.75
2010-11	**2886.00**	**1226.45**	**42.50**

The source-wise area irrigated through minor irrigation during 2008-09, 2009-10, 2010-11, and 2011-12 (up to September 2011) is shown in Table 24.

Table 24: Irrigated area through minor irrigation sources (Area in '000 hectares)[17]

Source	2008-09	2009-10	2010-11	2011-12, up to Sept.2011
Surface Canal (Minor)	29.21	17.59	23.00	48.84
Tanks (including Ahars and Pynes)	332.56	332.56	NA	22.20
Tube wells (Private and State)	2722.39	2726.6	2803.45	1715.00
Other Wells (Irrigation Wells)	145.79	145.79	145.79	NA
Other Sources (Lift Irrigation) and	24.36	16.74	15.50	4.98

[16] Source: Water Resources Department, GoB
[17] Source: Department of Minor Water Resources, GoB

Source	2008-09	2009-10	2010-11	2011-12, up to Sept.2011
Barge Lift Irrigation				
Total	**3254.31**	**3239.28**	**2987.74**	**1791.02**

Around 20,938 traditional irrigation systems of Ahar-Pynes/irrigation ponds exist in the state (Table 25). Out of these, around 3,255 are now defunct. These schemes are situated across 17 districts in south Bihar and they have existed for centuries. In a way, this is a self-developed traditional system, based on water harvesting, with the purpose of storage and distribution of the rainwater with wide potential of irrigation flood management and ground water recharge.

Table 25: District-wise data on Ahar-Pynes/Irrigation ponds[18]

S.No.	District	Number of Systems		Total	S.No.	District	Number of Systems		Total
		Functional	Defunct				Functional	Defunct	
1	Patna	212	86	298	10	Jahanabad			501
2	Nalanda	238	82	320	11	Arwal	91	11	102
3	Bhojpur	93	31	124	12	Bhagalpur	472	50	522
4	Buxar	69	00	69	13	Banka	2146	117	2263
5	Kaimur	1330	71	1401	14	Munger	162	04	166
6	Rohtas	398	19	417	15	Jamui	2449	73	2522
7	Aurangabad	1251	442	1693	16	Lakhisarai	251	15	266
8	Gaya	6502	762	7264	17	Sheikhpura	125	26	151
9	Nawada	1488	1371	2859		**Total**	**17683**	**3255**	**20938**

7.2 Key Issues

The total flood affected area of the state is 68.80 lakh ha which is nearly 74 % of the total geographical area of Bihar (94.16 lakh ha) and this is about one-sixth (17.2 %) of the total flood prone area of India. Within the state, North Bihar is by far the worst affected by floods. This is largely due to the fact that, upstream of the Indo-Nepal border, the bed slope of all the rivers in north Bihar is very steep, but when they enter into Bihar, the land is very flat.

On account of the sudden decrease in bed slope, the silt carried by these rivers along with water flow is deposited into the beds of the respective rivers within the territory of

[18] *ibid*

North Bihar. Besides the creation of new irrigation potential, the optimum utilization of previously created irrigation potential is also necessary.

On account of sedimentation and damaged canal systems, full utilization of the created irrigation potential is not possible in many areas. Restoration of lost irrigation potential created before is not only economically more beneficial than creation of new irrigation potential, but it is less time intensive as well. The reduction in irrigation efficiency in Bihar's medium and large irrigation systems is a cause for concern.

7.3 Priorities

Under the 12th FYP, the State proposes the several priority measures. Some of these are outlined below:

- Study of carrying capacity of the rivers, changes in drainage pattern and wetlands confined to North Bihar, management of shallow and deep aquifer particularly in arsenic prone area
- Significant research on surface hydrologic and geochemical responses to climate variability on intraannual and multidecadal time scales for ground water resources management
- Creation and restoration of irrigation potential of 30.362 Lakh hectares through surface and ground water schemes;
- Extensive renovation of surface irrigation schemes including Ahar/Pynes and irrigation tanks;
- Execution of surface irrigation schemes on priority basis in drought prone districts of the state. Execution of community based/owned electric power operated medium duty deep Tube wells in South Bihar and Sugar Cane areas;
- Incentivize execution of private shallow tube-wells under BIGWIS especially in north Bihar and non- hilly areas of south Bihar;
- Restoration of old State Tube-well and lift irrigation schemes, which have lost their useful lives;
- Strengthening the mechanism of ground water monitoring;
- Execution of artificial recharges schemes/water conservation schemes such as check dams in ground water stressed areas;
- Capacity building of engineers, officials, operational staff, beneficiaries, contractors and WUAs by Organizing training programs, refresher courses and

workshops and hiring of technical personnel and services of experts for preparation of DPR; and

- Infrastructure development: construction of new field office premises, establishment of quality control labs at headquarter as well as field levels, strengthening of monitoring and evaluation wing, provision of third party inspection facility, man power empowerment by upgrading them with latest technology; and
- During extensive renovation of traditional irrigation system such Ahar-Pyne and irrigation tanks, the main conductor channels will be taken up first and the minor conductors with command and less than 40 hectares will be renovated with MGNREGA.
- As far drinking water supply is concerned, following goals will be set for achieving the objective of providing safe, adequate, and sustainable drinking water supply to all habitations
- Ensure social equity in distribution of assets for drinking water so that SC/ST population and other poor and weaker sections including minority communities are covered fully;
- Generation of base line data for various water resources related parameters for validation and for future planning and development of infrastructure
- Traditional adaptation strategies for recharge ground water by rainfall.

7.4 Perceived Climate Impacts

No in-depth climate vulnerability and risk analyses currently exist for the State. Climate change can affect the hydrological regime changing water flows, precipitation levels, evaporation, and snow cover/melt. These changes would in turn impact the communities adversely as the pressure on natural resources and environment would compound; water availability in the rivers will be affected; crop yields could decrease, therefore jeopardizing food security; and leading to health concerns due to occurrence of extreme events such as floods and droughts. While some regions would receive excess precipitation, there might be reduction in other regions (adversely affecting arid and semi-arid areas); increased evaporation; changes in runoff and available surface flow also causing changes in the groundwater recharge.

The increase in rainfall due to climate change does not necessarily means an increase in surface runoff as may be generally predicted. It may be observed that even though an increase in precipitation is projected for the Ganga basins for the climate change

scenario, the corresponding total runoff for has not necessarily increased. Integrated water policies will help to cope with variability in rainfall· and river flows at the basin level such as in river basins in Bihar, few of which lies south of the Ganga are Karmnasa, Sone, Punpun, Halohar, Kiul, Badua and Chandan and few basin lies to the north of the Ganga are Gandak, Bagmati, Kamla, Balan, Kosi, Mahanand. Hydrological Treatment should be done for basins to the north and south of Ganga separately.

Observed global warming has been linked to changes in the large-scale hydrological cycle such as: increasing atmospheric water vapour content; changing precipitation patterns, intensity and extremes; reduced snow cover and widespread melting of ice; and changes in soil moisture and runoff. Precipitation changes show substantial spatial and inter-decadal variability.

By the 2050s, the land area will be increasing to water stress due to climate change. Increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas and will affect water quality and exacerbate many forms of water pollution and finally will affect food availability, stability, access and utilisation. Areas in which runoff is projected to decline face a clear reduction in the value of the services provided by water resources. Increased annual runoff in some areas is projected to lead to increased total water supply.

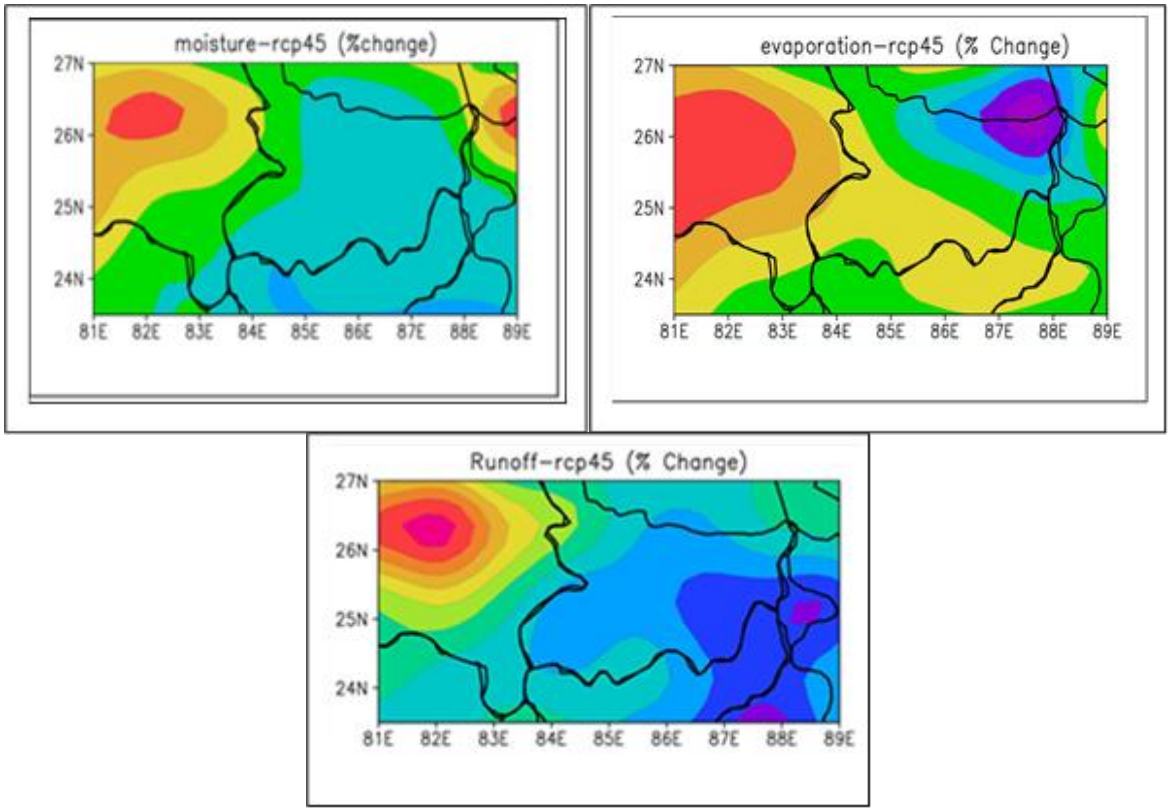


Figure 15: Soil moisture, Evaporation and Runoff for the period of 2006-2050 with respect to 1961-2005 under experiment of Representative Concentration Pathway (RCP) 4.5 in CMIP5 simulation (Source: CUB, Patna)

No in-depth climate vulnerability and risk analyses currently exist for the State. Although, Centre for Environmental Sciences, Central University of Bihar is conducting climate modelling studies and its impact on water resources. The Climate Model Inter-comparison Phase 5 (CMIP5) simulated % change in soil moisture, evaporation and runoff for the period of 2006-2050 with respect to 1961-2005 udder experiment of Representative Concentration Pathway (RCP) 4.5 is shown in Figs.15. Parts of Bihar is showing significant decrease in soil moisture, increased evaporation and decreased runoff in future time period of 2006-2050 with respect to 1961-2005.

Water availability: The gross per capita water availability in Bihar will decline from about 1,950 m3/yr in 2001 to as low as about 1,170 m3/yr in 2050. Bihar will reach a state of water stress before 2020 when the availability of clean water falls below 1000 m3 per capita

Probable impact of cumulative change on water resources include:

- Increased drought like situation;
- Increased flood events;
- Effect on ground water quality;
- Influence on ground water recharge;
- The atmospheric hydrological cycle is very likely [>90%] to be altered in significant ways due to climate change as early a by 2020s also due to warmer climate;
- There is a general reduction in the quantity of available runoff under some scenarios;
- River basins such as Ganga are likely to experience seasonal or regular water stressed conditions;
- By 2050s fresh water availability in South Asia is projected to decrease; and
- The rise of population will increase the demand for water leading to faster withdrawal of water in turn would reduce the recharging time of the water table.

7.5 Strategies

The BAPCC recognises that scientific knowledge and evidence base on impacts of climate change to the water sector is limited. As such, a comprehensive climate vulnerability analysis will be taken up. As a complementary activity, a comprehensive water data base in public domain and assessment of the impact of climate change on water resource through the various agencies responsible for different aspects of water resources management in the State will be developed, and updated and analysed on an on-going basis. Strategies towards this will include:

- Review of network of hydrological observation stations;
- Review of the network of automatic weather stations and automated rain gauge stations;
- Collection of necessary additional hydro-meteorological and hydrological data for proper assessment of impact of climate change in the state including other improvements required in hydrometric networks to appropriately address the issues related to the climate change. Such data will include Hydrological and hydro-meteorological data in low rainfall areas;
- Improved network for collection of evaporation and rain gauge data using automated sensors;
- Establishment/strengthening of ground water monitoring and geohydrology networks; and
- Collection of data about river morphology for monitoring erosion and carrying capacity.

Other initiatives will include adoption/development of modern technology for measurement of flow in rivers areas, developing inventory of wetlands, development of water resources information system, and reassessment of basin wise water situation, apart from projection of water resources availability as a result of impact of climate change which would inter-alia include the likely changes in the characteristics of water availability in time and space.

Capacity development, education, and awareness are high priority agendas for the sector, and as such, initiatives for this will be taken up including (but not limited to):

- Interactive sessions with policy makers for sensitization.
- Development and deployment of capacity building for professionals from various departments/organizations associated with water resources development and management including Panchayati Raj functionaries.

- Promotion of do-it-yourself action by citizens through intensive social communication, and
- Mass awareness programme including through school/college/university curriculum development and deployment.

In view of above, appropriate measures for mitigation of the impact of climate change on water resources, as also the adaptive measures are to be undertaken by various state departments and agencies. A water resources and climate change "Secretariat" will be explored for the necessary coordination and monitoring mechanisms.

Certain issues are essentially required to be addressed adequately to make conducive environment for state of the art R&D work for accurately predicting the climate change scenarios and its implications in order to fix up the indicators for designing the effective strategies to mitigate the climate change effectively on regional scales. For this, policy and institutional framework and institutional strengthening of government stakeholder/organizations concerning water resources need to be necessarily developed at State and Central Level. Issues which have to be addressed mentioned here in under as:

- Availability of historical and pre sent climate as well as hydrological data thereof. Policy framework need to be designed/adopted at Central level to develop necessary infrastructure;
- Development of the infrastructure for smooth data sharing amongst water resources stakeholders;
- Long periodical database on drought and flood need to be procured and for that capacity building need to be done;
- Customization of climate change models/ Regional Climate Models (RC!'1s) for regional water basins for future predictions with especial emphasis on water stress zones;
- Procurement and development of digital elevation models especially for flood prone areas;
- Network development of automatic weather stations;
- Extensive application and promotion of remote sensing and satellite data based technology for hydrological study purposes;
- Comprehensive water data base accessibility in public domain;
- Development of suitable techniques for efficient utilization of water including state wise implementation of rain water harvesting, roof top harvesting,

desalination, checking over exploitation of ground water storage, canal networking, recycling, basin-wise intra-linking of rivers on regional scale;

- Inventory of wetlands especially those with unique features;
- Study of change behaviour regarding the usage of water and addressing land use pattern and improvement of catchment characteristics;
- Promotion of the restoration and integration management of small scale hydraulic infrastructure such as multiple use small scale dams, artificial lakes and improved wells; and
- Mapping of catchments, surveying, and assessing land use pattern with emphasis on drainage, vegetation cover, silting, encroachment, conversion of mangrove areas, human settlement, and human activities and their impact on catchment and water bodies.

7.6 Institutional Linkages and Stakeholders

A range of institutional linkages, convergence potential, and partnerships is envisaged with, indicatively, the State Agriculture Department, State Energy Department; BREDA; Bihar Watershed Development Society; Central University of Bihar (CUB) and other agencies as necessary for enhancing green cover or achieving the imperatives under the BAPCC. Additional linkages with be built with National water research institutes/centres and universities; various international development agencies, private sector and financial institutions, civil society, community based organisations, and forestry and allied sector dependent communities in general.

7.7 Linkages with the NAPCC

The initiatives outlined above are consistent with the NAPCC and National Water Mission. Additionally, the strategies and imperatives under the forestry and biodiversity section of the BAPCC also have linkages with the National Mission on Sustainable Agriculture, National Mission for A Green India, National Mission for Enhanced Energy Efficiency, and the National Mission on Strategic Knowledge on Climate; and the National Mission on Sustainable Habitat.

7.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

8 Disaster Management

8.1 Overview, Characteristics and Status

Due to its topographic and climatic conditions, Bihar is vulnerable to numerous hazards on an almost on-going basis. The state faces flood, earthquake, drought, cyclones, heat waves, and cold wave as well as recurrent fires in the villages during summer. 33% of the State receives less than 750 mm rainfall, making Bihar chronically drought-prone. Bihar accounts 16.5% of the flood-prone area. Further aggravating is the fact that more than half the population of Bihar lives under potential risk of flooding during the annual monsoon. Bihar is prone to floods and droughts.

Floods

North Bihar is a courtyard of Himalayan Rivers and the whole of South Bihar the backyard of rivers flowing from south. Most of rivers namely Ghaghra, Gandak, Burhi Gandak, Bagmati, Kamla, Adhwara group of rivers, Kosi and Mahanada have Himalayan origin and have considerable portion of their catchment in the glacial region falling in Nepal and Tibet. They receive very copious rainfall during monsoon when discharge of these rivers is 50 to 90 times larger than fair weather flow. This causes frequent and large scale flooding of North Bihar.

As such, 73.63% of the geographical area of North Bihar is considered to be prone to floods. The southern part of Bihar, on the other hand, is drained by rivers that are largely rain fed, having their origins either in the Vindhyachal Hills or in the Hills of Chotanagpur and Rajmahal. These rivers are either dry or have scanty discharges in non-monsoon months.

Karmanasa, Sone, Punpun, Kiul, Badua, Chandan are the important rivers of this region. Falling between the Ganga and Indo-Nepal border, North Bihar has a general slope from northwest to southeast. The geographical area of South Bihar has a general slope of south to north. If the rivers of North Bihar, due to their large catchment area in the Himalayas, cause floods in around 74% of its geographical area, then the rivers of South Bihar drain their water of the tract and accumulate them behind the high southern Bank of the Ganges which has resulted in the formation of a number of tals viz, Fatuha Tal, Bhaktiyarpur Tal, Barh Tal, More Tal, Mokamah Tal, Barahiya Tal and Singhual Tal. These tals also receive backwater of the Ganges when it is in high spate. These tals, therefore, get submerged during monsoon and affect the kharif cultivation in most of the area. The area, thus, affected by tals is around 36 % of the total South Bihar area. Thus, the total geographical area affected by flood, water logging in tals etc. amount to 56 % of the total geographical area of Bihar. Floods in large parts of the plains of Bihar, especially North Bihar, are

recurring features and cause havoc destroying crops and the quality of land and threatening the conditions of life and livestock due to large-scale displacement.

Every year, almost 28 districts get flooded causing huge loss of property, lives, farmlands, and infrastructure. Out of these the area of Sitamarhi, Supaul and Kishanganj are 90% affected by flood, five districts- Bhagalpur, Darbhanga, Khagaria, Madhepura, Saharsa get around 70% affected and in the rest of the districts, the flood-affected areas vary from 55% to 25%. In all 56% of the total area of Bihar is affected by flood.

