Jharkhand- Action Plan on Climate Change

Government of Jharkhand,
Ranchi, Jharkhand
2014

Disclaimer

All the comments and suggestions received during the earlier consultative process have been duly incorporated in this report. However, further deliberation is still required for relating figures, targets; specific strategies, especially those requiring inter-departmental coordination etc. and yet certain indicative financial estimates for specific sectors have also been proposed, with calculations made by external consultant in consultation with concerned department using certain assumptions.

This report has been shared for review to various departments in the Government of Jharkhand or their representatives and other stakeholders in the state on several occasions for their comments, also the report has been shared with civil society and general public for comments. The comments have been incorporated

The various statistics that have been used herein are as per the information received from various Government departments in Jharkhand and other specific sources. However no claim is made for their accuracy and user is requested to confirm these figures from the official sources. Further all the projections are made with certain assumptions and hence they should not be taken on face value (because of limitation of climate science and its interaction with various ecosystems).

FOREWORD

Climate change is proving out to be one of the greatest challenges faced by the global community today. The analysis of past trends and current erratic behaviour in climatic events shows that changes being experienced in the climate of Jharkhand are the proof of natural climate variability prevailing in the state. Many studies for the state show that the Jharkhand is in precarious situation due to its high climate sensitivity and vulnerability, combined with low adaptive capacity.

The state is already suffering due to its high dependence on mineral resources. Further the forest and water resources in the State are facing threat due to industrial and urban growth and being uneven in distribution both temporally and spatially. Hence the challenge of climate change calls for appropriate, evidence based and coherent policy response, followed by the adequate action that can help reduce its vulnerability and build resilience of the various sectors of the state in the context of climate change impacts.

I am pleased to know that Department of Forest and Environment, Government of Jharkhand, has been able to draft a State Climate Change Action Plan, building upon the inputs from the various departments of GoJ. Mrs Alka Tiwari, Principal Secretary, Department of Forest and Environment, GoJ deserves compliments for her overall coordination in this endeavour. I also thank all the departmental secretaries of GoJ for their support in this effort; resulting in a valuable planning document.

Further the drafting team led by PCCF Jharkhand in general, its Co-chairman Dr. H. S. Gupta, State Programme Director, Jharkhand Tribal Development Society, in particular deserve to be congratulated for completing this job in a very short span of time.

I sincerely hope that the priorities identified under the Climate Change Action Plan will prompt us to have effective execution strategies that will help the state to address the challenges of climate change and ensure a sustainable pathway for development of Jharkhand.

Ranchi

Date: 19-02-2014

Development Commissioner

Government of Jharkhand

Nepal House

Ranchi

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- Chairperson, Jharkhand State Pollution Control Board, GoJ.
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- Sri A. K. Singh ,Principal Chief Conservator of Forest, Jharkhand.

  -Dr. A.K. Malhotra Principal Chief Conservator of Forest, Jharkhand

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Abbreviations

AIADA	Adityapur Industrial Area Development Authority
BAU	Business as usual
Bcm	Billion cubic meters
BIADA	Bokaro Industrial Area Development Authority
CAGR	Compounded annual growth rate
CDM	Clean Development Mechanism
CO_2	Carbon di-oxide
CPP	Captive power plants (CPP)
FRA	Forest Rights Act 2006
FSI	Forest Survey of India
GHG	Green House Gases
GSDP	Gross State Domestic Product
Ha	Hectares
HDI	Human Development Index
INR	Indian National Rupee
IPCC	International Panel on Climate Change
JFM	Joint Forest Management
JI	Joint Implementation
JREDA	Jharkhand Renewable Energy Development Agency
MDA	Mass Drug Administration
MFP	Minor Forest Produce
Mld	Million litres per day
MSME	Micro Small and Medium Enterprises
N2O	Nitrogen oxide
NAPCC	National Action Plan on Climate Change
NMDC	National Mineral Development Corporation
NREGI	New and Renewable Energy-Government of India
NSSO	National Sample Survey Organization
PIM	Participatory irrigation management
PRI	Panchayati Raj Institutions
RIADA	Ranchi Industrial Area Development Authority
SFR	State Forest Report
Sq KM	Square Kilometre
TW	Transmission Window
WALMI	Water and Land Management Institute
GDP	Gross Domestic Product
IPR	Intellectual Property Rights
ULB	Urban Local Bodies
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Climate change is one of the biggest challenges faced by the human race. IPCC has estimated the degree of threat to life and economic well being associated with each degree rise in the global mean temperature. The scenarios are generated using GHG concentrations resulting from varying economic growth estimations.