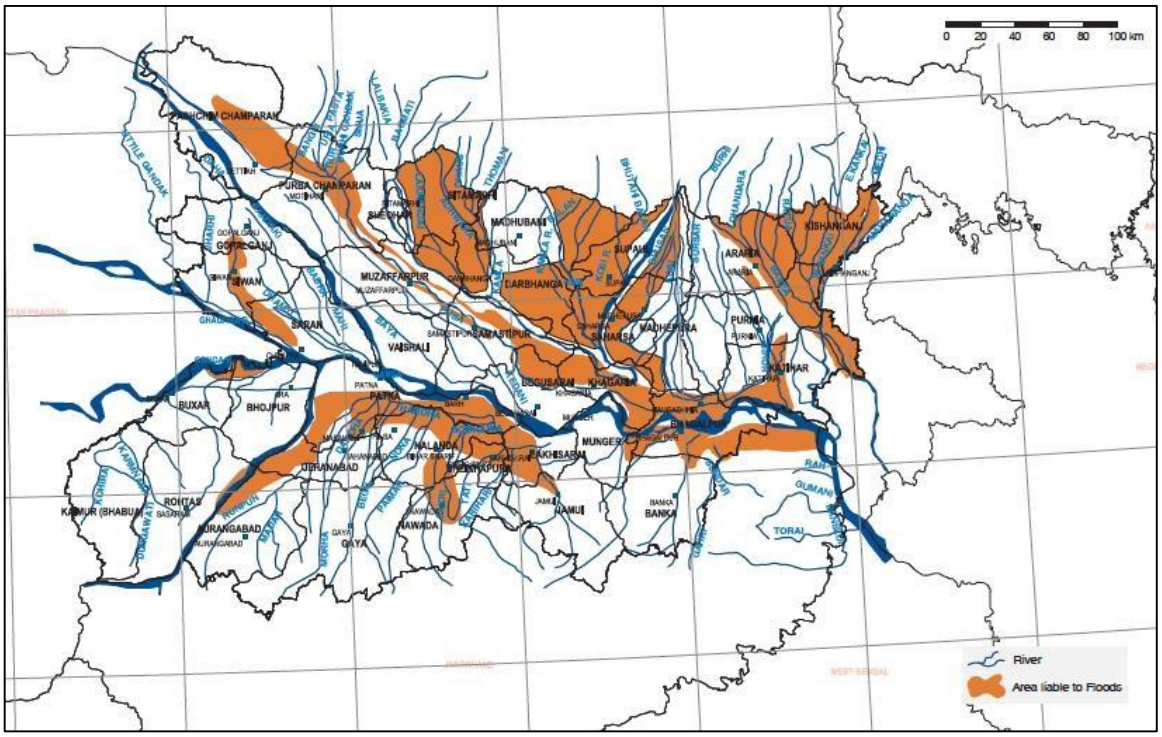


Figure 16: Flood Vulnerability Zone-Wise

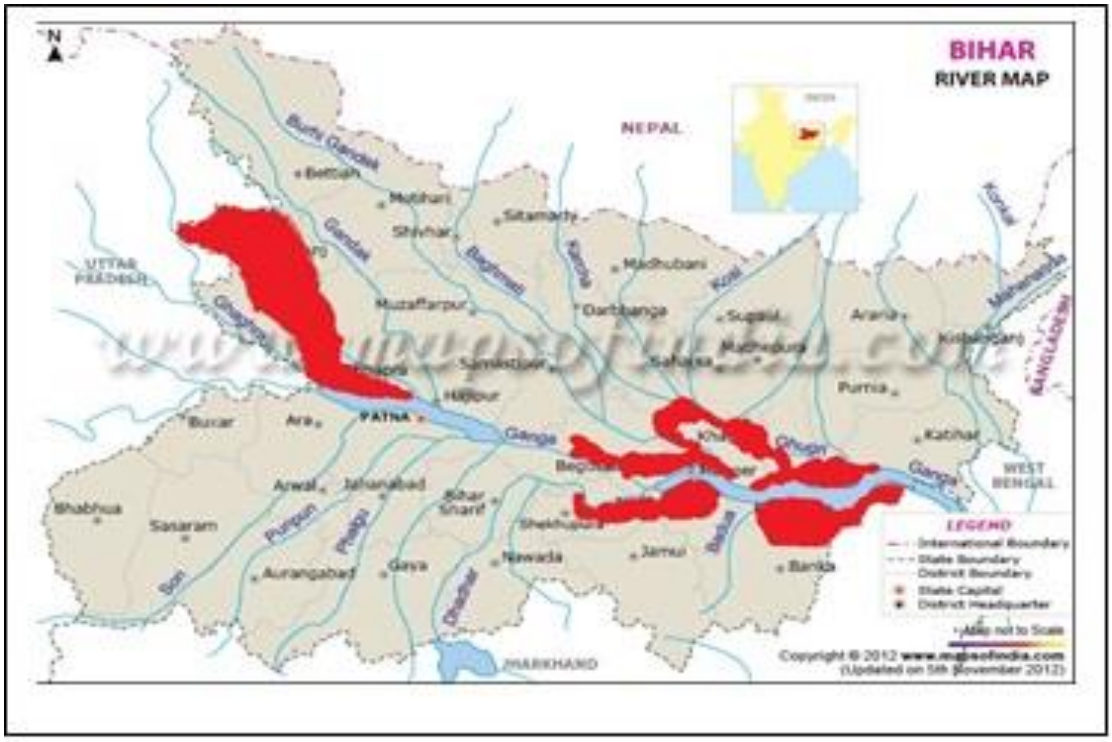


Figure 17 Flood prone districts of Bihar

A study of the flood stages in various river systems revealed that early flood takes place during the month of May-June in River Bagmati, Kosi, and Kamla. Thereafter, flood generally comes in River Burhi Gandak in the month of mid July. During these months River Ganga generally remains low but by September, the master drain, the Ganges, also rises making the flood -problem very acute. Thus, from the month of May to September, for five months, Bihar has to suffer through the ravages of floods of one kind or another, the impact of which was perhaps not felt to the same extent in the past as is felt now. It is so because of the ever-increasing encroachments on the flood plains by the growing population to meet its requirements of food and fiber.

Drought

Apart from deficiency in rainfall prime reasons of recurring drought in Bihar is the nature of soil with low mineral and humus-contents besides extremely poor water holding capacity. Recurrent rainfall variability and sustained departure from the normal rainfall vis-a-vis low reliability, fluctuating both surface and underground water resources and extremely poor water holding capacity of the major soil group appear to have clubbed together to cause frequent droughts in Bihar. Besides, there is a relationship between reducing forestland and the increasing rainfall variability and the phenomenon is well manifested in Bihar scenario of recurrent droughts.

Figure 18: Frequency of surface water deficit in Bihar (Source: CUB, Patna)

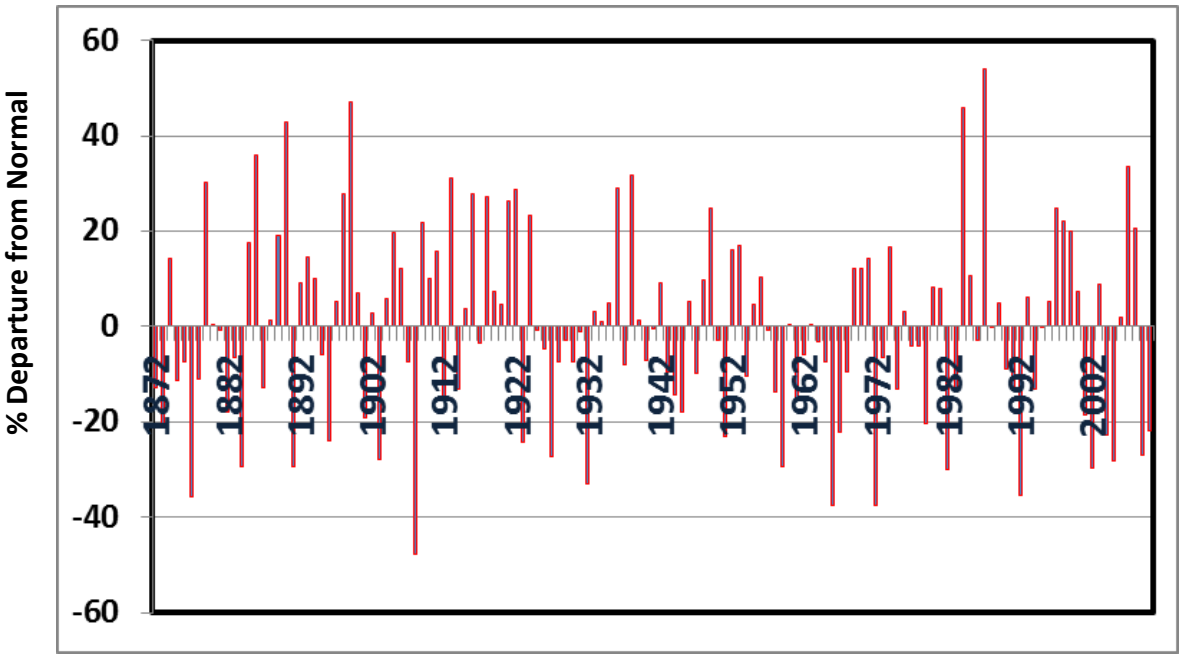


Figure 19: Summer Monsoon Rainfall (June-Sept) in Bihar (1872-2010) (Source: CUB, Patna)

Recent years show more meteorological drought years in Bihar. It seems that frequency in increasing.

Cyclonic Storms (High Speed Winds)

Among the natural hazards of the surface cyclones (High Speed Winds) are by far the most devastating both by causing loss of life as well as loss in terms of socio-economic development. The only saving grace is that its formation can be watched right from the

depression development to landfall stage. 27 districts in Bihar are fully affected by high-speed winds of 47 m/s intensity. The area of districts—Banka, Jahanabad, Arwal, and Nalanda is nearly 90% affected. Other districts of South Bihar except Nawada are partly affected by high-speed winds of 44 m/s. Nawada is, however, 100 % affected by high-speed winds of this intensity. In all 86 % of the total area of Bihar is prone to high-speed winds of 47 m/s intensity and only 14% of the area prone to high-speed winds of lesser intensity.

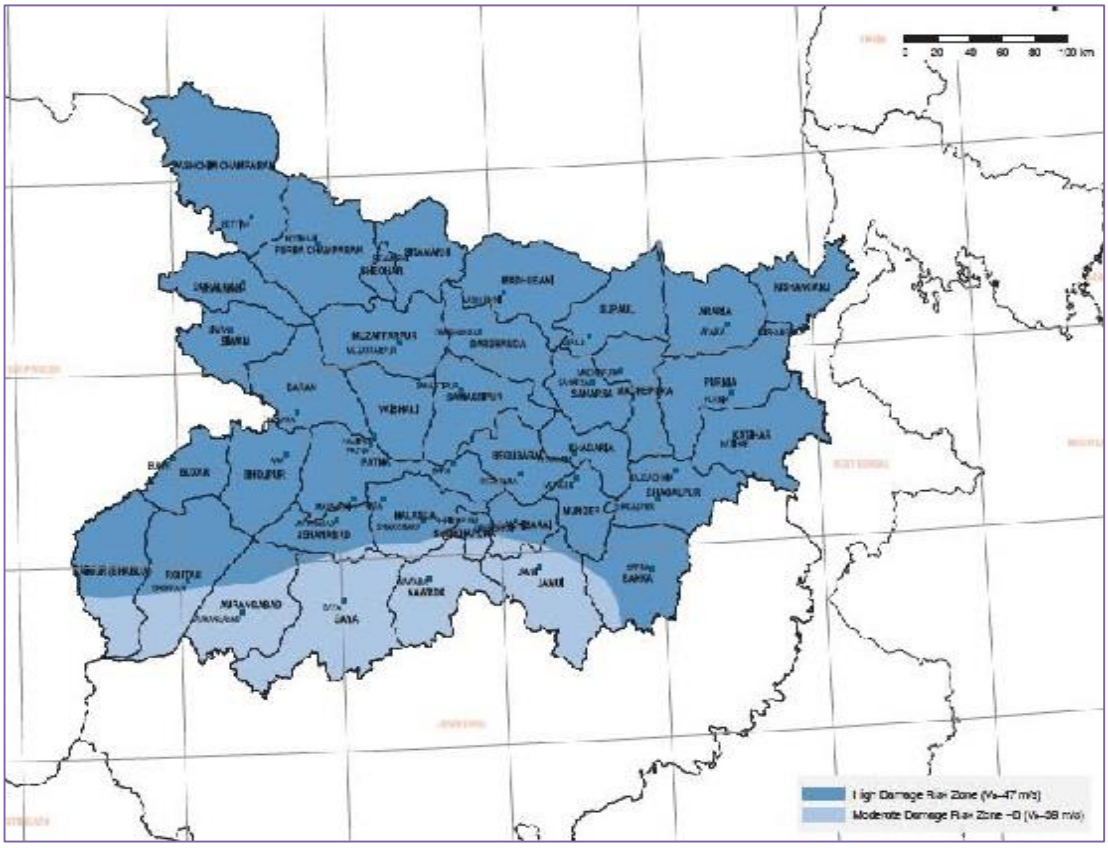


Figure 20: Cyclonic storms vulnerability zone-wise

8.2 Key Issues

Key issues relating to disasters in the State include the recurring nature of the main event categories – floods and droughts. The Kosi River is the main cause of recurrent floods in north Bihar. The river runs through a steep gradient in Nepal. Rainfall in the Kosi catchment in Nepal overloads the barrage compelling release from the Barrage, which causes floods and waterlogging in north Bihar. The heavy discharge from the Barrage causes downstream Bagmati, Burhi Gandak, and Ganga rivers to inundate. In addition, the discharge carries enormous amounts of sandy silt that gets deposited over arable land and renders it fallow. Additionally, disasters, as and when they occur, are exacerbated by a number of factors; some of these include:

- High population decadal growth rate;
- Illiteracy in general and Female illiteracy in particular, and therefore, low awareness levels;
- Low per capita income;
- Rural roads in poor condition;
- Scarce health infrastructure;
- Sand casting and changes in land use due to sand casting;
- Lack of adequate tree/green cover and resultant soil erosion;
- Debris disposal;
- Damage to water management resources;
- Damage to plantations;
- Increasing salinity due to poor drainage;
- Pressure on environmental resources in areas receiving the out-migration; and
- Environmental degradation due to pollution caused by reconstruction

8.3 Priorities

Key priorities for the State will include:

- Continuous on-going efforts at tracking and disaster risk indicators and developing improved early warning systems;
- Developing and putting in place strategies and action programmes for disaster vulnerability reduction;
- Extensive information, education and communication campaigns for the public in general, and specific communications in high risk zones;
- Improving inter-departmental coordination and communications for improved risk management and disaster response;
- Seamless integration of state disaster management machinery with other key stakeholders such as other developmental agencies and civil society for extended capability in all aspects of risk management and disaster response;
- Provision of all necessary equipment and infrastructure for speedy and efficient responses to disasters including search and rescue, relief measures, and rehabilitation/reconstruction;
- Upgradation and retrofitting of key infrastructure assets in risk-prone zones/areas; and
- Systematic implementation of the State Disaster Management Plan in all its aspects.

- Proper waste management practices, particularly biomedical waste management to improve health and laying scenario

8.4 Perceived Climate Impacts

No in-depth climate related vulnerability and risk analyses currently exist for the State, apart from the detailing already done in the Draft State Disaster Management. It is anticipated that such an in-depth vulnerability and risk analyses will be carried out as part of the larger overarching State strategies under the BAPCC.

However, it is expected that even without taking climate change into account, disaster risk will continue to increase, as more vulnerable people and assets are exposed to weather extremes. Available evidence seems to suggest that that climate change has changed the magnitude and frequency of some extreme weather and climate events. In the next two or three decades, the expected increase in climate extremes will probably be relatively small compared to the normal year-to-year variations in such extremes.

As climate change impacts become more dramatic, its effect on a range of climate extremes will become increasingly important and will play a more significant role in disaster impacts. However, it is also expected that even minor variations in existing climate extremes can exacerbate the challenges that the State, its different sectors, and its people face.

Past and Future scenarios of cyclonic storms

Past data show that cyclonic storms track is not covering Bihar and future projected cyclonic storms in Bay of Bengal (BoB) during 2071-2100 under A2 scenario would also not cover Bihar. Since the size of projected storms in BoB would be relatively larger, and more intense, therefore Bihar may experience more cloudy, windy conditions and intense rainfall.

8.5 Strategies

The overall approach to disaster management in the face of climate change under the BAPCC will be to seek closer integration of disaster risk management and climate change adaptation, along with the incorporation of both into state, district, and local planning and practices. It is anticipated that a multi-hazards approach will be used to planning and action for disasters and will address social welfare, quality of life, infrastructure, and livelihoods, and other aspects for managing disaster risk in the short term, and facilitating adaptation to climate extremes in the longer term.

Towards improving governance mechanisms, institutional decision making and convergence, specific mechanisms seamless coordination on an on-going basis will be

established between the State Disaster Management Department, State Disaster Management Authority, and various sectoral line departments.

The following initiatives will be undertaken for improving scientific knowledge and evidence base and understanding of climate change and its impacts:

(i) *Studies of recent changes in climate parameters and associated disaster related impacts:* These studies will be undertaken in collaboration with one or more centres/ of excellence/universities/institutes for climate research in India; on-going programmes of collaboration will be established with such centres for continued scientific analyses and evidence base inputs to the State's disaster management planning and practice;

(ii) *Documentation of adaptation strategies of the masses:* Various adaptation strategies and traditional being used by the masses to ward off or minimise the climate change related impacts will be documented. This would ensure intellectual property rights protection to the same where applicable;

(iii) *Land use/land cover change in the previous decade:* Temporal satellite data will be utilized to assess the changes in the land use/land cover pattern; and

(iv) *Monitoring of various climate parameters:* A series of automatic weather stations will be installed at critical location in the high reaches of the state so as to monitor the changes in various climate parameters.

(v) Assessment of the socio-economic vulnerability masses in various remote locations of the state with particular emphasis upon gender, class, caste, ethnicity, physical ability, community structure, existing decision-making processes and the other local factors;

(vi) In the absence of any authentic study, as on date both the magnitude of the problem related to migration and its impact is ill quantified. Data collection and compilation work on population movements (migration) across the region; primary and secondary data is proposed to be compiled at the regional level; and the impact of migration on poverty alleviation;

(vii) Documentation of best practices for livelihood and adaptation strategies and promotion of the same through various modes including policy interventions;

(viii) A study on migration and its possible impacts (considering that there is significant migration within the State);

(ix) Gender based studies to identify the role of women as first and most responsible responder in disasters and train the women leaders. Study would also understand the impact of the increase in predominantly women-headed households in the mountains;

(x) Gender mainstreaming and gender-sensitive approaches in regions affected by food shortages and decreased agricultural production based on approaches and methods developed by traditional knowledge; and

(xi) Trainings on livelihood options including small scale business, animal husbandry and agriculture with focus on adaptation and coping mechanism.

The following activities are planned for **education and awareness** on this important issue.

a. *School curriculum:* Disaster management has already been included in the school curriculum. Appropriate material would subsequently be developed for on various climate change related issues and the same will be introduced in the school curriculum.

b. School awareness program: Awareness programs will be organized by the Department for school children. Climate change will be included in these programs and these will be made a regular feature in all the schools of the state.

c. Awareness program for officials: It is urgently necessary to sensitize the government officials on this important issue. The Department will regularly organize sensitization programs for government officials at state, district and tehsil / block level. Various key issues related to climate change will be included in these training programs.

d. Training program for vulnerability assessment and risk reduction: For better appreciation of vulnerability and risk assessment reports as also for undertaking

These exercises on their own special training programs will be organized for the representatives of various sectors.

The following initiatives will be taken up to build **adaptive resilience** and **reduce vulnerability across communities and sectors**:

a. ***Capacity building for effective planning:*** Planning is the key to mitigating effects of various climate induced contingencies. Various stakeholders from amongst the community as also from various sectors will be trained in assessing their vulnerabilities and to prepare plans in the light of the various contingencies that they might face;

b. ***Planning for government infrastructure:*** The entire public infrastructure will be mapped under GIS environment and the climate vulnerability of the same will be assessed. This would help in developing adaptive climate disaster resilience plans, including retrofitting where required;

c. ***Preparation of disaster management plan for all major reservoirs in the state:*** In the case of extreme precipitation events in the catchment of major reservoirs the possibility of flash floods in the downstream areas cannot be ruled out. Various possibilities have therefore to be simulated and based upon these appropriate plans have to be developed for tackling these situations.

d. ***Raising quick response teams at grassroots level:*** In case of any disaster situations the people at the grassroots level are the first responders and in most events response activities are over before the arrival of formal responders on the scene. It is therefore critically important to raise quick response teams at the grassroots level. These will be raised in every village so as to effectively manage any contingency. Certified training in search and rescue and first aid will be imparted to selected volunteers.

e. ***Vulnerability assessment of all lifeline structures in the state:*** Vulnerability of all the lifeline structures will be assessed out and this would help the respective sectors to undertake appropriate measures for vulnerability reduction.

f. ***Retrofitting of lifeline infrastructure:*** After assessing vulnerability of the infrastructure the beneficiaries will be asked to undertake retrofitting of their infrastructure.

g. ***Relocation of critical infrastructure:*** The infrastructure and critical facilities falling in identified high-risk zone will be advised to relocate their infrastructure. This would at the same time act as a disincentive for infrastructure development in the high-risk zone.

h. ***Promoting green and disaster resilient construction technologies:*** Certified training programs will be organized for the engineers of the various engineering departments for promoting green and disaster resilient construction technologies.

i. ***Assessment of urban vulnerability particularly in case of extreme precipitation events:*** Major urban agglomerations of the state having population of more than one lakh will be undertaken under this program.

j. ***Vulnerability assessment of all industrial units in the state:*** Vulnerability of all the industrial units will be carried out and this would help the individual agencies in undertaking appropriate measures for vulnerability reduction.

k. ***Simulation of extreme precipitation scenario in major river basins of the state and planning for the same****:* Extreme precipitation in the downstream areas. It is therefore important to simulate various scenarios and accordingly plan for effectively managing these contingencies.

l. ***Review of various techno-legal regimes:*** The techno-legal regime has an important bearing in reducing risk of disasters. Various techno-legal provisions would therefore be reviewed and appropriate amendments in the same will be suggested.

m. ***Promotion of risk transfer mechanisms****:* Risk transfer is increasingly being seen as an important tool for reducing the burden of disasters upon public exchequer. Various risk transfer instruments would therefore be developed and the same will be promoted through various modes.

A robust monitoring framework will be put into place, and both financial and physical monitoring of the various activities will be resorted to. Besides in house monitoring independent third party monitoring will be undertaken.

Possibilities will be explored for **collaboration with private and cooperate sectors**. Special emphasis will be laid for collaboration in the following sectors:

a. Housing and infrastructure, health, and education -- safe housing is the most important aspect as far as disaster management and housing is concerned. Promotion of earthquake safe construction technology will be targeted through training of engineers, architects and masons working in private housing projects;

b. Advocate and convince the private sector in disaster prevention in reconstruction and rehabilitation;

c. Mobilizing private sector resources for investment in various disaster prevention measures;

d. Explore the opportunities for risk reduction in the design and construction of new systems and those available for risk reduction in the retrofitting of existing life line structures like hospitals, schools and other important buildings;

e. Study on the social and economic consequences of critical infrastructure failure from various disasters and approaches to estimation of direct and indirect losses from infrastructure service failure with emphasis on the comparison of expected scale and distribution of losses related to infrastructure failure with the costs of strengthening and other strategies for risk reduction; and

f. Many infrastructure systems are owned and managed by private sector therefore opportunities will be explored for promoting standards of design, construction, maintenance and operation as routine practice.

Civil society has an important role to play in bringing forth awareness amongst the masses and in propagating green technologies. The Department will work in close collaboration of various civil society organisations. Initiatives under the BAPCC will include:

- Civil society organisations will be approached as bridge between the centre and the people;
- Information and data of the civil society will be used and further research will be done through or with the help of these organizations;
- Advocacy programmes will be conducted through local NGOs; and
- For Knowledge sharing

8.6 Institutional Linkages and Stakeholders

Considering the nature of climate change and disasters, a wide range of institutional linkages, convergence potential, and partnerships is envisaged between the State Disaster Management Department, State Disaster Management Authority, all sectoral line departments, and sub-state administrative/sectoral units, apart from linkages with academia, civil society, international development agencies, private sector and financial institutions, and communities in general.

8.7 Linkages with the NAPCC

As is the case with institutional linkages and stakeholders, considering that climate change and disasters as well as their impacts cut across virtually all sectors, the initiatives outlined above are consistent with the NAPCC and all the National Missions under it.

8.8 Sectoral Action Plan and Budgets under the BAPCC

Details are given in Part C

9 Urban Development

9.1 Overview, Characteristics and Status

The state percentage decadal growth of urban population at 35.11 against 31.80 for the country as speaks of its urban growth. From a population of less than a million residing in urban areas in 1911, urban Bihar now is the home to n early twelve million people. The absolute urban population of the State at 1.17 Crores is more than the urban population of all the eight North Eastern States together.

9.1.1 Urban Agglomerations and Population Growth

There are in all 141 urban institutions — Corporations (11) Municipal Councils (43) and Municipal Panchayats (86) in the state. These correspond to the number and size of urban agglomerations in Bihar. A list of urban agglomerations and cities, with a population above 100,000 as per 2011 census in Bihar is given below.

Table 26: Urban agglomeration with over 100,000 population

Rank	Name	District	Population 2011	Male	Female	Literacy Rate
1	Patna	Patna	2,046,652	1,087,864	958,788	84.05
2	Gaya	Gaya	470,839	249,797	221,042	85.45
3	Bhagalpur	Bhagalpur	410,210	218,284	191,926	80.76
4	Muzaffarpur	Muzaffarpur	393,724	208,509	185,215	85.07
5	Purnea	Purnea	310,817	163,892	146,925	74.04
6	Darbhanga	Darbhanga	306,089	161,346	144,743	80.74
7	Bihar Sharif	Nalanda	296,889	154,915	141,974	80.32
8	Arrah	Bhojpur	261,099	139,319	121,780	83.41
9	Begusarai	Begusarai	251,136	133,931	117,205	79.35
10	Katihar	Katihar	240,565	126,834	113,731	80.09
11	Munger	Munger	213,101	113,173	99,928	81.83
12	Chhapra	Saran	212,955	112,280	100,675	81.01
13	Bettiah	West Champaran	156,200	82,663	73,537	80.89
14	Saharsa	Saharsa	155,175	82,589	72,586	77.66
15	Sasaram	Rohtas	147,396	77,687	69,709	82.31
16	Hajipur	Vaishali	147,126	78,561	68,565	79.26
17	Dehri	Rohtas	137,068	72,311	64,757	83.38
18	Siwan	Siwan	134,458	70,670	63,788	84.65
19	Motihari	East Champaran	125,183	67,438	57,745	87.20
20	Nawada	Nawada	118,820	62,361	56,459	81.80
21	Bagaha	West Champaran	113,012	59,946	53,066	60.67

9.1.2 Urban Infrastructure and Services

Levels of urban service in 24 selected towns of Bihar in comparison to national standards/average are given below:

Table 27: Level of urban service - Bihar in comparison with national standard, national average and 24 town average

	24 Towns	Water Supply					Sewerage		Solid Waste		Drainage	
		Water Supply Coverage	Per Capita Supply of Water (MOUD SLB)	Total Water Supplied into Distribution/ Population in Coverage Area	Hours per day supply in coverage areas	Number metered connections	Sewerage Coverage	Population with Toilets	Population Covered	Disposal to landfills	Coverage of storm water drainage network	Aggregate number of water logging incidents reported in a year
	Units	**%**	**lpcd**	**lpcd**	**hrs**	**%**	**%**	**%**	**%**	**%**	**%**	**unit**
	National Standard	100	135		24	100	100	100	100	100	100	0
	National Average	81	123		4	25	28	82	51	2	53	
	24 Town Average	49	28	56	7	0	0	72	46	0	32	9
1	Arrah	70	56	80	8	0	0	90	28	0	70	12
2	Bagaha							50	15	0		12
3	Begusarai	60	20	33	4	0	0	90	67	0	65	15
4	Bettiah	30	10	33	5	0	0	90	43	0	20	8
5	Bhagalpur	81	57	70	5	0	0	58	60	0	70	0
6	Bihar Sharif	80	46	57	8	0	0	90	28	0	60	12
7	Chapra	70	34	48	5	0	0	50	28	0	60	10
8	Danapur Nizamat	80	69	86	12	0	0	80	46	0	0	9
9	Darbhanga	36	28	78	12	0	0	70	70	0	37	0
10	Dehri	60	12	19	4	0	0	80	53	0	50	11
11	Gaya	82	29	35	5	0	0	53	70	0	47	0
12	Hazipur											
13	Jamalpur						0	90	78	0	0	8
14	Katihar	45	3	7	6	0	0	90	41	0	40	10
15	Kishanganj	20	9	45	8	0	0	90	60	0	40	7
16	Motihari	40	48	120	6	0	0	80	73	0	15	8
17	Munger	75	0	0	8	0	0	90	41	0	0	12
18	Muzaffarpur	30	76	253	11	0	0	0	60	0	86	0
19	Nawada	40	27	68	8	0	0	97	60	0	20	12
20	Patna	95	102	107	16	0	46	82	75	0	60	8
21	Purnea	40	4	10	8	0	0	84	42	0	15	15
22	Saharsa	24	6	25	6	0	0	93	28	0	15	8
23	Sasaram	40			6	0	0	67	10	0	0	12
24	Siwan	80	29	36	6	0	0	74	31	0	0	15

(A) Water Supply: The water supply situation in Bihar is highly critical for per capita supply of water and hours of supply of water for most towns with the exception of Patna, Muzaffarpur, and Danapur Nizamat. For water supply coverage-the situation is highly critical for about half the towns-mainly the towns with smaller populations further from the capital Patna.

Town suffering particularly badly from a lack of water supply are lack of water supply are Bettiah, Darbhanga, Katihar, Kishanganj, Motihari, Muzaffarpur, Nawada, Purnea, Saharsa and Sasaram. In particular, Bettiah , Darbhanga, Kishanganj, and Saharsa show very poor water supply service for all three parameters. In many town of Bihar the groundwater resources, which have been the most common water supply source in the past, are generally insufficient to meet the Ministry of Urban Development standard of per capita requirement of 135 lpcd.

There has been a lack of investment for new Water Treatment Plants and water supply pipelines-but the fact that many surface water sources are further away from the town adds to the cost of improving the water supply network. There is a lack of water meters so it is difficult to charge commercial and high users of water, and also no incentive to stop people wasting water. An improvement in accounting practices in urban local bodies (ULBs) is required so that water consumers can be identified, and the introduction of billing to ensure that revenue is obtained for the water service delivered.

(B) Sewerage: The Bihar sewerage subsector is lagging substantially behind the national standard and national average. In Bihar there are very few towns with modern sewerage systems with the exception of town along the Ganga River like Patna and Bhagalpur. These towns have benefited from specific investments in sewerage infrastructure provided under the National Ganga Action Plan 1985-2000.The initiation of improved sewage disposal and sanitation facilities throughout Bihar has a very high priority.Whilst most town are low to moderate critical for toilet coverage, the disposal of toilet wastes to septic tanks are directly to drains and ditches needs to be addressed.

The issues affecting sewerage are similar to those affecting water supply but the sewerage system issues are more serious that water supply issues. Implementation of sewerage systems in Bihar lags far behind the National Standard and even the National average 28 percent-which itself is low for India by comparison with international standards. The issues are lack of Town Sewerage Master Plan, inadequate water supply, intermittent and unreliable power supply for sewage pump stations and powering sewage treatment plants (STPs), lack of investment in sewerage infrastructure.

(C) Solid Waste Management: About half of the towns in Bihar are highly critical for solid waste collection. Nevertheless the widespread practice of disposing of garbage along the roadside or just beyond town limits represents a serious health risk to communities from vermin and flies as well as being unsightly and offensive.

The issues affecting solid waste management are lack of Solid Waste Master Plans, no landfill site identified, lack of investment in solid waste management, inadequate capital and O&M budget for garbage disposal, garbage which is collected is disposed of indiscriminately at the side of the road or at town boundaries (e.g. Gaya), effect on the environment and public health effects of indiscriminate garbage disposal and lack of trained staff. Non availability of land for processing & disposal of waste is the major issue.

(D) Drainage: For drainage the situation in Bihar is highly critical for storm water drainage coverage for 75 % of towns with the exception of Patna, Muzaffarpur, Bhagalpur, Arrah and Begusarai. The issues affecting drainage are lack of Drainage Master Plans, limited capacity of city storm water drainage channels ,periodic and serious town flooding due to monsoon, use of open drains for disposal of sewerage and toilet wastes, lack of storm water pump stations to clear flooding from monsoon rains, lack of investment in drainage infrastructure,inadequate capital & O&M budget for drainage management, effect on the environment and public health effects of flooding and use of drains and ditches for sanitation and lack of trained staff.

9.2 Keys Issues

The State's urban development sector faces a number of key challenges. With growing urban populations across all the cities and towns, the existing infrastructure and services deficit is only likely to widen further increasing the risk to these agglomerations unless urgent steps are taken. The institutions responsible for providing the civic amenities are themselves starved of resources; while reform measures are underway, the financial health of urban local bodies in the state is a cause of concern. Further, urban roads congestion and traffic management are major problems in most cities and towns. Urban Local Bodies (ULBs) lack skilled manpower for O&M of infrastructure.

9.3 Priorities

- Building up of a comprehensive and consistent municipal database- a well – structured uniform needs to be prepared to compile urban datum and update it periodically across all the ULBs.

- Mapping of municipal areas by geographical information system (GIS).
- Promoting energy efficiency and appropriate use of solar energy is going to be promoted in street lighting.
- Emphasis will be given to 'greening' the towns.
- For improving storm and wastewater management, the UDD will, in co-ordination with other relevant departments, examine the existing drainage and wastewater handling situation in all the cities and towns and develop appropriate plans.
- Provision of rainwater harvesting tanks in all ULB buildings and new constructions in municipal limits will be taken up. The concept of 'Green Buildings' will be promoted in both the public and private sectors to save energy, water, and reduce/recycle waste.
- For disaster preparedness and mitigation, an extensive screening of buildings will be done across the urban settlements; retrofitting or reconstruction will be carried out by modifying the Building Byelaws.
- ULBs would plan for the convergence of all government programs being / to be implemented within their jurisdiction in consultation with the District Collector by synergizing the efforts of all stake holder till the activation of DPC.
- Disposal of rejects from processing Municipal Solid Waste from cluster of towns on Regional Landfill will be encouraged. 14 Regional Landfill sites have already been identified to cover 104 towns.
- Piped water supply to households through metering will be planned. The soft path water demand management in residential cluster may include three water demand management in techniques- economic, structural, and operational, and socio political. Although a minimum/ subsidized domestic tariff for lifeline consumption up to a modest quantity will be levied, telescopic tariff will be followed for consumption beyond lifeline supply and up to a limit. Linking of tariff with variations in cost of energy and raw water quality should guide the fixation of tariff.
- PPP approach will be adopted wherever feasible from water treatment down to water billing and collection.
- Natural water bodies/ wetlands and natural waterways (other than rivers) will be protected through a detailed rehabilitation plan for discharging treated sewage water into them.

- Planned Dhobi Ghats & Community Toilets/ Public Toilets in 20 towns settled along the river Ganga will be constructed. Detailed Project Reports are under preparation. DPRs for River Front Development in 8 towns are under preparation.
- The UDD will develop and deploy a range of awareness and capacity-building programmes for municipal officials for promoting appropriate measures towards climate resilience in their respective ULBs, as also similar programmes for building awareness about climate change and its impacts for urban populations.

9.4 Perceived Climate Impacts

The concentration of urban population in a few large cities has led to tremendous pressure on civic infrastructure systems like water supply, sewerage and drainage, solid waste management, parks and open spaces, transport, etc. In several cities, the problems of traffic congestion, pollution, poverty, slums, crime and social unrest are assuming alarming proportions. Climate change is likely to exacerbate the existing stresses that these settlements already face.

Climate change is likely to affect infrastructure related to water, sanitation, energy, transportation, health- care, fire services, and other forms of emergency measures. Climate change could affect water supply systems in any number of ways. It can affect the water demand for drinking and cooling systems. Where climate change leads to failure of small local water sources such as wells, it could lead to greater demand for regional water supplies. Changes in precipitation patterns could lead to greater demand for regional water supplies and reduction in water availability and fall in water tables. A change in water availability and supply also affects sewered sanitation and drainage systems. Further, sewage treatment plants are vulnerable to floods, as these are often located near rivers or water bodies. Storm water drainage systems could become frequently overloaded and cause flooding if heavy storms become more frequent due to climate change. The urban-heat island effects could get exacerbated due to increase in baseline temperatures, affecting climate comfort of the urban populations and may consequently lead to additional costs in climate control.

The vulnerability of human populations varies with economic, social, and institutional conditions. The poor and the marginalized have little capacity to adapt to changes in climate by adopting such mechanisms as air-conditioning or heating. The traditional coping mechanisms of these vulnerable communities may be over stretched due to additional stresses related to climate change. Climate change threatens the homes, livelihoods, and health of the urban poor. When disasters strike, their homes may be damaged or destroyed

and they may be unable to travel to work causing them to lose money for food and other basic needs. Poor people often live in informal settlements on land, which is susceptible to climate change- flood plains, lowlands, or unstable hillsides. Drains and culverts are frequently blocked with rubbish. Slum dwellers often lack secure tenure, proper shelter, water, sanitation, electricity and other services. Most have no insurance.

9.5 Strategies

- To exploit the potential for mitigating climate change through reduction in demand for energy in the residential and commercial sectors by adopting various energy efficiency and conservation measures. Energy efficient street lights with LED lamps will be installed in 11 corporation towns. Rs. 24 Crore for energy efficient LED street lights has already been allotted to BUIDCo for implementation. With respect to adaptation, the aim would be to promote greater use of renewable sources and to reduce dependence on a single source. In formulating climate change strategies, mitigation efforts need to be balanced with those aimed at adaptation;
- To promote energy efficiency and appropriate use of solar energy is going to be promoted in street lighting. Solar water heating will be encouraged through Bihar Renewable Energy Development Agency (BREDA).
- Taking appropriate action with respect to the transport sector such as evolving land use and transportation plans, achieving a modal shift from private to public mode of transportation, encouraging the use of non- motorized transport, improving fuel efficiency, and encouraging use of alternate fuels, etc. To evolve strategies for adaptation in terms of realignment and relocation, design standards and planning for roads, rail and other infrastructure to cope with warming and climate change;
- To facilitate adoption of technologies and research and development which lead to energy efficiency and reduction in emissions;
- Emphasis will be given to 'greening ' the towns, and plans will be developed and implemented for increasing the available green cover in the cities and towns in the State. Provision of rainwater harvesting tanks in all ULB buildings and new constructions in municipal limits will be taken up.
- Establishment of official or informal energy building codes that reflect the " state of the art" in energy efficiency
- Energy efficient housing;
- Water supply augmentation and efficiency improvements;

- Door –to- door collection of municipal and household solid waste, secondary storage, development of transfer station & transportation, treatment and processing; and disposal, including development of sanitary landfill; integrated municipal solid waste management systems (with combination of above)
- Waste water collection, handling, treatment, and disposal including storm water drainage, sewerage systems including treatment plants, decentralized waste water treatment units, sewerage gas based power generation etc.;
- Establish Partnerships for green transportation.
- To promote patterns of urban growth and sustainable urban development that help secure the fullest possible use of sustainable transport for moving freight, public transport, and encourage cycling and walking; thereby reducing the need to travel, especially by car;
- To conserve the natural resources that are the key to sustainability of human habitats like water vulnerability consistent with social cohesion and inclusion;
- To conserve the natural resources that are the key to sustainability of human habits like water , clean air, flora and fauna, recognizing the integrated nature of human and other systems;
- To reflect the development needs and interests of communities that are especially vulnerable to climate change;
- To encourage competitiveness and technological innovation in mitigating and adapting to climate change;
- To develop a transparent, flexible, predictable, efficient, and effective planning system that will produce the quality development needed to deliver sustainable development and secure sustainable communities. National policies and regional and local development plans provide the framework for planning for sustainable development and for that development to be managed effectively;
- To encourage community involvement in ensuring more sustainable patterns of development;
- To bring together key stakeholders at the central, state, district and local levels for a coordinated and comprehensive response to vulnerabilities arising out of climate change; and
- To promote and strengthen efforts aimed at generating awareness related to climate change.