Impacts of climate change on India are going to be severe. Water resources, forests, agriculture and human health are going to be impacted due to shift in precipitation and change in average minimum and maximum temperatures. To prepare for the climate change, long term persistent efforts will be required on both the adaptation and mitigation fronts. The international mitigation obligations are centred around the emission reduction for the developed countries. India, although not bound by mitigation commitments has taken a proactive stance by coming out with voluntary emission reduction vision for the country as well as prepared a forward looking adaptation plan for the country. Termed National Action Plan on Climate Change (NAPCC), the national adaptation strategies are guided by eight national missions. The NAPCC also sets the stage for the development of state climate change action plans.

Jharkhand's climate change action plan was envisaged with a vision of '*achieving economic growth -poverty alleviation objectives and enhancing livelihood opportunities while ensuring environmental sustainability.'* Supported by UNDP, the state government of Jharkhand initiated the action plan development process in May 2011 with the formation of State Steering Committee and State Advisory Group. The action plan development process included development of sectoral papers identifying issues and constraints and developed climate change responses specific to each of the sectors. The responses included both mitigation and adaptation measures. The climate change action plan thus developed was shared with department heads on 28th Jan 2013, further the plan was open for wider public comments. Public consultation approach included posting the report on the website of SPCB followed by advertisement in local newspapers inviting comments on the report. The refined report was also shared with general public, industries, state departments through three regional workshops conducted in each of the ecological zones. The workshops were organized in Dec 2013 in the cities of Ranchi, Hazaribag and Jamshedpur.

The state action plan thus developed report is divided into three segments, Section-A sets the background for climate change action plan. Describing the national level actions taken and quantifying the climate change impact on the state in the short, medium and long duration the segment established the requirement for urgent action towards making the state adapt to changing climatic conditions. The Section-B of the report analyzes the state of affairs of the selected sectors (agriculture, forestry, human health, industries, mining power, urban-transportation and water) quantifying the impact of climate change on each of the sectors and details out the actions that will be required to prepare the capacity sectors to successfully deal with issues arising from climate change. Section-C of the report charts the action plan for states action, resources required for implementing the state actions and timeframe for implementation of the prescriptions.

The climate change impacts in the state of Jharkhand are apparent. In this report attempts have been made to quantify the impacts of climate change on the natural resource stock and flows in the state. Multiple simulations carried out by reputed national and international research institutions are analyzed to quantify the impact of climate change. All the major climate change projects predict increase of rainfall in the state, under A1B scenario it's projected that by the end of this century the number of rainy days will go up by atleast 10 days, similarly B2 scenario predicts that the average rainfall in the state will rise by ~20%. The WORLDCLIM data (for A2B) scenario projects that the average temperature (both minimum and maximum) in all the districts will rise over time and both summer and winters will become hotter by 2080. The summer temperature will go up by a maximum of 2-3^0 C during 2020-2050 whereas average winter temperature will go up by 4.78-5.2^0 C during the same duration. Similarly B2 scenario too predicts that on an average Jharkhand will witness a temperature rise of 2.5-3.0 ^{0} C by the year 2085.

The climate change impacts are already recorded in the state. The weather pattern changes are reflected in the data recorded by the weather station in the state. A snapshot of extreme weather events witnessed during 2008-2012 is provided in following table.