9.6 Institutional Linkages and Stakeholders

A range of institutional linkages and partnership is envisaged, including with the Water Resource Department, the Energy Department, BREDA, Disaster Management Department, BUIDCO, the Transport Department, ULBs as well as apart from linkages with academia, civil society, international development agencies, private sector and financial institutions and urban communities in general.

9.7 Linkages with the NAPCC

The strategies and actions proposed in the BAPCC under the Urban Development section are consistent with the NAPCC and the National Mission for sustainable habitat. In addition, it has also linkages with the National Mission for a Green India, National Water Mission, National Mission for Energy Efficiency and the National Solar Mission.

9.8 Sectorial Action Plan and Budget under the BPACC

See Part C, Action Plans and Budgets

10 Transport

10.1 Overview, Characteristics and Status

10.1.1 Vehicular Growth

The Transport Department of the state government is responsible for improvements in the road transport system, along with collection of fees, road taxes, etc. under the Central Motor Vehicles Act, 1988. Thus the Transport Department plays a major role in raising the internal resources for the state government. The number of registered vehicles is on continuous increase and the registration of new vehicles recorded a phenomenal increase of around five fold, from around 80 thousand in 2005-06 to 3.87 lakh in 2010-11.

Table 28: Number of registered vehicles (2005-06 to 2011-12; up to Dec. 2011)[19]

Year	Truck	Bus	Car	Taxi	Jeep	Auto	Two-Wheeler	Tractor	Trailer	Others	Total
2005-06	579	113	5062	427	2321	3273	61333	3509	2440	1306	**80363**
2006-07	1989	921	7409	1326	4430	5027	112985	6160	5281	1781	**147309**
2007-08	2409	1341	8223	3042	4229	6030	120296	8164	5358	2665	**161757**
2008-09	3598	1121	10549	3791	5748	8423	166882	11203	7510	1588	**220413**
2009-10	8474	1555	14854	7347	9862	12392	233656	19496	10529	969	**319134**
2010-11	6990	1494	18814	5419	9746	17422	293204	21208	11137	1947	**387381**
2011-12	6982	2080	14858	5551	6143	15110	244032	16950	7994	933	**320633**
Total	**31021**	**8625**	**79769**	**26903**	**42479**	**67677**	**1232388**	**86690**	**50249**	**11189**	**1636990**

With substantial increase in the number of vehicles, the actual revenue collection also doubled in 2010-11 over 2006-07. It is also noted that the actual collection of revenue remained very close (98.69 percent) to the target in 2010-11, which is a welcome achievement compared to 2006-07 when the achievement was 57.75 percent. During April-December, 2011, the trend in revenue collection has also been quite encouraging (101.48 percent) of the cumulative target.

[19] Source: Department of Transport, GoB

10.1.2 Sector Growth

The transport sector has shown modest growth over the years as can be seen from the tables below.

Table 29: Transport and allied sectors as sectoral composition of GSDP at constant price (2004-05 to 2011-12)[20]

Sector	Triennium Average (2004-05 to 2006-07)	Triennium Average (2007-08 to 2009-10)	2011-12 (Adv.)
Transportation, Storage & Communication	6.23	6.53	7.51
Railways	1.97	1.84	1.48
Other Transportation and Storage	2.62	2.46	2.33

10.1.3 Bihar State Road Transport Corporation (BSRTC)

Bihar State Road Transport Corporation was established in May 1959 with primary objective of making safe, adequate, economical and systematic bus services available to the passengers. The Corporation has undertaken various steps to improve its performance during the last two years.

10.1.4 State Waterways and Inland Navigation

There is virtually no organised inland navigation in the waterways of the state, and there is ample scope for development in this sector in Bihar. With promotion of waterways and navigation in the state, the rural economy can be substantially transformed.

10.1.5 Railways

The state has an extensive railway network providing vital connectivity within the state, as also with other areas in the country. The total rail length exceeds 5400 Kms. in the state. The East Central Region, one of the biggest railway zones in the country with five divisions of Danapur, Mughal Sarai, Dhanbad, Sonepur, and Samastipur, has its headquarters at Hajipur.

10.1.6 Airways

Patna's airport emerged as number one among 46 airports in the country in terms of growth of domestic passengers as well as domestic aircraft movement for the second consecutive year in 2010-11. There is virtually no international aircraft movement in the state, since the state does not have an international airport. Although Gaya airport is declared as an International airport, it is only nominal, because the big aircrafts do not operate on regular basis from here.

[20] Economic Survey of Bihar 2011-12, Finance Department, GoB

10.2 Key Issues

Some of the key issues in the sector include:

- Increasing congestion, especially in urban agglomerations; increasing air pollution from vehicular emissions
- Very little public transport facilities especially in urban areas; what exists is largely out-dated vehicle fleets;
- Virtually no organised inland waterways transport networks/systems.

10.3 Priorities

- Well integrated multimodal public transport system will be planned for seamless travel across modes by designing a sound interchange infrastructure and introducing a single ticket over all such systems;
- Urban transportation will be incorporated as an important parameter at the urban planning stage;
- Rather than being a consequential requirement, different types of public transport for different segments of commuters will be planned for. Smaller buses along arterial roads may be a good substitute for private vehicles;
- Intermediate public transport (IPT) will be promoted to cater intra urban mobility mostly along;
- Arterial/low density principal roads. Fare structure of IPT modes will be properly framed and strictly enforced;
- Working hours of offices, educational institutions, and commercial establishments will be staggered to avoid the conflict of traffic movement dedicated to these activities; and
- Development of waterways navigation system on river Ganga to reduce the cost of transportation.

10.4 Perceived Climate Impacts

Transport-related pollution, noise, and vibration can pose serious threats to human health and wellbeing. Local air pollution is caused by exhaust emissions produced by traffic, mostly in the form of Sulphur Oxides (SO_x), Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Hydro Carbon (HC), Volatile Organic Compounds (VOC), toxic metals, Lead Particles and Particulate Matter (PM) – including Black Carbon.

Climate change can exacerbate these impacts, leading to traffic-filled roads that can become physical and psychological barriers that can sever communities and divide entire cities. Roads, railways, and other transport infrastructure can also have a severe impact on the natural environment, from the removal of vegetation during construction or the subsequent fragmentation of habitats and disturbance of animals; such fragmentation, without proper ecological infrastructure planning can severely disturb wildlife and reduce biodiversity.

10.5 Strategies

In the short to medium term, the transport department will seek to:

- Promote the use of ensure availability of cleaner fuels such as CNG and bio-fuels Improve access to bus services and service quality;
- Promote initiatives such as vehicle pooling, etc., especially in cities and towns;
- Partnerships for green transportation.
- Shift to more environmentally efficient modes such as public and non-motorised transport
- Invest in public transport and infrastructure that promotes walking and cycling generates jobs, improves wellbeing and add considerable
- Improve vehicles, vehicle maintenance, and fuels as a priority to reduce urban air pollution and greenhouse gas emissions as also ensuring that vehicles that have passed their useful life do not come out on roads
- Develop green-belts and avenue plantation for in-situ urban pollution dispersal
- Undertake capacity building of personnel in the Transport Department and other agencies as required;
- Rigorously implement measures for vehicular pollution control;
- Systematise and ensure uniformity in institutional arrangements for providing public transport services.

In the long term, the Department will undertake following steps:

- Promote access instead of mobility; shift to less harmful modes of transportation; and improve vehicles towards lower carbon intensity and pollution. A fundamental shift in investment patterns will be sought, based on the principles of avoiding or

reducing trips through integrating land-use and transport planning and enabling more localised production and consumption.

- Shift to more environmentally efficient modes such as public and non-motorised transport (for passenger transport) and to rail and water transport (for freight)
- Invest in public transport and infrastructure that promotes walking and cycling generates jobs, improves wellbeing and add considerable value to the state economy, as well as reduce greenhouse gas emissions;
- Improve vehicles, vehicle maintenance, and fuels as a priority to reduce urban air pollution and greenhouse gas emissions;
- Adopt green transport policies will also reduce road accidents and alleviate poverty by improving access to markets and other essential facilities.

10.6 Institutional Linkages and Stakeholders

Institutional linkages are envisaged with the State Transport Corporation, the Urban Development Department, BUIDCO, Tourism Department, and the State Tourism development Corporation, Indian Railways, other State Road Construction Department, as well as linkages with academia, civil society, international development agencies, private sector and financial institutions, and communities in general.

10.7 Linkages with the NAPCC

The outlined strategies herein are consistent with the NAPCC in general; they also have linkages with the National Mission on Sustainable Habitat and the National Mission on Energy Efficiency.

10.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budget

11 Energy

11.1 Overview, Characteristics and Status

11.1.1 Power Situation in Bihar

In its quest for increasing the availability of electricity, Bihar has adopted a blend of thermal and hydel sources. Bihar has the lowest annual per capita consumption of electricity at 122.11 KWH in the country, against the national average of 778.71 KWH. There is an acute shortage of power not only for peak demand, but even the base demand in the state.

Table 30: Power supply position in Bihar[21]

Year	Peak Demand (MW)	Peak Availability (MW)	Deficit (MW)	Deficit (%)
2007-08	1800	1244	556	30.88
2008-09	1900	1348	552	29.05
2009-10	2500	1508	992	39.68
2010-11	3000	1664	1336	44.53

The forecasts are presented in Table 31.

Table 31: Forecast of peak load and energy requirement (2011-12 to 2016-17)[22]

Year	Peak Load (MW)	Energy Requirement (MU)
2011-12	3607	18125
2012-13	4203	22623
2013-14	4799	26361
2014-15	5395	29472
2015-16	5991	32866
2016-17	6587	36316

There are three key agencies in the energy sector in Bihar – BSEB, Bihar State Hydroelectric Power Corporation Limited (BSHPC) and BREDA.

11.1.2 Bihar State Electricity Board

BSEB is a vertically integrated agency and is responsible for generation, transmission, and distribution of electricity in Bihar. At present, there are only two thermal power stations in the state sector – Barauni Thermal Power Station (2x50 MW and 2x110 MW) and the Kanti Thermal Power Station (2x110 MW). At present, more than 10 lakh consumers in the state

[21] Source: Bihar State Electricity Board, GoB

[22] *ibid*

under various categories are unmetered and are, therefore, billed at a flat tariff rate, leading to huge revenue losses. However, the transmission and distribution (T&D) losses declined during 2008 to 2010. The T&D loss during 2011 remained at 35.26 percent on the basis of previous norms of consumption in case of un-metered categories of consumers adopted for calculation of T&D loss during the years prior to 2011.

11.1.3 Bihar State Hydroelectric Power Corporation Limited (BSHPC)

The BSHPC conducts survey for this purpose and prepares the schemes on hydroelectric power generation. There are 11 minor hydel projects that are currently operational in the state with installed capacity of 53 MW.

11.1.4 Bihar Renewable Energy Development Agency (BREDA)

The Bihar Renewable Energy Development Agency (BREDA) is responsible for development of projects using non-conventional energy sources in the state. The overall picture of the renewable energy potential of the state is given in the Table 38.

Table 32: Renewable energy potential of Bihar[23]

Renewable Energy Sector	Potential (MW)
Large Wind	Marginal, to be explored further
Small Wind	Marginal, to be explored further
Small Hydro	195.25
Bio Energy	1950 to 2150
Solar Grid Connected	2850 to 8549
Solar Off-Grid	7300
Total Range	12295 to 18194

11.1.5 Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

The rural electrification work is being carried out in all 38 districts of the state under RGGVY. This work is carried out by the Power Grid Corporation of India Limited (24 districts), National Hydroelectric Power Corporation (NHPC) (six districts) and by BSEB (eight districts).

11.1.6 Restructured Accelerated Power Development and Reforms Programme (R-APDRP)

Part A of the scheme is dedicated to establishment of IT enabled system for achieving reliable and verifiable baseline data in all towns with a population greater than 30,000 as per 2001 census. Part B of the scheme deals with strengthening and upgradation of regular sub-transmission and distribution system. The focus for Part B is on ATC (Aggregate Technical and Commercial) loss reduction on a sustainable basis. Part A of R-APDRP covers 71 towns of the state.

[23] Source: Renewable Energy Potential Assessment and Renewable Energy Action Plan for Bihar

11.2 Key Issues

The generating capacity of Bihar is the lowest in the country. The peak availability is about 1000 MW against the peak demand of 2500 MW, causing a peak shortfall of about 1500 MW, which results in widespread Power Shortage in Bihar. Bihar has targeted to achieve per capita consumption of electricity at least 731.66 units by the end of the 12th plan. This per capita consumption translates to a staggering 11,650 MW of power generating capacity for Bihar.

11.3 Priorities

During the 12th FYP, peak demand for electricity is expected to surge in Bihar owing to electrification of villages and setting up of many industries. Industrial demand for power is also expected to pick up substantially in the wake of new incentives for investment provided by the Bihar Single Window Clearance Act, 2006; the Bihar Infrastructure Development Enabling Act, 2006 and the State Government's Industrial Policy, 2011. A target of per capita consumption of about 731.66 units by 2016-17 has been set. The State plans to achieve this target in the phased manner. The State Government considers the involvement of the private sector in the development of thermal power projects in the state, as an important aspect of the Power Policy.

The State Government encourages captive power generation by industries using any of their waste, by- product or similar substances like bagasse-based co- generation in the Sugarcane industry, provided that for continuity of generation in the off-season, any other substance could be used for generation. The State Government shall provide all such co- generation plants similar incentives as available to Captive Power Plants outlined in the Policy.

The State has planned to procure 1500 MW Power through Case - I bidding. The Power purchase agreement (PPA) for 450 MW has already been made and the power will be available from July 2014. For the remaining 1050 MW +20 percent Power, bids have been invited and procurement process is likely to be finalized by September 2011. The availability of power is expected from September 2015. In addition, Restoration of Unit No. 6 of BTPS, the only generating plant owned by BSEB, was done in the year 2007 and Renovation and Modernization of 2x110 MW units each at BTPS and MTPS was approved by Planning Commission with limited scope of work.

To derive full benefit and ensure sustenance of desired PLF, certain essential infrastructural requirements are needed, which have not been included in the scope of repair and

maintenance work awarded to BHEL under RSVY. So, under BRGF scheme for the 12th Plan remaining works have been proposed. Bihar State Electricity Board is availing 300 MW Power under Short Term from September 2011 to November 2011. BSEB has initiated bidding process for procurement of 450 MW+20 percent under Medium Term for 3 years 10 months with effect from March 2012. Phase-1 of investment projects to strengthen the transmission system under the Rashtriya Sam Vikas Yojna has been completed. The augmentation of transmission system in the remaining part of the State is under progress in phase - II of the same scheme. Major works will be completed by March 2012. Out of sanctioned amount of Rs2246.58Crores, Rs1886 Crores has been spent so far for strengthening of transmission works of Phase I and II.

During the 12th plan period, the State Government will provide active support to ensure the financial viability of developing new transmission capacity in the State, and the SIPB will give priority to the clearance of new transmission systems. Wherever required, the State Government will also provide counterpart funding and guarantees for obtaining loans from central financial institutions and international funding agencies like ADB, World Bank, JBIC, etc. Existing transformation capacity with expected upcoming addition by March 2012 is 220/132 KV- 4650 MVA and 132/33 KV-5423 MVA. The transmission capacity would therefore require massive strengthening to support the projected growth. ADB have prepared a Master Plan for transmission through its consultant SNC LAVLIN. They have recommended year-wise enhancement of capacity of existing G.S.S. and installation of reactors, etc. at voltage level 400 KV to 132 KV level. The total capacity after aforesaid addition shall be 3320 MVA at the level of 400/220 KV and at level of 220/132 and 132/33 KV will be 9800 MVA and 13023 MVA, respectively. The above works have been proposed under BRGF.

In order to create the new infrastructure in the State transmission system and to augment the existing capacity of the transmission system, Bihar will follow the model of Public Private Partnership developed by the Planning Commission, GoI. This would help in improving efficiency, and reducing tariff. The above mechanism will also attract private investments in the development of State transmission system. The real challenge of reforms in Bihar's power sector lies in improving the efficiency of distribution.

The current power distribution system is characterized by huge ATC losses of approximately 45 percent, which calls for a radical change in the way electricity distribution is managed. Fundamental restructuring and institutional development of distribution operations is crucial to the reforms planned for the power sector as a whole. Distribution Reforms will contain the following elements:

- New distribution licensees for med as successor entities of BSEB will begin operations afresh, and without the burden of past losses, unserviceable liabilities and unrecoverable arrears.

- Feasibility of adoption of PPP Model for distribution management of Patna is being studied in collaboration with the Planning Commission. After feasibility study, PPP Model will be tried for four major cities viz., Patna, Gaya, Muzaffarpur, and Bhagalpur.

- Under Distribution reforms, NIT has been floated for awarding input based franchisee for rural and urban feeders. Hundred and seventeen bidders have participated for Rural Feeders and 11 for Urban

- Feeders. The tender is in the stage of finalization for the award.

Strengthening of distribution network of 49 towns (not covered under R-APDRP) whose population is more than 5000, has been proposed under BRGF for the 12th Plan. A total of Rs 245.47 Crores has been proposed for strengthening of 49 non-R-APDRP towns.

The lack of any medium or large hydropower plants in Bihar restricts its ability to meet peaking requirements or to have the flexibility to meet intra-day changes in system demand. Bihar has a current installed capacity of about 53.30 MW from small hydro power (SHP) and 27.00 MW is under construction with the potential for 250 MW more. SHP for 3.70 MW is likely to be added by March 2012. The State also has large hydro power generation potential in Dagmara 125 MW (Kosi) and Indrapuri 450 MW besides five pumped storage projects, pre-feasibility for which have been established by the BHPC.

Bihar has high potential of generation of renewable energy especially in the field of solar as well as biomass. The renewable energy production in the field of wind energy however is limited to some riverine and hilly regions only. The energy production through solar photovoltaic as well as solar thermal has immense potential in the state for power generation.

It is expected that the plateau and hilly areas as well as the riverine belts in Bihar have sufficient wind speeds suitable for wind power generation. Wind energy potential in Bihar is being assessed by C-WET, a GoI undertaking which has so far established 3 high mast stations at Adhaura (District Kaimur), Lalganj (District Vaishali) and Simultala (District Jamui). Three more places have been identified and are being assessed for their potential at Bodhgaya (District Gaya), Pirpahari (District Munger), and Ruxaul (District Motihari).

Rural electrification plays a vital role in all economic activities; it provides for a better quality of life and may be considered as an instrument the socio-economic development of remote areas. The State has good opportunity to cover these villages under RGGVY for DDG in the 12th FYP in a big way. For these, a large-scale survey of concerned villages is required and other preparatory works are also to be undertaken. This will facilitate the action plan and estimate of the costs. Primary work for preparing action plan has started. The New and Renewable Energy policy, 2011 has come into being which has several incentives, some of which are as follows:

- Single window clearance of the renewable projects through the State Investment Planning Board (SIPB).
- State Government would facilitate land availability through State Land Bank whenever necessary.
- The Bihar Electricity Regulatory Commission has fixed the purchase rate of the energy produced through renewable as well as the procurement quota year wise.
- The State government will facilitate loan from banks and other financial institutions to the project developers. Moreover wheeling facilities have been adequately defined and explained for all grid-connected sources of Renewable Energy electricity generation projects up to 25 MW.
- Provision for waiver of entry tax on equipment and electricity duty apart from other incentives available under the industrial incentive policies of the State.
- BREDA as a nodal Agency for the implementation of the Renewable Energy projects will co-ordinate with the provide project developers.
- The renewable energy production through biomass is another potential area for the state and to encourage investment in these projects special concessions are envisaged.
- The State government shall encourage project developers to install mechanisms such as Clean Development Mechanism (CDM) for leveraging funds for renewable energy-based power projects. BREDA is a nodal agency for helping private developers to apply for CDM benefits. Bundling of projects shall be encouraged for CDM application to make the initiative viable.

Bihar State Energy Conservation Fund has been constituted for the promotion of efficient use of energy and conservation. The state has three types of projects for consideration:

- Grid connected renewable energy projects based on biomass.