Extreme weather events in Jharkhand during 2008-2012

Event	Observations
Heat Waves	100 incidences in 2010
Highest temperature recorded	46.5° C in June 2010
Lowest temperature recorded	3.2°C in January, 2008
Highest rainfall recorded	338.1 mm in June 2008

The change in precipitation and temperature will reflect in the economic performance of the sectors. The experiments suggest that the agriculture productivity will decrease in the state as the temperature rises. Also the incidences of pests and other crop diseases will be on rise. And since most of the agriculture in the state is rain-fed, in absence of a robust irrigation infrastructure the state's agriculture production will go down over time. Water woes will increase over time, already marred with water stress, climate change will trigger demand for water for agriculture, domestic and industrial sector adding to the stress on the

water resources of the state. The forestry resources, being the cheapest available carbon sink will also suffer due to temperature rise, of the 1148 FSI grids in the state, its projected (based on the A1B scenario) that due to climate change about 24.30 grids will get affected in 'long term' period, though there is no short term threat perceived for the forests in the state. This will not only affect the plant species but will force the fauna to make adjustment to altered conditions by moving to newer locations. This will increase the human-wildlife conflict over time.

Climate change will have repercussions on the performance of industrial processes and power generation in the state. The water woes will reduce the output of the power plants. The hydro power plants will suffer as lesser water will be available, whereas the thermal power plants will require larger amount of coolants (water in this case) to maintain production levels (temperature rise reduces performance of machines that run on the principles of heat exchange). Similarly, industrial demand for water and power will rise to maintain their productivity levels. Since the demand for these critical services (water and power) will go up across sectors, hence the direct procurement cost of such services will rise, reducing the financial self sufficiency of the industries.

Most importantly, climate change will constrain the availability of clean air, drinking water, sufficient and safe quality food and also expose the human shelters to physical risk (due to extreme weather events).Provisioning of clean water for consumption purpose will over time become more difficult and costly for the state and consumers will have to allocate additional resources to ensure supplies of potable water. The climate change linked natural disasters due to heavy rainfall, floods can damage the human settlements (in urban as well as rural areas) thus causing losses to human welfare, in addition the surge of water can also temporarily spoil the clean water sources.

To combat climate change, the state will have to adopt two pronged approach. Actions will be required to help the state adapt to climate change to a certain degree and efforts will have to be made to reduce the GHG emissions from anthropogenic activities. The state will have to invest heavily to safeguard the welfare interests of the population, especially tribal who suffer from acute poverty. Ensuring adequate and quality water and food will become the priority of the state as due to stress on stock and flow of natural resources (water, agriculture, forestry) supplies of critical inputs to economy will dwindle. All the sectors will have to invest on technologies and processes to improve their performance at the same time reduce emissions. Sector wise detailed actions are prescribed in this report, the actions are based on the need to make the selected sectors climate proof, hence most of the actions suggested are innovative and do no match with the existing departmental plans (BAU approach). Thus it will be required for the state to develop capacities of the departments so that they can comprehend the climate change issue and its impacts and accordingly make climate change linked planning integral part of the departmental planning process. The prescriptions for the state are listed in Section- C of the report, which includes detailed action plan as well as funds required to mobilize resources and develop capacities of various stakeholders.

SECTION A: CLIMATE CHANGE AND JHARKHAND

Chapter 1

CLIMATE CHANGE AND ITS IMPACTS ON GROWTH AND DEVELOPMENT

Climate change is one of the biggest challenges ever faced by the human race. The projected rise in global mean temperature and associated weather pattern shifts and sea level rise will have far reaching implications on the balance of stock and flow of the environmental resources, with potential of wiping a large number of species from the face of earth. The climate change models suggest that the direct short term impacts of the climate change will be on fresh water availability, food security, energy security, biodiversity, and human health.

Scientists have estimated the degree of threat to life on Earth with each degree added to mean global temperature. There are studies commissioned at the global and national levels to determine indicative as well as highly probable impacts on the ecosystems.

Impact of climate change on India will be severe. India's large and growing population, its 7500-km long densely populated and low-lying coastline, and the extent to which its economy is closely tied to its natural resource base, makes the country 'considerably vulnerable' to the impacts of climate change. India also has witnessed rise in the mean temperature by about 0.2^0 per decade for the period 1971-2007[1], sea level rise of approximately one cm per decade has been recorded along the Indian coast, and there are concerns that global warming may lead to an increase in extreme weather events such as cyclones. Disturbing trends have been witnessed in precipitation, minimum and maximum temperature which presents an alarming situation for the country. It is evident that farmers are already feeling impacts of climate change. Observed parameters include movement of apple orchards to higher altitudes (ADB, 2010). There has been suggestion that global warming may influence monsoon dynamics. In a country where 60% of farmland depends on rains, a shift in the rainfall distribution due to climate change would have far-reaching implications for the agriculture based population.

The 2nd National Commission (Ministry of Environment & Forests, 2012) highlighted the impact of climate change on various sectors affecting Indian ecological and economic health.

Table 1: Highlights of possible climate impacts (Ministry of Environment & Forests, 2012)

Sector	Predicted impact			
Impact on water resources	Most of the river systems (except Brahmaputra, Cauvery and Pennar) in India show increase in precipitation in the mid-century scenario.	Majority of rivers End of Century basin level precipitation increases by upto 40% (except for Cauvery an Krishna river basins which show decrease in precipitation)		
Impact on forests	Vegetation distribution as simulated by IBIS for baseline and A1B scenario predict expansion of tropical evergreen forests in eastern Indian plateau and in Western Ghats. There is no significant impact on vegetation in northeast and slight expansion of forests in western part of India.	In A1B scenario during 2021-2050 period about 30.6% of the forest-grinds will become vulnerable, whereas this number will rise to 46% during 2071-2100.		
Agriculture sector	An increase of temperature from 1 to 4^0C reduced the grain yield of rice (0 to 49%), potato (5 to	In the absence of adaptation and CO_2 fertilization benefits, a 1^0C increase in temperature alone could lead to a	The stimulating effect of CO_2 could offset the negative impact of climate on cotton production, hence the cotton	Legumes are the major rain-fed agro-ecosystems of the country. Simulation studies were conducted using InfoCrop models for soybean and groundnut and the DSSAT CROPGRO model for chickpea with projected changes

[1] India's Second National Communication, 2012

Sector	Predicted impact			
	40%), green gram (13 to 30%) and soybean (11 to 36%). The linear decrease per ^{0}C temperature rise was 14%, 9.5%, 8.8%, 7.3%, and 7.2% in rice, potato, soybean, wheat and green gram respectively	decrease of 6 million tonnes of wheat production. This loss is likely to increase to 27.5 million tonnes in case of a 5^{0}C increase in mean temperature.	production will largely remain unchanged.	in temperature, CO_2 and rainfall. The current (baseline, 1961-1990), A1B (2021-2050) and A1B (2071- 2100) scenarios all indicated a positive impact of future climate (combined change in temperature, rainfall and CO_2 levels) on their productivity
Human health	The Transmission Window (TW) for malaria changes across the country and an increase in the open months (months when malaria incidences are possible) increases across the regions endemic to malaria. Also Malaria window in some northern states opens up in climate change scenario.			

The impacts highlighted in 2nd National Communication have been corroborated by several international and regional research work. Based on such feedback, Government of India has already initiated climate change mitigation and adaptation process. Current Government expenditure in India on adaptation to climate variability is estimated to exceed 2.6 per cent of the GDP; with the priorities being agriculture, water resources, health and sanitation, forests, coastal zone infrastructure and extreme events (DoEA).

1.1 INTERNATIONAL POSITION AND EFFORTS ON CLIMATE CHANGE REGULATION VIS-À-VIS INDIA

Recognizing the need of an international effort for combating climate change, the United Nations Conference on Environment and Development (popularly known as Earth Summit) was held in 1992 which laid a roadmap of future international negotiations and treaties. The term 'Sustainable Development' was first mentioned in the Brundtland Commission Report and it paved the way for further climate negotiations. Kyoto Protocol, signed in 1997, was adopted by Parties willing to take significant cuts in their emissions (referred to as Annex-I Parties). This Protocol also laid down certain mechanisms for assisting the Annex -1 Parties to invest in developing countries (i.e. Non-Annex) to reduce their emissions in order to meet their commitments to the Protocol. The mechanisms such as Clean Development Mechanism (CDM), Joint Implementation (JI) and Carbon Market were designed to provide flexibility to the Kyoto signatories and to reduce the economic burden of emission reduction.