- Co-generation of renewable energy through bagasse in sugar mills and rice husk in rice mills.
- Off-Grid renewable energy distributing projects based on biomass. The investment of the private sector and cooperative sector is very important in the field.

There is an urgent need to have a system that encourages energy conservation and provides disincentives for inefficient use of energy. The State government shall promote measures for economy and efficiency in energy consumption. The State government also proposes to implement the provisions of the Energy Conservation Act, 2001 and to set up the State Resource Fund to promote activities for energy conservation.

In co-ordination with the Bureau of Energy Efficiency (BEE), PESU has planned to facilitate 'Bachat Lamp Yojna' in Patna on experimental measure. Demand side management will also be given emphasis. There is a compelling need for second green revolution for Bihar, which has a three-crop land and whose crop intensity is only 1.52. Ninety percent of the total energy required for irrigation purposes is to be met through conventional sources.

11.4 Perceived Climate Impacts

Today 70 percent of greenhouse gas emissions come from fossil fuel combustion for electricity generation, in industry, buildings, and transport – and these emissions are projected to rise. By 2050, the global population will grow to 9 billion, with growth mostly concentrated in developing countries with improved living standards. If we continue as we are today, delivering energy services and sustaining economic growth will result in a tripling of annual GHG emissions.

Climate impacts cross the entire energy supply chain. Impacts on energy supply and demand are the most intuitive but there are also direct effects on energy resource endowment, infrastructure, and transportation, and indirect effects through other economic sectors (e.g., water, agriculture). This exposure is driven in part by the current state of the sector (e.g., inefficiencies in energy and water use mean energy services are vulnerable and have less capacity to deal with change).

Increasing temperatures are almost certain to reduce heating demands but increase cooling demands overall, but inter-annual variability will remain and cold periods will not disappear. Seasonal demand profiles will alter responding to user needs for energy for heating and cooling in buildings, for industrial processes, and for agriculture (e.g., irrigation).

Energy transportation infrastructure (for power, oil, and gas) are also variously exposed to wind gusts, storms, storm-related landslides and rock falls, land movements, siltation and

erosion processes, as well as changes in water basins. The table below summarizes potential impacts on the energy sector.

Flooding and droughts will continue, with likely impacts on infrastructure (including silting of reservoirs), and on demand. Climate change may impact the generation cycle efficiency and cooling water operations of fossil fuel fired, nuclear, and biomass fired power plants. The generation potential of renewables may change but is impossible to assess without additional locally specific study:

- Hydro-generation may benefit or suffer, or both at different times, from changes in rainfall;
- Solar generation may not be affected in a substantial manner, although some regions may see future decreased generation;
- Wind generation may be impacted either positively or negatively by local adjustments to the wind regime; and
- Biomass/biofuel generation could be affected by changes in cultivation regimes.

Table 33: Potential energy sector vulnerability to climate change

Item	Relevant Climate Impacts			Impacts on the Energy Sector
	General	Specific	Additional	
Climate Change Impacts on Resource Endowment				
Hydropower	Runoff	Quantity (+/-) Seasonal flows high & low flows, Extreme events	Erosion Siltation	Reduced firm energy Increased variability Increased uncertainty
Wind power	Wind field characteristics, changes in wind resource	Changes in density, wind speed increased wind variability	Changes in vegetation (might change roughness and available wind)	Increased uncertainty
Biofuels	Crop response to climate change	Crop yield Agro-ecological zones shift	Pests Water demand Drought, frost, fires, storms	Increased uncertainty Increased frequency of extreme events
Solar power	Atmospheric transmissivity	Water content Cloudiness Cloud characteristics		Positive or negative impacts
Wave and tidal energy	Ocean climate	Wind field characteristics No effect on tides	Strong non-linearity between wind speed and wave power	Increased uncertainty Increased frequency of extreme events
Climate Change Impacts on Energy Supply				

Item	Relevant Climate Impacts			Impacts on the Energy Sector
	General	Specific	Additional	
Hydropower	Water availability and seasonality	Water resource variability Increased uncertainty of expected energy output	Impact on the grid Wasting excessive generation Extreme events	Increased uncertainty Revision of system reliability Revision of transmission needs
Wind power	Alteration in wind speed frequency distribution	Increased uncertainty of Energy output.	Short life span reduces risk associated with Climate change Extreme events	Increased uncertainty on energy output
Biofuels	Reduced transformation efficiency	High temperatures reduce thermal generation efficiency	Extreme events	Reduced energy generated Increased uncertainty
Solar power	Reduced solar cell efficiency	Solar cell efficiency reduced by higher temperatures	Extreme events	Reduced energy generated Increased uncertainty
Thermal power plants	Generation cycle efficiency Cooling water availability	Reduced efficiency Increased water needs, e.g., during heat waves	Extreme events	Reduced energy generated Increased uncertainty
Oil and gas	Vulnerable to extreme events	Floods, erosion and siltation (coastal areas, on land)	Extreme events	Reduced energy generated Increased uncertainty
Impacts on Transmission, Distribution, and Transfers				
Transmission, distribution, and transfers	Increased frequency of extreme events Sea level rise	Wind and ice Landslides and flooding Coastal erosion, sea level rise	Erosion and siltation Weather conditions that prevent transport	Increased vulnerability of existing assets
Impacts on Design and Operations				
Siting infrastructure	Sea level rise Increased extreme events	Flooding from sea level rising, coastal erosion Increased frequency of extreme events	Water availability Geomorphodynamic equilibrium	Increased vulnerability of existing assets Increased demand for new good siting locations
Downtime and system bottlenecks	Extreme weather events	Impacts on isolated infrastructure Compound impacts on multiple assets in the energy system	Energy system not fully operational when community requires it the most	Increased vulnerability Reduced reliability Increased social pressure for better performance
Energy trade	Increased vulnerability to extreme events	Cold spells and heat waves	Increased stress on transmission, distribution, and transfer	Increased uncertainty Increased peak

Item	Relevant Climate Impacts			Impacts on the Energy Sector
	General	Specific	Additional	
			infrastructure	demand on energy system
Impacts on Energy Demand				
Energy use	Increased demand for indoor cooling	Reduced growth in demand for heating Increased energy use for indoor cooling	Associated efficiency reduction with increased temperature	Increased demand and peak demand, taxing transmission and distribution systems
Other impacts				
Cross-sector impacts	Competition for water resources Competition for adequate siting locations	Conflicts in water allocation during stressed weather conditions Competition for good siting locations	Potential competition between energy and non-energy crops for land and water resources	Increased vulnerability and uncertainty Increased costs

11.5 Strategies

The energy sector vision is to strive for improved energy security in Bihar through multiple strategies including improving generation, transmission, distribution, scaling up use of renewables, promoting energy efficiency across all sectors, as well as fostering mechanisms for demand side management.

A range of initiatives is already underway in the State as described in Section. New initiatives are planned under the 12th FYP Approach Paper; additionally, the State has now developed a Hydropower Policy as well as a Bihar Policy for promotion of New and Renewable Energy Sources 2011.

The State recognises that while energy systems already take account of some climate risks in their operation and planning, adaptation measures can further reduce their vulnerability to environmental change, by building capacity and improving information for decision making, and integrating climate risks into management and operational decisions, and as such, is committed to taking all necessary measures to build in climate concerns into energy sector policy, planning, and implementation. The Energy Department has already planned a set of measures in the context of climate change, and these are given below:

11.5.1 Generation

Since coal based thermal power plants are the highest contributors in CO_2 emissions, the following actions are being taken to improve the overall efficiency of such thermal power stations:

- Renovation and modernisation of existing units to restore original efficiency along with reduced auxiliary power consumption and reduced chimney emissions. Modernisation work on the BTPS units 6 and 7 are expected to be completed by February 2013, and for the MTPS units 1 and 2, by December 2012;
- Adoption of super critical technology for all upcoming coal based power stations to have better efficiency and reduced emissions;
- Fly ash utilisation is part of each plant's environment plan. While some quantity of fly ash is used in land development, expressions of interest has been sought from cement manufacturers for use of fly ash for their current needs and future expansion projects;
- Sufficient green lands have been identified around future projects; and
- Feasibility of gas based and nuclear (including thorium-based) power plants are being explored.

11.5.2 Transmission

The following measures have been planned to reduce transmission losses:

- Expansion of high voltage transmission network with latest and state of the art technologies and adequate coverage network to prevent loading beyond limits;
- Use of sufficient reactors and capacitors in the network;
- Replacement of old and jointed conductors;
- Better load management, efficient scheduling and use of information systems to achieve optimum network utilisation; and
- Proper upkeep of GSS transformers.

11.5.3 Distribution

The following measures are being taken and planned to reduce AT&C losses:

- Replacement of old and jointed conductors;
- Procurement of start rated distribution transformers and load balancing of existing ones;
- Tariff structure to be such as to levy lower tariff for lesser energy consumption and ToD tariff, etc. to promote lower energy withdrawal and promote conservation;
- Underground cabling in green areas;

- Addition of adequate capacitors and upkeep of PSS transformers and distribution transformers;
- Expansion of network with high HT/LT ratio;
- Adoption of HVDS systems where feasible and putting into place effective anti-power theft measures; and
- To facilitate power supply for monorail and metro-rail schemes envisaged for Patna as part of improving public transportation systems, which will also be expected to considerably reduce emissions.

11.5.4 Demand Side Management

The following demand side management measures have been planned:

- Promoting the use of energy efficient pumps and motors in the State;
- Implementing promotion of CFLs under the Bachat Lamp Yojana (BLY) in identified areas of the PESU and expanding the scheme to other parts of the state in a phased manner; and
- Investing in building consumer awareness about energy efficient equipment and energy conservation measures.

11.5.5 Small Hydropower Projects

The State intends to develop large hydropower projects and pumped storage schemes either through loan from bilateral/multilateral funding agencies or as joint ventures with government companies such as the National Hydro Power Corporation (NHPC) or even through private sector participation.

Bihar has a current installed capacity of about 53.30 MW from small hydropower (SHP) and united to generate an additional 27 MW are under construction, with the potential for an additional 250 MW. SHP capacity for 3.70 MW is likely to be added in the immediate near future. The State also has large hydropower generation potential in Dagmara by way of 125 MW in the Kosi, and 450 MW at Indrapuri, besides five pumped storage projects, pre-feasibility for which has been established by the BSHPC.

The DPR of the Dagmara HEP has been prepared, and is currently being modified before submission to the CEA. The State intends to complete both the large projects by the end of the 12th Plan period, and as such, the installed capacity in Bihar is likely to be around 209 MW by the end of the 12th Plan period.

11.5.6 Renewable Energy Projects

Renewable energy based generation has a significant role to play in Bihar especially in the biomass and small hydro subsectors. Given the predominantly agrarian nature of the economy, such sources are likely to be self-sustaining and economically viable. In addition, it is expected that the plateau and hilly areas as well as the riverine belts in Bihar have sufficient wind speeds suitable for wind power generation. As such wind energy potential development is to be shortly taken up in the State for assessment under the sanction of the Ministry of New and Renewable Energy.

BREDA has been nominated as the nodal agency to take up rural electrification work in those villages which are inaccessible or where conventional grid connectivity is not commercially viable. The State has decided to sign MoUs with the GoI to take up rural electrification work in such villages. The preparatory work for the survey of these villages is being taken up and accordingly, plans will be prepared and submitted in due course.

To encourage local private sector participation in renewable energy power generation projects including solid waste and sewerage gas based projects or decentralised distributed generation (DDG), the policy will include renewable energy projects, and adequate budgetary allocations in plan funds to augment Central support.

The State will also work closely with the Electricity Regulatory Commission to fix the renewable energy procurement quotas and tariffs for renewable energy based power over the next six months or so. The State will also provide banking and wheeling facilities for all grid connected renewable energy electricity generation projects up to 25 MW. Entry tax will be waived on capital costs for equipment for DDG based renewable energy plants of less than five MW.

The State will also encourage project developers to install or adopt mechanisms such as Clean Development Mechanisms (CDM) for leveraging funds for renewable energy based projects, and BREDA is the nodal agency for coordinating this. Bundling of projects or initiatives will also be considered. As part of the State's commitment to renewables, the BERC has made provision of renewable power purchase obligation by distribution licensees from 2.5 percent in 2011-12 to 5 percent in 2014-15. Such obligation also includes a minimum 0.5 percent of solar power in 2011-12.

11.5.7 Other Initiatives

- Research, Climate Impacts Needs Assessment
- Awareness and knowledge exchange
- Development of project screening tools
- Development of adaptation standards for the energy sector

- Promotion of energy efficiency
- Capacity building
- Addressing poverty and equity concerns

11.6 Institutional Linkages and Stakeholders

Institutional linkages are envisaged with virtually all state government departments and other institutions, since efforts will be required across sectors, especially in the promotion of energy efficiency measures. Linkages are also envisaged with academia, civil society, international development agencies, private sector and financial institutions, and communities in general.

11.7 Linkages with the NAPCC

The outlined strategies herein are consistent with the NAPCC in general and with the national Mission on Energy Efficiency as well as the national Solar Mission. Additionally, they also have linkages with the all the other National Missions under the NAPCC.

11.8 Sectorial Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

12 Industries and Mining

12.1 Overview, Characteristics and Status

12.1.1 Industrial Situation

The small industries in the state are dominated by tiny enterprises and artisan based industries and its share is as high as 99.9 percent among all the Medium, Small, and Micro Enterprises (MSME) units. Though Bihar's enterprises sector is the smallest in India, it too felt the pinch of global downturn and registered a marginal decline of (–) 3.7 percent in the growth rate of manufacturing sector in 2009-10. In 2010-11, however, it grew by 8.9 percent and is projected to increase further to 9.2 percent in the current year 2011-12.

Table 34: Large scale industries in Bihar (2010-11)[24]

S.No.	Type of Unit	Number	Location
1	Rural Agriculture Business Centre – Fruit Processing	7	East Champaran, Vaishali, Ara, Purnea, Muzaffarpur, Samastipur
2	Food & Vegetable Processing	2	Muzaffarpur, Nalanda
3	Rice Mill	9	Rohtas, Gaya, Banka, Kaimur
4	Roller Flour Mill	6	Patna City, Patna, Darbhanga, Ara
5	Biscuit Production	3	Hajipur, Muzaffarpur
6	Edible Oil/ Refined Vegetable Oil	3	Ara, Rohtas
7	Others	6	Araria, Muzaffarpur, Munger, Banka, Bhojpur
	Total	**36**	**-**

12.1.2 Processing Industries

There are only 45 licensed fruits and vegetables processing units in the state and most of these are engaged in manufacturing fruit juices, pulps, squashes, pickles, tomato ketchup/juice/puree, and jam/jelly, etc. The fruits and vegetables processing segment is marked by a complete absence of cold chain, resulting into quality deterioration of raw materials. Further, even after processing, the products are kept under either minimum refrigeration or no refrigeration. A large number of processing units operate on work-order basis for longer chain and, therefore, the operative margins are very thin, leaving no scope for technology upgradation or expansion.

Presently, there are around 5000 rice mills in the state of which over 95 percent are hullers. Only 5 percent of these mills may be considered as modern. There is a tremendous potential in maize processing, which needs to be exploited on commercial basis. The potential of maize-based products are corn oil, poultry, and animal feed, and high value products like ethanol and extra neutral alcohols, given the high protein

[24] Source: Department of Industry, GoB

content of Bihar maize. There are only a limited number of medium sized registered maize-processing units in the state, with no estimate available for unregistered units. Some large private players have recently shown interest in maize processing in the state.

The sugar industry is another important agro-based industry in Bihar. It generates considerable employment in the farm sector, both directly and through ancillarisation and related activities. Among the agro-based industries in the state, tea industry is growing very fast and has started assuming a place of importance involving 1000 small and medium planters employing about 30,000 people.

Bihar produces around 3 million tonnes of milk, which accounts for 3.28 percent of the total milk production in the country. Only about 10 percent of the milk production is processed by COMFED (Sudha Dairy). Compared to the annual growth rate of 4 percent in India, milk processing in Bihar has recorded a much lower rate.

Bihar is one of the leading honey producing states in India, accounting for almost half of the country's total production of 8400 tonnes. The litchi honey is produced on commercial scale, sold at prices at par with some of the premium honey in the world market, because of its uniqueness. The yield of honey with the Italian honeybee species is the highest in Bihar compared to other states, with a production rate of 40 and 60 kgs honey/hive/year, for stationary and migratory beekeeping respectively.

12.1.3 Non Agro-Based Industries

There are a large number of handloom units in Bihar, of which 10,850 are under cooperative sector and 25,503 units are outside. Besides, there are 11,361 power looms in the state. The state has a great potential of leather-based industries. There are around 50,000 footwear artisans in the state. The state also has tanneries in both the public and private sectors. The major problem faced by the tanneries is the disposal of industrial waste. This necessitates establishment of the Common Effluent Treatment Plan (CETP), and unless this is established, the existing tanneries may also face environmental problems and ultimately will be forced to close down production. The major minerals in the state include pyrite, limestone, and mica, whereas minor minerals primarily consist of sand and stones. The decorating stones like granite, magnate, and quartz are also available in large quantity. A fair proportion of major mines fall under forest areas rendering it almost difficult to approve mining lease for the mining work.

12.2 Key Issues

The industries in Bihar remained plagued by a plethora of problems. According to Economic Census 2005, out of a total of 12.25 lakh enterprises, only 7 percent were financed by banks, 80 percent enterprises did not have power linkage, 11 percent functioned without premises and 4 percent were seasonal. Only 63 percent enterprises were registered and 82 percent had only five or less employees. At all-India level, a total of 1.55 lakh factories were covered in 2008-09 as against 1777 in Bihar, of which 96.76 percent and 87.17 percent respectively were in operation.

A comparison with the corresponding figures for 2007-08 reveals that while the percentage of operational units for all- India showed a moderate increase, the same for Bihar recorded a decline. A detailed analysis of the data further reveals that while at all-India, the proportion of agro-based factories in operation remained almost the same in both the years, the same for the non-agro based industries showed a modest increase. However, in Bihar, the proportion of units in both the categories registered a drop in 2008-09, more so for the non-agro based industries.

The industrial group-wise analysis of net value added shows that, except for food products/beverages/tobacco, all other groups under agro-based industries performed poorly in terms of the state's share to all-India in 2008-09, compared to 2007-08.

The major agricultural products of Bihar are cereals, pulses, and oilseeds, along with varieties of fruits and vegetables like mango, litchi, makhana, potato, tomato, cauliflowers, etc. However, the farmers have been unable to harness the full benefits of these important agricultural products in the absence of processing industries, which have also high potential for employment generation. It is all because of poor pre-and post-harvest management, as well as inadequate infrastructure for food processing.

Bihar is pioneer in production of rabi maize of quality variety with high protein content. The farmers are shifting from wheat to rabi maize in the state for quite sometime. However, there are no processing facilities worth the name to complete the supply chain of maize and, as such, bulk of maize goes out of the state for milling and maize-based products. Similarly, all the groups under non-agro based category registered a major setback, primarily on account of poor post- recession recovery, accentuated by poor infrastructure in the state.

Bihar has witnessed complete turnaround during the last 6 years, and the state has moved ahead on the trajectory of development with justice. However, the revival of sick industries is yet to take place. With the creation of SIPB in the state, a total of 42,941 investment proposals have been received since 2007-08. But, there remains a vast gap between the investment proposals received, proposals approved and actual

investments made. Though all efforts are made by the state government, yet the slowing of the Indian economy in recent years has affected the growth of the state's enterprises sector.

12.3 Priorities

In the 12th FYP, focus will be on intensive efforts to promote industrial growth in areas where the state has comparative advantage such as agro and food processing, tourism, healthcare industry, higher and technical industrial education, FMCG and other consumer goods, secondary steel sector, textiles, power and renewable energy generation. Growth of the manufacturing sector in the 11th Plan is likely to remain at 8.2 percent.

There is need to raise this growth to 11-12 percent per year in the 12th Plan period to create more jobs for the growing labour force. This has become an urgent need, since it is now clear that agriculture will no longer absorb more workers. The manufacturing sector (industry) performance is weak at the present scenario. Hence it has to perform better in investment, production, and creation of jobs.

The overall strategy under the 12th FYP will include:

- Promoting MSMEs 'cluster';
- Thrust on skill upgradation/Skill development Institutions. To adopt and encourage PPP mode of investment;
- Revival of PSUs of the state;
- Rehabilitation of Sick Units; and
- To promote value added production (food Processing) diversified products- milk, fish, meat, and poultry, agro based wealth- consumer products.

The State government and private sector will collaborate for development of tourism infrastructure. The state government will prepare an area-based Master Plan for developing infrastructure as necessary for the respective areas and regions. Efforts will be made to dovetail external assistance, central assistance, and the State plan resources with private investments to attain the set goals as under the Master Plan.

12.4 Perceived Climate Impacts

While there have been no Bihar specific detailed studies on climate change available evidence shows several pointers, as in the case of the energy sector. Industry is likely to

be vulnerable to a variety of climate risks, including extreme weather events that can adversely impact industrial infrastructure. Agro-based and food processing industries that rely on agricultural resources can be particularly vulnerable. Likewise, industries that are either water or energy intensive could also be similarly vulnerable to climate change and its impacts. Because of their financial and technical resources, large industrial organizations typically have a significant adaptive capacity for addressing vulnerability to weather extremes. SMEs typically have fewer financial and technical resources and therefore less adaptive capacity.

As such, climate change is likely to disproportionately impacts smaller industrial establishments, in particular those in high risk or highly dependent on climate vulnerable resources such as agriculture. On the other hand, industries could also contribute to climate change. The industrial sector emissions of greenhouse gases (GHGs) include carbon dioxide (CO_2) from energy use, from non- energy uses of fossil fuels and from non-fossil fuel sources (e.g., cement manufacture); as well as non-CO_2 gases. Many industrial segments also emit a range of non-CO_2 GHGs including N_2O from the chemical and food industries. Industries can also contribute to climate change by a variety of other means, including energy inefficiency.

12.5 Strategies

Towards improving scientific knowledge and evidence base and understanding of climate change and its impacts, the Department will commission cluster-wise or district-wise studies to estimate the carbon footprint of industrial clusters in the State. This would include a baseline study, as well as periodic studies. In line with the overarching State objectives of improving governance mechanisms, institutional decision-making and convergence, the Industries Department, together with various industries associations will initiate the following:

- Carry out a review of the current industrial policy and strengthening it with reference to climate change including explicit incorporation of climate concerns and the institutional and governance framework for climate change initiatives vis-à-vis industry will be enshrined in a proposed new Industrial policy;
- Constitute a state-level Task Force, comprising representatives of the state government, industry, and technical experts to drive the climate initiatives of the BAPCC. The possibility/viability of establishing cluster-wise or district wise Sub-Task Forces will also be examined.

The Industries Department recognises that many options exist for mitigating GHG emissions from the industrial sector, in three broad categories:

- *Sector-wide options,*
- *Process-specific options,*
- *Operating procedures,*
- As such, the Department will identify and put into motion processes for leveraging these options in existing industrial units, as well examine ways to build these into plans for the development of new industrial units. While it is clear that industries will not invest in GHG mitigation if other factors provide a return on their investment, the Department will examine ways of incentivising such investments and linking it to initiatives such as energy efficiency projects, through which economic gains can accrue.
- Where industries lack of the financial and technical resources needed to implement mitigation options, and have limitations in the ability to access and absorb technological information about available options, the Department will seek to build adequate linkages with financial institutions as also to build capacities of industrial establishments (potentially in partnership with other relevant agencies/institutions/industries associations).
- The Department will also seek to develop appropriate policy and regulatory instruments that encourages the implementation of existing and new mitigation technologies that could lead to lower GHG emissions, and seek to develop policy portfolios that reduce the barriers to the adoption of cost-effective, low-GHG-emission technologies, including CDM. The Department will also examine the possibility of promoting voluntary agreements between industry and government to reduce energy use and GHG emissions as part of its policy package.
- The Department will promote and build awareness, and develop and deploy measures to incentivise industries to adopt a range of management practices including energy audits, adoption of energy efficiency measures and technologies, benchmarking, etc. Likewise, the Department will also build awareness on options, opportunities and benefits of fuel switching, including the use of waste materials, energy (especially heat and power recovery), cogeneration (which could, for example, be readily adopted in Bihar's sugar industry), use of renewable energy including biomass and by-product wastes based generation, and materials efficiency and recycling. Efforts will also be initiated to undertake infrastructural improvements in industrial areas in the State.
- The Department will also examine the options for developing and deploying a range of financial instruments such as taxes, subsidies and measures to improve

access to capital as these could potentially lead to energy savings and corresponding emission reductions and can create a larger market for energy efficient technologies. At the same time, the Department will also examine options for budget allocations for research and development on innovative technologies, subsidy, or legislation to stimulate specific environmental technologies, or regulation/disincentives to reduce/eliminate use of unsustainable technologies.

- The Department will also take proactive steps to build partnerships with industry associations, and through them, initiate sustained process to stimulate technological innovation and change to reduce dependency on imported fuels, to improve resources use efficiency, waste management, water and air pollution reduction, and enhance use of renewables, while providing health benefits and improved services to communities. Sector specific studies will also be undertaken, to examine options for improvement – these will include, for example, the brick making sector, which generates significant emissions from a large number of brick kilns in the state.

Mining activities are negligible in the State after the separation of Jharkhand, and as such, will not need focus on in the BAPCC. However, the Department will undertake a study of the mining sector, its status, and prospects from the standpoint of climate change and its impacts in association with the Department of Mines and Geology. Appropriate strategies and actions for the mining sector, if required, will be developed on the basis of the findings of the study.

12.6 Institutional Linkages and Stakeholders

Institutional linkages are envisaged various agencies/departments including BIADA, the Energy Department, Water Resources Department, Environment and Forest Department in addition to linkages with various industries associations, industrial groups and entrepreneurs, as well as with academia, civil society, international development agencies, private sector and financial institutions, and communities in general.

12.7 Linkages with the NAPCC

The outlined strategies herein are consistent with the NAPCC in general, as well as with the National Mission on Energy Efficiency, the National Solar Mission, the National Mission for Sustainable Agriculture, and the National Water Mission.

12.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

13 Human Health

13.1 Overview, Characteristics and Status

13.1.1 Key Health Indicators and Performance

Climate Change may be described 1st as "global" and 2nd as "nature". **Global** - Change includes environment disturbance arising from localized source, but having widely dispersed effects. Global climate changes occur because of perturbation in systems operating on a global level, and this makes stand out from other wide-ranging, human induced environmental problems. **Nature –** Nature of Phenomenon and not by the distribution of its impacts.

The average temperature is a convenient metric for describing climate, but there are other aspect of climate change that is more closely related to the incidence of disease and injury.

Besides education, the status of health is also an important component of the human development of a state. The status of health services in Bihar is still inadequate, but substantial improvements have been recorded in this sector in recent years. This is because of increase in expenditure for health services on one hand and better monitoring of the health services on the other.

This section will present the relevant information on the various initiatives taken by the state government to improve the health services in the state. These improved services have indeed resulted in improved overall health situation in the state, as indicated by some crucial health indicators. One of the key indicators of status of health in the state is the Infant Mortality Rate (IMR). In spite of being the poorest state in the terms of per capita income and having the least literacy rate, the IMR in Bihar is 48 per thousand live births in 2010, nearly equal to national average of 47 per thousand live births. Between 2005 and 2010, the IMR in India has been reduced from 58 to 47. This pace of decline was even higher for Bihar, as the IMR for Bihar has decreased from 61 in 2005 to 48 in 2010.

For the period 2005 to 2010, the rate of decline in birth rate in Bihar is higher than the national average; but there is a still a long way to go to attain the replacement level fertility rate.The District Level Household Survey (2002-04 and 2007-08) and Coverage Evaluation Survey (2009) conducted by Ministry of Health and Family Welfare of the central government show that there has been considerable improvement in Bihar as

regards Ante-Natal Care (ANC) for mothers, institutional delivery, and immunisation of children.

13.2 Key Issues

Key issues in the health sector primarily centre on the availability of health infrastructure, which is lower than national standards/averages. Drinking water supply and sanitation coverage and infrastructure is also relatively low, leading to frequent outbreaks water-borne diseases. This is further compounded by frequent floods, heat and cold waves that the State experiences. Shortage of skilled frontline health personnel (ANM, LHV) to provide timely and quality ANC and PNC services is another problem confronting the state. Besides, public health facilities providing obstetric and gynaecological care at district and sub-district levels are inadequate.

Bihar also has a high burden of diseases, which arises from natural calamities (such as floods), poor environmental conditions (such as water and vector borne diseases), poor nutrition status, and acute poverty in which a day's wage is a significant incentive to skip treatment.

13.3 Priorities

Under the 12th FYP, expansion of the State's health infrastructure will be accorded high priority. Two bills namely – (1) Bihar Clinical Establishment (Registration and Regulation) Act and (2) Bihar Medical Service Institution and Individual Protection Act have been passed by the State government. With the enactment of Bihar Clinical Establishment Act, qualitative health services will be made available at government and private health hospitals.

At the same time registration will also be essential. Bihar Medical Service Institution and Individual Protection Act ensure security to doctors and health personnel at one end and on the other hand also ensure that the poor and the common people are experiencing excellent services at the health facility. By making Bihar Medical Services and Infrastructure Corporation limited functional steps are being taken for purchasing of equipment and construction of buildings. Setting up of Advance Trauma Centre is being taken care of by State Health Society, Bihar.

ANM and GNM Training Schools will be strengthened after increasing the number of seats as well as setting up new nursing colleges. Private players will be especially encouraged to establish such schools and colleges. The state plans to move ahead with

five primary objectives that are going to define its guiding principles in the sector in the coming years:

- Reduce Maternal Deaths
- Reduce infant deaths
- Reduce Total Fertility Rate
- Increase availability of medical professionals
- Reduce barriers to access health services

Keeping in view the dearth of Super Specialist Hospitals in the state, at least one Super Specialist Hospital will be established for each main disease in next five years. In order to reduce the number of patients going outside for treatment, quality changes are being made in health facilities located within the State. Efforts are being made to enhance facilities provided by Mahavir Cancer Sansathan so that number of patients moving out of state for treatment can be reduced.

The proposals to build three medical colleges in the state and its proper functioning will be ensured. Besides, investors will be encouraged to invest for private medical colleges. With the vision to strengthen the present medical colleges of the state, facilities like building, specialized equipment, trained doctors and para-medical doctors will be provided. In order to bring better health facilities to the present medical colleges, efforts for improvement are being made by contacting Public Service Engineering Department for building and electricity. Steps to improve all the medical colleges will be planned.

13.4 Perceived Climate Impacts

The three main categories of health risks include:

(i) Direct-acting effects (e.g. due to heat waves, amplified air pollution, and physical weather disasters),

(ii) Impacts mediated via climate-related changes in ecological systems and relationships (e.g. crop yields, mosquito ecology, marine productivity), and

(iii) The more diffuse (indirect) consequences relating to impoverishment, displacement, resource conflicts (e.g. water), and post-disaster mental health problems.

No detailed studies are currently available documenting climate vulnerability and risk to the health sector in Bihar. However, a range of other studies has shown that climate Change is bound to affect the basic requirements for maintaining health. It leads to

extremes and violent weather events; resurgence of disease organisms and vectors; affects the quantity of air, agriculture and water; and the stability of the ecosystems.

A study was carried out to find out co-relation between rainfall and instances of malaria infection in different villages of Purnia district, Bihar. The study clearly indicates that there occurs a high positive co-relation between rainfall and instances of malaria in the studied villages of the district. Data of monthly rainfall (mm) and instances of malaria in Purnia district are shown in table 1 and fig. 1. The result of the study show that except for colder months of the year (Nov to Feb), infection of malaria was in rise during rest of the eight months .The study revealed a trained of rise from the month of May to August (Table 35 and Figure 21), When peak value of patients were found in the district. The instance of malaria started falling from September (Table 1 and Fig. 1).The instances of malaria increases as the amount of rainfall increased.

Table 35: Average monthly value of rainfall and malaria cases in Purnia district during the period of Sept 2010 to Aug 2010 (source: Ranjana Kumari and B. N. Pandey, Egypt. Acad. J. Biolog. Sci., 5(1): 193-195 (2012))

MONTHS	RAINFALL in mm	NO. OF POSITIVE CASES
SEP. 2010	7.38	9
OCT.2010	5.65	7
NOV.2010	0.2	0
DEC.2010	Trace	0
JAN 2011	0.15	0
FEB 2011	2.86	1
MARCH2011	2.9	2
APR2011	0.82	0
MAY2011	4.33	5
JUNE 2011	13.89	10
JULY 2011	11.28	9
AUG 2011	14.51	12

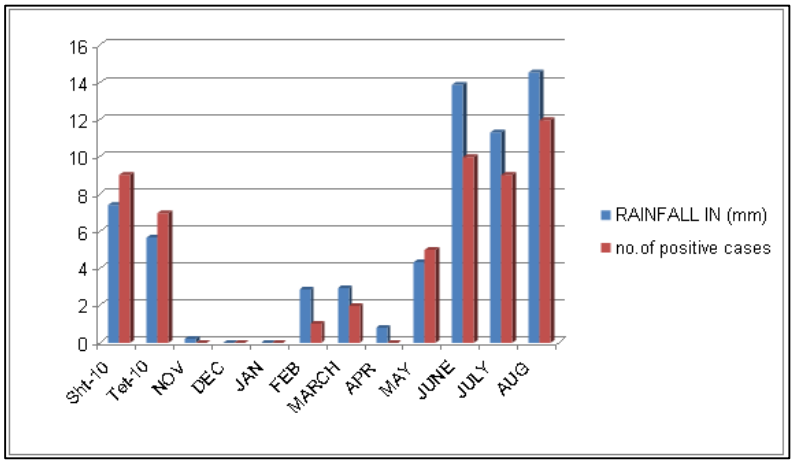


Figure 21: Average monthly value of rainfall and malaria cases in Purnia district during the period of September 2010 to August 2010 (source: Ranjana Kumari and B. N. Pandey, Egypt. Acad. J. Biolog. Sci., 5(1): 193-195 (2012))

The maximum cases of malaria where observed in rainy season, when rainfall by maximum (Table -1) followed by summer and winter. The incidence of malaria was maximum in the month of August followed by June and July. This clearly indicates that there is positive co-relation between incidence of malaria and pattern of rainfall. The malaria shows its appearance in the month of February, when ambinent temperature is quite congenial for the parasite, vector as well as host.

13.4.1 Future Projection

No significant changes in Malaria transmission is seen over Bihar for future time periods as in Figure 22

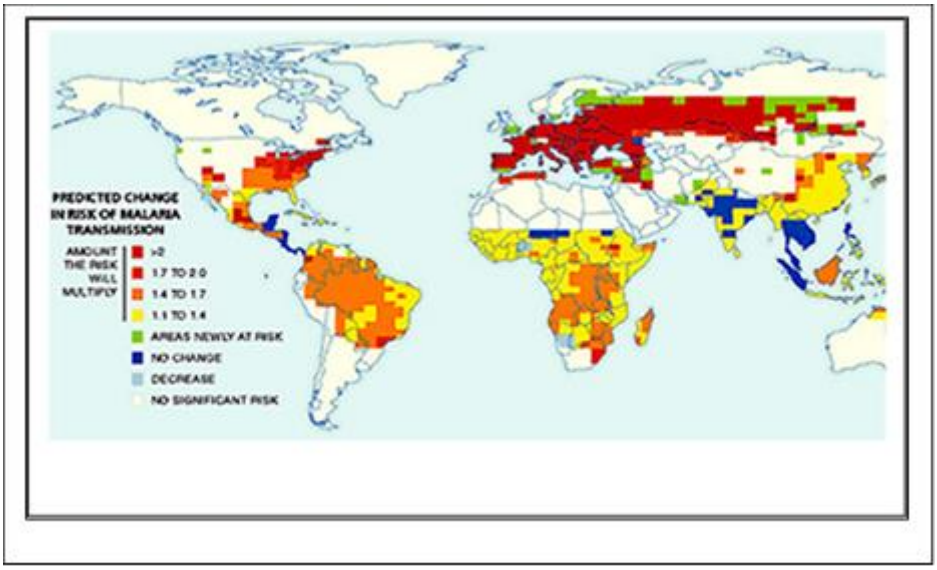


Figure 22: Projected risk of malaria transmission in the year 2020, compared with the average risk in the years 1961 to 1990 (Source: IPCC 2007)

13.5 Strategies

The State Health Department is committed to the health and wellbeing of all citizens and visitors to the State, and as such, the Department will stake the necessary steps to gear up for the potential health impacts from climate change, while continuing to contribute to the achievement of the State's health targets as well as the national health targets plan for 2012 – 2017. As the highest priority agenda, a Climate Change Cell will be constituted in the Health Department, as well as district level sub-cells and these will be mandated the task of coordinating all climate related activities of the Department under the BAPCC as well as liaising with the State institutional and coordination mechanisms outlined in an earlier section of this report.

The Department will undertake collation and review of all available material and evidence related to climate change impacts on human health, and also undertake a

review of health policies, plans, and nstitutional frameworks in the State with a view to incorporating climate concerns. In line with the overarching principle of improving scientific knowledge, evidence base and understanding of climate change and its impacts on human health, the Health Department will begin building a strong evidence base including collecting, compiling, and analysing relevant data and information in terms of perceptions of affected people and communities.

Based on the results of the comprehensive vulnerability analyses to be undertaken by the State, will review the adequateness of its current plans and institutional frameworks to respond to climate concerns in the health sector at all levels. Plans at all levels including the District health Plans will be suitably amended.

Based on current evidence, it is anticipated that the Department will initiate action relating to:

- Coordination with other departments will be a key strategy towards seeking a comprehensive health plan within the state. Towards establishing this a state level coordination committee comprising of members from ICDS, Panchayati Raj, Education, Water and PHED under the chairmanship of Development Commissioner would jointly work to seek support from other development departments in improving the quality of service delivery is proposed.
- Conducting regular survey and surveillance for heat related illness and Filling up the existing shortfalls in the health infrastructure of the State and increasing the percentage of population covered under the health drugs.
- Awareness building for the decision makers: Awareness generation and training programs to sensitize them on the climate change and its impact on human health
- Integration Early Warning System with health departments – Short term weather forecast and seasonal forecasts should be used to plan for the coming weeks and season ahead. This will allow for early action in terms of procurement and pre-positioning of stocks and giving health prevention message to communities.
- Setting up of an Institute of Environmental Health Sciences: A full- fledged institute in the state to undertake operational research on epidemic-prone diseases and also to impart training for different functionaries of the health services department and other line departments. Research studies on the eco-epidemiology, virology, parasitology, entomology, and environmental factors with respect to the epidemic- prone diseases can be undertaken under the institute.

- A hub at the Panchayat level is proposed that could provide various entitlement based facilities to people. For achieving efficiency, accountability and providing transparent services focus will be on developing the capacity of the departments; improve the direction, utilization and effectiveness of budget spending, enhance the availability of skilled medical, nursing and support professionals, strengthen information, monitoring and evaluation systems, enhance the capacity for strategic planning and evidence based decision making, improve governance, social accountability and transparency.
- Identify most vulnerable communities – Identify specific population with limited capacity to adapt to various health related stresses.
- Undertaking measures to manage increased vector borne and water borne disease burden;
- Design and deploy improved approaches to deal with heat and wave conditions;
- Dealing with the physical and psychological impacts post-extreme weather events.
- Addressing drought, malnutrition, and food security issues; and
- Addressing food safety arising due to increased ambient temperature and extreme events.
- Undertaking reviews of the State's health infrastructure and potential climate change related vulnerabilities and risks (and where such infrastructure is found to be at high risk, retrofit to make these more climate resilient);

The Department will initiate a range of capacity building measures including:

- Awareness of people about health hazard from climatic change, covering all areas like rain water harvesting, energy efficiency, health hazards, water conservation, protection from extreme climate etc.;
- Information, education and communication efforts;
- Behavioural change communications interventions in relation to the impacts of climate change;
- Trainings and Sensitizations for Department personnel;
- Capacity Building of the all medical personnel of in districts including frontline functionaries and personnel associated with various programmes such as the Integrated Disease Surveillance Programme, Auxiliary Nurse Midwife, Aanganwadi Worker, ASHA & all the medical NGO's in the district to identify the early signs of extreme climatic effects on the population; and

- Developing and strengthening of disaster management teams in every district hospital specifically to respond to the effect of extreme climate changes.

13.6 Institutional Linkages and Stakeholders

Institutional linkages are envisaged various agencies/departments including the Agriculture Department and the Water Resources Department, in addition to linkages with various industries associations, industrial groups and entrepreneurs, as well as with academia, civil society, international development agencies, private sector and financial institutions, and communities in general.

13.7 Linkages with the NAPCC

The outlined strategies herein are consistent with the NAPCC in general.

13.8 Sectoral Action Plan and Budgets under the BAPCC

See Part C, Action Plans and Budgets

Part C: Climate Change Action Plans and Budgets

Annexure 1: Overarching State Level Actions

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Coordination and networking	Coordination/management	Setting up of State Climate Change Action Plan Coordination Cell	1 year		Multi-sector coordination across all departments	Streamlined mechanisms for coordination of all activities under the BAPCC
Climate risk assessments	Risk management	Detailed vulnerability assessments across all focus sectors	1 year		Multi-sector approach	Improved understanding of climate change vulnerabilities and risks across sectors and districts
State Centre for Climate Change	Scientific research, cooperation and capacity building	Setting up of State Centre for Climate Change	1 year		Coordination across scientific community in state and elsewhere; coordination with Bihar Space Applications Centre and other remote sensing centres/agencies	Coordination mechanisms for scientific research and capacity building on Climate change
		Roadmap for Sector climate change impacts evidence base strengthening and documentation	1 year		Coordination across scientific community in state and elsewhere; convergence with focus sectors	Detailed strategy for collation and strengthening of evidence base towards improving scientific understanding of climate change and impacts
Capacity Building	Human resource development	Capacity needs assessment and roadmap for capacity building at State level	1 year		Convergence with focus sectors	Clear understanding of capacity needs at State level vis-à-vis climate change and its impacts
Monitoring and Evaluation	Monitoring	Development of detailed reporting and M&E plan	1 year		Convergence with all line departments	Comprehensive framework for M&E for the BAPCC

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Knowledge management	Knowledge management	Development of detailed KM strategy	1 year		Convergence with all focus sectors	Detailed multi-year strategy for KM under BAPCC
Medium-term actions						
Climate Change Coordination Cell	Coordination/management	*To be detailed by GoB*	5 years (12th FYP period)		Convergence with all focus sectors	Fully functional Climate Change coordination cell
State Centre for Climate Change	Scientific research, cooperation and capacity building	*To be detailed by GoB*	5 years (12th FYP period)		Convergence with all focus sectors	Fully functional State Centre for Climate Change
Capacity building	Human resource development	*To be detailed by GoB*	5 years (12th FYP period)		Convergence with all focus sectors	Improved state capacities to understand and address climate change issues
Monitoring and evaluation	M&E	Quarterly BAPCC monitoring reports	5 years (12th FYP period)		Convergence with all focus sectors	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of BAPCC implementation	5 years (12th FYP period)		Convergence with all focus sectors	
		External mid-term review of BAPCC Implementation	5 years (12th FYP period)		Convergence with all focus sectors	
		Evaluation of BAPCC implementation	5 years (12th FYP period)		Convergence with all focus sectors	
Knowledge Management	Knowledge Management	Hosting of geo-portal on climate change	5 years (12th FYP period)		Convergence with all focus sectors	Significantly improved awareness of and understanding of climate change in the State, and among its citizens/communities
		Host-hub for knowledge/information	5 years (12th FYP			

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		sharing related to climate change; detailed dissemination planning and dissemination	period)			
		Identification of potential research and development domains concerned with climate change issues in the state	5 years (12th FYP period)			
		Knowledge repository	5 years (12th FYP period)			
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change	5 years (12th FYP period)			

Annexure 2: Agriculture

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy reviews	Policy	Review of state agriculture and allied sector policies; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	**15**	Convergence with linked sectors such as water resources, energy, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**25**	Convergence with districts and linked sectors such as water resources, energy, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**25**	Convergence with districts	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Development of agro-climatic zone-wise adaptation plans, incorporation into Agriculture Roadmap	1-1.5 years	**76**	Convergence with districts	Zone-specific climate response plans in place
		Poverty, equity and livelihoods study and strategy formulation		**15**	Convergence with districts	Enhanced understanding of poverty and equity issues in the sector; integrated into policy and planning
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**50**	Convergence with districts	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**25**	Convergence with districts and linked sectors such as water resources, energy,	Sector KM strategy in place

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
					etc.	
Medium-term actions						
Capacity building	Human resource development	*Capacity building of department personnel and stakeholders (to be detailed by Department)*	Within/over 5 years (12th FYP period)	**150**	Convergence with all focus sectors	Improved sector capacities to understand and address climate change issues
Forecasting and early warning systems	Risk management	Weather services and early warning systems through enhanced agro-met technology deployment and information dissemination	Within/over 5 years (12th FYP period)	**200**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved risk management and early warning systems
Improved varieties and practices	Science and technology	Development and deployment of improved crop varieties (drought and flood tolerant)	Within/over 5 years (12th FYP period)	**750**	Convergence with scientific research institutions/academia	Improved crop resilience
Irrigation	Research, technology adoption/transfer	Study on irrigation efficiency improvements	Within/over 5 years (12th FYP period)	**25**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved irrigation efficiency; diversified and climate resilient irrigation infrastructure
		Study on irrigation infrastructure improvements/adaptation		**25**		
		Revival/rehabilitation of traditional irrigation systems		**400**		
		Micro-irrigation systems augmentation		**500**		
		Solar and wind power systems for irrigation		**200**		
Soil and water conservation	Watershed development	Agroforestry, integrated watershed management	Within/over 5 years (12th FYP period)	**500**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved soil and water management practices; improved climate resilience in intervention areas
Integrated nutrient and pest	Risk management; research/technology	Study on integrated nutrient and pest management based on sector climate vulnerability assessment;	Within/over 5 years (12th	**1000**	Convergence with scientific research	Improved nutrient and pest management practices and

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
management	transfer	development of management options	FYP period)		institutions/academia	climate resilience
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**100**	Convergence with districts and linked sectors such as water resources, energy, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of sector implementation under BAPCC		**100**		
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**500**	Convergence with districts and linked sectors such as water resources, energy, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**100**		
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**10000**		
		Sector co-benefits identification study		**25**		
		Documentation on community perceptions of climate change and impacts		**25**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**50**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**50**		
		Consultations with communities		**50**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Total Budget for 5 years (12th FYP period)				**14981 ***		

Budget for Department of Animal and Fisheries Resources, Bihar, Patna

S.No.	Interventions	Intervention Type	Activities	Total Cost On Lakh)	Possibility of convergence	Expected outcome
1	Policy Formulation	Policy	Formulation of State Livestock Policy incorporation of climate concerns (based on sector vulnerability assessment).	**10.0**	Convergence with linked sectors such as Agriculture, Forestry, Water Resources, Energy and Rural Development etc.	Sector policies would try and address the climate change concerns and the modus operandi to tackle it.
2	Co-ordination and Networking	Co-ordination/ Management	Setting up of Climate Change Cell is proposed for Policy Formulation in the changing scenario.	**20.00**	Convergence with linked sectors such as Agriculture, Forestry, Water Resources, Energy and Rural Development etc.	Streamline mechanism for coordination of all sector activities.
3	Capacity Building	Human Resource Development	Sector capacity need assessment/Training/ Extension.	**250.0**	Convergence with linked sectors such as Agriculture, Forestry, Water Resources, Energy and Rural Development etc.	Clear understanding of sector capacity need at State, District and Panchayat levels vis-a-vis climate change and its impact.
4	Infrastructure Management	Infrastructure Development	Strengthening of Artificial Insemination (AI) centers	**26370.48**	Convergence with linked sectors such as Building Construction Department etc.	Breed improvement of milch animals with a view to enhance milk production to counter production loss due to adverse climatic condition.
5	Resource Management.	Conservation of native breeds of cattle and buffalo	In-Situ conservation of Cattle and Buffalo Native to Bihar through Establishment of Nucleus Herds	**759.03**	Convergence with linked sectors such as Agriculture University etc.	Conservation of disease resistant and stress resistant native breeds of cattle and buffalo to adjust with climatic changes and production.

S.No.	Interventions	Intervention Type	Activities	Total Cost On Lakh)	Possibility of convergence	Expected outcome
6.	Infrastructure/ Resource Management.	Livestock Health Management	Strengthening of Veterinary Hospitals/ Dispensaries/ Mobile Veterinary Clinics.	**14326.00**	Convergence with linked sectors such as Building Construction Department etc.	Treatment of livestock through well equipped hospitals and dispensaries as well as through Mobile Veterinary Clinics in remote areas in case of emerging diseases.
7.	Infrastructure/ Resource Management.	Coservation of local disease resistant native breeds of cattle and Bio-gas utilization.	Strengthening of Goshalas	**860.00**	Convergence with linked sectors such as Building Construction Department, Agriculture, BREDA etc.	Coservation of local disease resistant native breeds of animals as well as setting up of Bio-gas plants so as to capture and utilize methane gas.
8.	Health Care Management.	Livestock Health Management	Mass deworming programme.	**33810.00**		Mass deworming of livestock to combat endo and ectoparasitic infestation in adverse climatic condition to sustain. stress.
9.	Nutritional Management.	Nutritional Management of Livestock.	Distribution of Seeds of Green fodder.	**2450.00**	Convergence with linked sectors such as Agriculture, Forestry, Water Resources etc.	Seeds of green fodder suitable for changing climate will be distributed to combat fodder crisis.
10.	Health Care Management.	Livestock Health Management.	Livestock Disease Early Warning System	**58.40**		Development of disease forecasting system in changing climatic scenario through NADRS.

Total budget for 5 years **78913.91**

This is a tentative budget. The amount may be finalized as per discussion/decision taken by competent authority

Annexure 3: Forests and Biodiversity

Interventions	Intervention type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy reviews	Policy	Review of state forest sector policies; incorporation of climate concerns (based on sector vulnerability assessment)	1.15 years	**25**	Convergence with linked sectors such as water resources, energy, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**100**	Convergence with districts and linked sectors such as water resources, energy, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**50**	Convergence with districts and linked sectors such as water resources, energy, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Review of forest working plans and incorporation of climate concerns	1 year	**25**	Convergence with districts and linked sectors such as water resources, energy,etc.	Revised working plans explicitly incorporate climate concerns
	Institutional arrangements	Activation of State Biodiversity Board; development of multiannual action plans covering 12th FYP	1 year	**50**	Convergence with districts and linked sectors such as water resources, energy,etc.	Functional State Biodiversity Board in place, with action plans
Sub-total – Policy-Planning, HRD, Climate Change Cell Institutional Arrangement				**250**		
Interventions in forest and non-	Forest/biodiversity protection,	Interventions in very dense forests initiated	1-1.5 year	**100**	Convergence with districts and linked sectors such as	Initial Interventions on-stream

Interventions	Intervention type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
forest areas	conservation, and green cover augmentation	Interventions in moderately dense forests initiated	1-1.5 year	**400**	water resources, energy, etc.	
		Interventions in open forests initiated	1.15 years	**1000**		
		Interventions in scrub forests initiated	1.15 years	**500**		
		Specific interventions in the Valmiki Tiger Reserve and National Park initiated	1.15 years	**500**		
		Specific interventions in wetlands and river ecosystems initiated	1.15 years	**1000**		
		Specific interventions in non-forest areas initiated	1.15 years	**2500**		
	Sub-total			**6000**		
Research	Research	Study on forest and NTFP dependence of communities	1.15 years	**50**	Convergence with district administrations and social sector departments	Comprehensive understanding of community-forest interface and dependence, especially on NTFP's
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**25**	Convergence with districts	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**25**	Convergence with districts and linked sectors such as water resources, energy, etc.	Sector KM strategy in place
	Sub-total			**100**		
	Total short-term actions			**6350**		
Medium-term action						

Interventions	Intervention type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Capacity building	Human resource development	Capacity building of department personnel and stakeholders	Within/ over 5 year (12th FYP period)	**2500**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved sector capacities to understand and address climate change issues
Interventions in forest and non-forest areas	Forest / biodiversity protection, conservation, and green cover augmentation	Interventions in very dense forests		**1000**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved quality and management of forest areas including green cover augmentation; improved protection, infrastructure, and visitor facilities in protected areas and notified wetland areas, Lower incidence of forest fires/improved fire control
		Interventions in moderately dense forests		**5000**		
		Interventions in open forests		**10000**		
9		Interventions in scrub forests		**5000**		
		Specific interventions in the Valmiki Tiger Reserve and National Park		**1000**		
		Fire management - Measures for fire management in all forest types		**5000**		
		Specific interventions in wetlands and river eco-systems		**10000**		
		Specific interventions in non-forest areas		**15000**		
		Survey, identify, catalogue, document , protect; and improve/ enhance the status of biodiversity rich areas in the State		**1000**		Biodiversity registers in place/progress; publication/s on state's biodiversity resources; enhanced biodiversity

Interventions	Intervention type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
						conservation/management practices in places
	Sub-total – Interventions in forests and non-forest areas			**53000**		
Planning	Research; Planning	Study on and development of plans for interventions in wetlands areas		**100**	Convergence with districts and linked sectors such as water resources, energy, etc.	Detailed strategy and management plans for interventions in wetland areas in place
Research	Research; Planning	Study on potential for REDD +	Within/over 5 year (12th FYP period)	**100**	Linkages with academia, consulting organisations/individuals	Enhanced strategies and action for forest and biodiversity conservation
		Studies on indigenous trees species to assess their vulnerability to climate change		**200**		
		Assessing and documenting additional threats to biodiversity and wildlife		**100**		
		Population dynamics and movement of key indicator wildlife species,		**100**		
		Population dynamics and movement of key indicator wildlife species		**100**		
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 year (12th FYP period)	**500**	Convergence with districts and linked sectors such as water resources, energy, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't, input for improved annual plans for 13th FYP
		Internal Annual Review of sector implementation under BAPCC		**100**		
Knowledge management	Knowledge management	Identification of potential research and development	5 year (12th FYP	**50**	Convergence with districts and linked sectors such as water	Significantly improved awareness of and

Interventions	Intervention type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		domains concerned with climate change issues in the sector, initiating studies	period)		resources, energy, etc.	understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**50**		
		Technical demonstration research and development, extension and transfer of technology protocols, relating to climate change		**1000**		
		Documentation on community perceptions of climate change and impacts		**50**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 year (12th FYP period)	**50**	Linkages with academia civil society and communities	Improved networking and communications with academia participatory sector
		Consultations with civil society		**50**		
		Consultations with communities				
	Sub-total – Planning, Research, M & E , Knowledge management, Networking			**2550**		
	Total – Medium-term Actions/Interventions			**58050**		
	Total Budget for 5 years (12th FYP period)			**64400**		

Annexure 4: Water Resources

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy Formulation	Policy	Formulation of State Water Policy; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	**10**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**20**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**10**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Formulation of State Water Sector Roadmap	1 – 1.5 years	**10**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Comprehensive water sector plan in place
Research	Research	Study on projection of water	1 – 1.5	**50**	Convergence	Enhanced

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		resources availability in time and space	years		with linked sectors such as agriculture, forestry, energy, etc.	understanding of key sector issues; improved management practices
		Study on poverty and equity issues in the water sector; incorporation of findings into Water Sector Roadmap	1 – 1.5 years			
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**50**	Convergence with districts	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**20**	Convergence with districts and linked sectors such as water resources, energy, etc.	Sector KM strategy in place
		Comprehensive water data base in public domain and water resources information system initiated	1 year	**50**		
Total Budget for Short Term Actions				**220**		
Medium-term actions						
Capacity building	Human resource development	Capacity building of department personnel and stakeholders (to be detailed by Department) including Panchayati Raj Institutions, urban local bodies and primary stakeholders such as WUAs in participatory management of water facilities	Within/over 5 years (12th FYP period)	**50**	Convergence with districts and linked sectors such as water resources, energy, etc.	Improved sector capacities to understand and address climate change issues
Planning	Research; Planning	Study on and development of plans for interventions in non-notified wetland areas	Within/over 5 years (12th FYP period)	**400**	Convergence with districts and linked sectors such as water resources, energy, etc.	Detailed strategy and management plans for interventions in non-notified wetland areas in place

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Infrastructure/resource management	Water infrastructure/resource augmentation/conservation/management	Inventory of and revival/ repair of Ahar-Pynes and traditional systems of water initiated	Within/over 5 years (12th FYP period)	**1000**	Convergence with districts and linked sectors such as water resources, energy, etc.	Enhanced water sector infrastructure assets and management practices; improved sector resilience
		Conservation and preservation of wetlands and maintenance of optimal wetland hydrology	Within/over 5 years (12th FYP period)	**10000**		
		Groundwater resources regulation and recharge/replenishment	Within/over 5 years (12th FYP period)	**5000**		
		Actions for water use efficiency across sub-sectors	Within/over 5 years (12th FYP period)	**5000**		
		Actions for improving water quality	Within/over 5 years (12th FYP period)	**1000**		
		Actions for adaptive retrofitting of infrastructure assets and O&M improvements	Within/over 5 years (12th FYP period)	**10000**		
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**1000**	Convergence with districts and linked sectors such as water resources, energy, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input
		Internal Annual Review of sector implementation under BAPCC		**1000**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
						for improved annual plans for 13th FYP.
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies (may be with Central University of Bihar, Patna)	5 years (12th FYP period)	**200**	Convergence with districts and linked sectors such as water resources, energy, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**50**		
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**10**		
		Sector co-benefits identification study		**20**		
		Documentation on community perceptions of climate change and impacts		**20**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**50**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**50**		
		Consultations with communities		**50**		
Total Budget for 5 years (12th FYP period)				**43900***		

Annexure 5: Disaster Management

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**5**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**10**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Incorporation of climate change concerns into State Disaster Management Plan (based on climate vulnerability and risk assessment)	1 – 1.5 years	**5**	Convergence with linked sectors such as agriculture, forestry, energy, etc.	Comprehensive water sector plan in place
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**5**	Convergence with districts	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**5**	Convergence with districts and linked sectors such as water resources, energy, etc.	Sector KM strategy in place
Medium-term actions						
Capacity building	Human resource	*Capacity building of personnel at Department,*	Within/over 5 years (12th	**50**	Convergence with districts and linked sectors such as	Improved sector capacities to understand and address

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
	development	*SDMA, and other stakeholders*	FYP period)		water resources, energy, etc.	climate change issues
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	25	Convergence with districts and linked sectors such as water resources, energy, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of sector implementation under BAPCC				
Improving scientific knowledge and evidence base and understanding of climate change and its impacts; capacity building	Research Training & Capacity Building	Study of recent changes in climate parameters Monitoring of various climate parameters	Within/over 5 years (12th FYP period)	10	In collaboration with IISc Bangalore and PRL Ahmedabad Forest & agriculture For community level training: PRIs, District Administration	Data on changes in various climate related parameters Monitoring the changes in various climate parameters. Land use /land change scenario Promotion of Safe construction technology More trained persons
		Land use / land cover change studies for various towns of the state using high resolution satellite imageries (IKONOS and WV 2)		10		
		Community based risk assessment Preparation of disaster management plan Training of community members on search and rescue.		10		
		Training of: • Departmental officials in vulnerability assessment. • Departmental officials in the use of GIS and RS tools for effective resource		25		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		management. • Engineers in retrofitting of existing structures and safer construction practices. • Mason in safer construction practices. • Formal first responders in search & rescue&first aid. • State government officers in post-disaster needs assessment (PDNA). • Media personnel in reporting disaster related issues. • Government officials in preparation of disaster management plans Government officials in post disaster response and utilisation of ICS (IRS) principles.				
		Mock drills and table top exercises involving nodal officers of various government departments		**25**		
Awareness generation School Safety Hospital preparedness and safety	Awareness	Knowledge sharing on Disaster management through various media (performing, print and electronic)	Within/over 5 years (12th FYP period)	**25**	Nagar Palika Parishads, PRIs; Department of Education, and National and state schemes like SSA; Department of Health	Safety of vulnerable section and lifeline building Safety of vulnerable section and lifeline building

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		Training of schoolteachers in vulnerability assessment and school disaster management plans preparation. Vulnerability assessments: Structural and Non-structural Training and Mock Drills Competitions School curriculum Online education and competitions Awareness program for officials		**25**	and National and state schemes like NRHM	
		Training of doctors in mass casualty management and hospital disaster management plan preparation. Vulnerability assessments: Structural and Non-structural		**25**		
Vulnerability and risk management	Risk management; infrastructure adaptation	• Vulnerability assessment of lifeline structure and demonstrative retrofitting • Relocation of critical infrastructure • Relocation of a few threatened habitations • Assessment of urban		**50**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		vulnerability particularly in case of extreme precipitation events • Vulnerability assessment of all industrial units in the state				
Knowledge Management	Knowledge Management	• Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**10**	Convergence with districts and linked sectors such as water resources, energy, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		• Knowledge repository, strengthening evidence base		**10**		
		• Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**10**		
		• Sector co-benefits identification study		**10**		
		• Documentation on community perceptions of climate change and impacts		**20**		
Networking and linkages	Networking and coordination	• Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**10**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		• Consultations with civil society		**10**		processes
		• Consultations with communities		**10**		
Total Budget for 5 years (12th FYP period)				**425**		

Annexure 6: Urban Development

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy review	Policy	Review of urban development policy; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**200**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Formulation of Urban Sector Roadmap incorporating climate concerns	1 – 1.5 years	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Comprehensive water sector plan in place
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**100**	Convergence with linked sectors such as agriculture,	Sector KM strategy in place

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
					forestry, water, etc.	
Medium-term actions						
Capacity building	Human resource development	*Capacity building of department personnel and stakeholders (to be detailed by Department) including ULBs*	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Improved sector capacities to understand and address climate change issues
Energy demand reduction and efficiency	Energy efficiency	Energy efficiency and conservation measures	Within/over 5 years (12th FYP period)	**100**		Enhanced energy efficiency and reduced demand
		Promotion of and codes for green/energy efficient buildings, including in urban housing projects under various programmes		**100**		
Adoption of renewables	Alternative energy sources	Promotion of renewable energy sources and technologies	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Enhanced energy source mix
Management of water, municipal solid waste and waste water	Urban utility management	Comprehensive approach in the management of water, municipal solid waste and waste water with a view to realize their full potential for energy generation, recycling and reuse, and composting, rainwater harvesting, etc.	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such Water Resources Department, etc.	Improved utility performance, services delivery, and infrastructure resilience
		Retrofitting of urban infrastructure for climate resilience based on vulnerability and risk assessment		**100**		
Urban transportation	Transportation	Evolving integrated land use and transportation plans, achieving a modal shift from private to public mode of transportation, encouraging the use of non-motorised transport, improving fuel	Within/over 5 years (12th FYP period)	100	Convergence with Transportation Department	Improved urban transportation systems

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		efficiency, and encouraging use of alternate fuels				
		Adaptation in terms of realignment and relocation, design standards and planning for roads, rail and other infrastructure to cope with risks from climate change		100		
		Promote and foster alternative fuels such as CNG, bio-fuels		**100**		
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of sector implementation under BAPCC		**50**		
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**50**		
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**100**		
		Sector co-benefits identification study		**50**		
		Documentation on community perceptions of climate change and impacts				

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**100**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**50**		
		Consultations with communities		**50**		
Total Budget for 5 years (12th FYP period)				**2190**		

Annexure 7: Transport

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy review	Policy	Review of transport policy; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Formulation of Transport Sector Roadmap incorporating climate concerns	1 – 1.5 years	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Comprehensive water sector plan in place
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	50	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector KM strategy in place

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Medium-term actions						
Capacity building	Human resource development	*Capacity building of department personnel and stakeholders (to be detailed by Department)*	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Improved sector capacities to understand and address climate change issues
Transport Infrastructure, planning, and management	Infrastructure, planning, management	Improve access to bus services and service quality	Within/over 5 years (12th FYP period)	**500**	Linkages with Urban Development Department, Roads Department, Energy Department, etc.	Enhanced and resilient transportation infrastructure and systems in place
		Improve the poor image of bus and public transport	Within/over 5 years (12th FYP period)	**500**		
		Mechanisms for proper planning and provisioning of infrastructure facilities	Within/over 5 years (12th FYP period)	**100**		
		Improve route and traffic planning, and regulate issue of permits through surveys and scientific data	Within/over 5 years (12th FYP period)	**50**		
		Provide/improve passenger information systems, and remove institutional and regulatory hurdles	Within/over 5 years (12th FYP period)	**100**		
		Promote initiatives such as vehicle pooling, etc., especially in cities and towns	Within/over 5 years (12th FYP period)	**50**		
		Rigorously implement measures for vehicular pollution control	Within/over 5 years (12th FYP period)	**50**		
		Promote the use of ensure availability of cleaner fuels such as CNG and bio-fuels	Within/over 5 years (12th FYP period)	**100**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		Systematise and ensure uniformity in institutional arrangements for providing public transport services	Within/over 5 years (12th FYP period)	**50**		
		Promote access instead of mobility; shift to less harmful modes of transportation; and improve vehicles towards lower carbon intensity and pollution	Within/over 5 years (12th FYP period)	**50**		
		Enable and promote environmentally efficient modes such as public and non-motorised transport (for passenger transport) and to rail and water transport (for freight)	Within/over 5 years (12th FYP period)	**200**		
		Invest in public transport and infrastructure that promotes walking and cycling	Within/over 5 years (12th FYP period)	**200**		
		Improve vehicles, vehicle maintenance, and fuels as a priority to reduce urban air pollution and greenhouse gas emissions	Within/over 5 years (12th FYP period)	**300**		
		Adopt green transport policies will also reduce road accidents and alleviate poverty by improving access to markets and other essential facilities	Within/over 5 years (12th FYP period)	**300**		
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked
		Internal Annual Review of sector implementation under BAPCC		**50**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
						and what didn't; input for improved annual plans for 13th FYP.
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**50**		
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**100**		
		Sector co-benefits identification study		**50**		
		Documentation on community perceptions of climate change and impacts		**50**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**100**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**100**		
		Consultations with communities		**50**		
Total Budget for 5 years (12th FYP period)				**3400**		

Annexure 8: Energy

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy review	Policy	Review of energy sector policies; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cell	1 year	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
Research, Climate Impacts Needs Assessment	Research	Develop comprehensive Bihar specific energy sector vulnerability analyses, and options for developing in-house skills for data analyses, modelling, and forecasting will be considered	1-1.5 years	**50**		
Risk Management	Risk Management	Templates to screen individual energy projects for climate vulnerability and risks, either retrospectively or during project planning and implementation will be developed	1-1.5 years	**50**		
Standards Development	Management	Develop adaptation standards for the energy sector -- defined, codified and	1-1.5 years	**50**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		adopted into standard operating procedures in all aspects of energy sector planning and implementation				
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Research	Research	Study on poverty and equity issues in energy sector; incorporation of findings into energy sector planning	1-1.5 years	**50**		
Planning	Planning	Formulation of Energy Sector Roadmap incorporating climate concerns/Revision of existing Roadmap to incorporate climate concerns	1 – 1.5 years	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Comprehensive water sector plan in place
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector KM strategy in place
Medium-term actions						

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Capacity building	Human resource development	*Capacity building of department personnel and stakeholders (to be detailed by Department)*	Within/over 5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Improved sector capacities to understand and address climate change issues
Generation Improvements	Power generation infrastructure enhancement/adaptation and management	Renovation and modernisation of existing units to restore original efficiency along with reduced auxiliary power consumption and reduced chimney emissions. Modernisation work on the BTPS units 6 and 7 are expected to be completed by February 2013, and for the MTPS units 1 and 2	Within/over 5 years (12th FYP period)	**100**		Enhanced generation systems
		Adoption of super critical technology for all upcoming coal based power stations to have better efficiency and reduced emissions		**100**		
		Fly ash utilisation management		**50**		
		SHP capacity addition for 3.70 MW		**50**		
Transmission Improvements	Power transmission infrastructure enhancement/adaptation and management	Expansion of high voltage transmission network with latest and state of the art technologies and adequate coverage network to prevent loading beyond limits	Within/over 5 years (12th FYP period)	**200**		Enhanced transmission systems
		Use of sufficient reactors and capacitors in the network		**50**		
		Replacement of old and jointed conductors		**50**		
		Better load management, efficient		**100**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		scheduling and use of information systems to achieve optimum network utilisation				
		Proper upkeep of GSS transformers		**100**		
Distribution improvements	Power distribution infrastructure enhancement/adaptation and management	Replacement of old and jointed conductors	Within/over 5 years (12th FYP period)			Enhanced distribution systems
		Procurement of start rated distribution transformers and load balancing of existing ones		**100**		
		Tariff structure review and revision; incentivisation for lower energy withdrawal promotion of conservation		**100**		
		Underground cabling in green areas		**50**		
		Addition of adequate capacitors and upkeep of PSS transformers and distribution transformers		**50**		
		Expansion of network with high HT/LT ratio		**100**		
		Adoption of HVDS systems where feasible and putting into place effective anti-power theft measures		**100**		
		Facilitate power supply for monorail and metro-rail schemes envisaged for Patna as part of improving public transportation systems		**100**		
Demand Side Management	Energy conservation and efficiency improvements	Promoting the use of energy efficient pumps and motors in the State	Within/over 5 years (12th FYP period)	**500**		Enhanced demand side management in place
		Promotion of CFLs under the Bachat		**500**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		Lamp Yojana (BLY) in identified areas of the PESU and expanding the scheme to other parts of the state in a phased manner				
		Building consumer awareness about energy efficient equipment and energy conservation measures		**100**		
Renewable energy	Renewable energy promotion and adoption	Electrification of rural villages through renewables based DDGs	Within/over 5 years (12th FYP period)			Increase in the share of renewables in stake energy mix; cleaner sector
		Encourage local private sector participation in renewable energy power generation projects including solid waste and sewerage gas based projects or decentralised distributed generation (DDG)		**100**		
		Fix the renewable energy procurement quotas and tariffs for renewable energy based power		**100**		
		Provide banking and wheeling facilities for all grid connected renewable energy electricity generation projects up to 25 MW		**100**		
		Waive entry tax capital costs for equipment for DDG based renewable energy plants of less than five MW		**100**		
		Encourage project developers to install or adopt mechanisms such as Clean Development Mechanisms (CDM) for leveraging funds for renewable energy based projects		**200**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Infrastructure adaptation	Infrastructure adaptation	Based on climate vulnerability analyses, retrofitting of existing energy infrastructure	Within/over 5 years (12th FYP period)	**100**		Improved infrastructure resilience
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of sector implementation under BAPCC		**50**		
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**100**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Significantly improved awareness of and understanding of climate change in the sector and its stakeholders
		Knowledge repository, strengthening evidence base		**50**		
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**50**		
		Sector co-benefits identification study		**50**		
		Documentation on community perceptions of climate change and impacts		**50**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**100**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**50**		
		Consultations with communities		**50**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Total Budget for 5 years (12th FYP period)				**4450**		

Annexure 9: Industries and Mining

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Short-term actions						
Policy review	Policy	Review of industries and mining policies; incorporation of climate concerns (based on sector vulnerability assessment)	1-1.5 years	**15**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector policies explicitly reflect climate concerns
Coordination and networking	Coordination/management	Setting up of Climate Change Cells; setting up of Task force at State and Cluster levels	1-1.5 years	**50**	Convergence with linked sectors such as agriculture, forestry, water, private sector, industries associations, etc.	Streamlined mechanisms for coordination of all sector activities under the BAPCC
		Build partnerships with industry associations, and through them, initiate sustained process to stimulate technological innovation and change to reduce dependency on imported fuels, to improve resources use efficiency, waste management, water and air pollution reduction, and enhance use of renewables		**50**		
Capacity Building	Human resource development	Sector capacity needs assessment	1 year	**30**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Clear understanding of sector capacity needs at State and sub-state levels vis-à-vis climate change and its impacts
Planning	Planning	Formulation of Sector Roadmap incorporating climate concerns	1 – 1.5 years	**25**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Comprehensive water sector plan in place

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
Research	Research	Cluster-wise or district-wise studies to estimate the carbon footprint of industrial clusters in the State; This would include a baseline study, as well as periodic studies	1 – 1.5 years	**30**		Improved understanding of key emissions and carbon footprint issues in clusters, and industry sectors
		Studies on brick making industry (and associated mining issues) and on mining industry		**25**		
Monitoring and Evaluation	Monitoring	Contribution to BAPCC Monitoring Plan	1 year	**50**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector M&E framework in place
Knowledge management	Knowledge management	Contribution to BAPCC KM Strategy and roadmap	1 year	**25**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Sector KM strategy in place
Medium-term actions						
Capacity building	Human resource development	*Capacity building of department personnel and stakeholders (to be detailed by Department)*	Within/over 5 years (12th FYP period)	**20**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Improved sector capacities to understand and address climate change issues
Promoting GHG Mitigation	Mitigation	Build awareness of and promote sector-wide, process-specific, and operating procedure based mitigation options for industries	Within/over 5 years (12th FYP period)	**10**	Linkages with academia, financial institutions, industry associations, media, private sector, etc.	Increased adoption of GHG mitigation options
		Actions for incentivising adoption of GHG mitigation options		**15**		
		Build capacities of financial institutions to finance GHG mitigation options		**10**		
		Develop regulatory instruments and		**20**		

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		promote CDM				
Promoting Energy efficiency	Energy efficiency	Promote and build awareness, and develop and deploy measures to incentivise industries to adopt a range of management practices including energy audits, adoption of energy efficiency measures and technologies, benchmarking, etc.	Within/over 5 years (12th FYP period)	**20**	Linkages with academia, financial institutions, industry associations, media, private sector, etc.	Enhanced energy efficiency in industries/industrial clusters
		Build awareness on options, opportunities and benefits of fuel switching, including the use of waste materials, energy (especially heat and power recovery), cogeneration, use of renewable energy including biomass and by-product wastes based generation, and materials efficiency and recycling		**50**		
		Developing and deploying a range of financial instruments such as taxes, subsidies and measures to improve access to capital to adopt energy efficiency technologies and processes		**25**		
Monitoring and evaluation	M&E	Quarterly sector monitoring reports	Within/over 5 years (12th FYP period)	**10**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Results for programme implementation improvements and mid-course corrections; lessons learnt on what worked and what didn't; input for improved annual plans for 13th FYP.
		Internal Annual Review of sector implementation under BAPCC		**25**		
Knowledge Management	Knowledge Management	Identification of potential research and development domains concerned with climate change issues in the sector; initiating studies	5 years (12th FYP period)	**15**	Convergence with linked sectors such as agriculture, forestry, water, etc.	Significantly improved awareness of and understanding of climate change in the sector and its

Interventions	Intervention Type	Activities	Duration	Total Cost (in lakh)	Possibility of convergence	Expected Outcome
		Knowledge repository, strengthening evidence base		**10**		stakeholders
		Technical demonstration, research and development, extension and transfer of technology protocols, relating to climate change		**25**		
		Sector co-benefits identification study		**20**		
		Documentation on community perceptions of climate change and impacts		**20**		
Networking and linkages	Networking and coordination	Institutional linkages with research/academic institutions	Within/over 5 years (12th FYP period)	**20**	Linkages with academia, civil society and communities	Improved networking and communications with academia, participatory sector processes
		Consultations with civil society		**10**		
		Consultations with communities		**15**		
Total Budget for 5 years (12th FYP period)				**340**		

Annexure 10: Human Health

S.No.	Area of Issues on Climate Change	Actions proposed to be expected	Time line years	Remarks	(INR Crore)
1	Addressing enhanced diseases burden	With reference to Climate Change • An assessment needs to be carried out to understand the extent of disease burden that may occur due to climate change and population projections, • Identification of vulnerable areas for each disease, and • Identification of vulnerable communities along with identification of windows of opportunity of new diseases that might occur due to change in climate determinants, • An assessment of number of additional health centres and health personnel required. • IDSP to continue to monitor disease prevalence and outbreak • IDSP to include private, public as well as all village level health care centres for surveillance • Putting in place additional health care centres and medical personnel	5 10 10 10		**4.0** Funding to continue from present source ----------do---------- To be funded from existing programmes if they continue

2	Reduction targets for Vector Borne diseases	Reduction in Malaria incidence by at least 50%. To bring API below 1 in all the Districts of the State. Enhanced use of ITBNs (especially in High Risk Areas) by 50% among Below Poverty Line (BPL) Population. Enhanced use of larvivorous fish in 75% villages of high-risk areas 50% villages of all areas. 50% reduction in use of Indoor Residual Spraying by spraying only high-risk areas. Entomological study on prevalence and vector densities for Malaria, JE, Dengue, CCHF (Chimean-Congo Haemorrhagic Fever) in the state.		@ Rs.0.05 Cr per districts and Rs.0.2 Cr for State Hq. Includes also training cost, monitoring, field work and lab. Test etc.	To be funded from current NVBDCP ----------do---------- ----------do---------- 1.25

3	Control of TB	Under RNTCP the aim is in terms of Universal Access is 100% case detection. Requires Expansion of DOTS Plus services. Extend services in private hospitals with OPD patient intake of 100-150 per hospital	5 5	To be funded from the RNTCP -do-	
4.	To control NCD	To control NCDs main emphasis will be given on IEC activities to reach out target communities, continuous monitoring and independent evaluation of the program and research, Promotion of public private partnerships, Mainstreaming AYUSH – revitalizing local health traditions	10	To be funded from NPCDCS and NRHM	
5.	Ecological study on air	Pilot study is proposed for all districts Hospitals, *To		@ 0.1 Cr rupees per district	

	pollutants- from industry, transport and domestic cooking, pollen and molds (as triggers of Asthma and Resp. diseases) and how they are affected by CC	screen and study patients suffering from Bronchial Asthma and other Resp. Diseases	5	*Required Med. Specialist and Chest Specialist are available.	**2.1**
6.	Enhanced provision of Primary, Secondary and Tertiary health care facilities and implementation of public health measures, including vector control, sanitation and clean drinking water supply	i) Primary level:- Awareness and sensitization to all sectors on Climate change. ii) Secondary level:- Early diagnosis and treatment i.e. Testing kits and drugs. iii) Tertiary level:- Testing kits and treatment with drugs		Primary level: Rs.0.05 Cr per districts and Rs.1.8 Cr for State Hq Secondary and tertiary level each: Rs.1 Cr @ of Rs.0.05 Cr per districts and Rs.2 Cr for State Hq.	**2.5**
7.	Providing high resolution weather and climate data to study the regional pattern of diseases. Development of a high resolution health impact model at the state level	i Through IDSP (Integrated Disease Surveillance Project) which is a project by GOI on Disease Surveillance and is engaged in Outbreak/ Epidemic forecasting and investigation/management. Assistance of department. Of Science and Technology, Remote Sensing section will be taken for real time high resolution weather and climate data.		Fund will be needed for engaging Remote Sensing department for high resolution data transfer.	**1.0**
8.	GIS mapping of access routes to health facilities	Both State Remote Sensing Health departments under NVBDCP will be utilized for GIS mapping. / Centre for Environmental Sciences Central University of Bihar, Patna			**1.0**
9.	Development of a disaster Risk reduction Plan	In association with the National Disaster Management Authority / Bihar State Disaster Management Authority/Centre for Environmental Sciences, Central University of Bihar, Patna. Develop plans for risk reduction of diseases escalation and outbreaks due to climate change			**1.0**
10.	Climate change	A committee needs to be formulated with members			**0.5**

	coordination committee	from all disease control programmes who will ensure integration of climate change concerns in planning and implementing diseases control measures for existing and new and emerging diseases			
	Total budget proposed