India's per capita emission is estimated to be 1.38 tonnes (UNstats, 2010) and is much lower than those of the developed countries. India has also maintained that its per capita GHG emissions in 2031 will be well below global average in 2005 (MoEF, 2009). Despite that India has still agreed to take voluntarily emissions cut. India has voluntarily agreed for reducing its emission intensity[2] of its Gross Domestic Product (GDP) by 20-25% by 2020 in comparison to 2005 level[3]. Achieving this target might seem a daunting task and international community further expects comprehensive national plans from India towards meeting its target.

1.2 INDIA'S NATIONAL INITIATIVES TOWARDS CLIMATE CHANGE

India, acting as a responsible nation, has made voluntary commitments to reduce the GHG emissions from economic activities. Considering that a large population in India is vulnerable to climate change impacts, it also

[2] Emission from agriculture not included

[3] India's Nationally Appropriate mitigation actions (NAMA) submitted to UNFCCC (http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/indiacphaccord_app2.pdf)

plans to pursue an Adaptation plan which is aligned with the economic growth targets of the country. In order to take a comprehensive sector wide approach for adaptation India launched its National Action Plan on Climate Change (NAPCC) in 2008[4]. The plan, in itself, is an adaptation strategy considering the fact that India is still at an early stage of economic development and such actions at this juncture would further push India on a sustainable development pathway.

Under its NAPCC, India has enshrined eight National Missions which cover almost every sector representing a long-term, multi-pronged and an integrated approach with time-bound programme. These eight missions focus on enhancing energy efficiency; increasing the penetration of solar in the total energy mix; developing climate friendly sustainable habitats; a water mission for integrated water resources management; a mission on sustainable agriculture for making it more resilient to climate change; a green mission for enhancing ecosystem services of forests and for enhancing its carbon sequestration capacity; a mission on Himalayan ecosystem for sustaining and safeguarding the Himalayan glacier and mountain ecosystems; and the last mission is aimed towards developing strategic knowledge base to address the concerns of climate change.

By asking State to prepare respective State Action Plans, India seeks to adopt a more decentralized approach and to some extent, pursues the principle of 'common but differentiated responsibilities since every State has its own unique characteristics. This combined with eight National Missions would enable working on several sectors with a focused approach by setting up relevant institutional mechanisms[5].

1.3 GUIDING PRINCIPLES FOLLOWED FOR TACKLING CLIMATE CHANGE ADAPTATION APPROACH

While India needs high economic growth to reduce poverty, sustaining high GDP would also require larger development activities and hence more emissions, even in the business-as-usual scenario. With its growing population and high demand for resources, India's greenhouse gas emissions are expected to increase steadily. Facing the twin challenges of sustaining its economic growth as well as mitigating and adapting to the impacts of global climate change threats; a sustainable economic development path which strikes a balance between development and conserving the environment is need of the hour. NAPCC, thus seeks to support economic development which also not disturbs the climate, it is an inclusive strategic plan for adopting an ecologically sustainable development path

Some of the key principles on which NAPCC is based are[6]:

- Adopting an inclusive and sustainable development strategy to protect the poor and vulnerable sections of the society which are most sensitive to climate change.
- Achieving national growth objectives through a qualitative change in approach that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions.
- Deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions extensively as well as at an accelerated pace.
- Engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development.
- Effective implementation of programmes through unique linkages, including with civil society and local government institutions and through public-private partnership.
- Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global IPR regime that facilitates technology transfer to developing countries under the UNFCCC.

The overall approach, as laid down in the vision document is bringing a 'directional shift in the development pathway' and identifying measures that promote development objectives with co-benefits for addressing climate change[7]. This approach is valid to all the states, including Jharkhand.

[4] Details of NAPCC are provided in Annexure 1
[5] http://india.gov.in/innerwin20.php?id=15651
[6] http://india.gov.in/innerwin20.php?id=15651

Chapter 2

JHARKHAND: AN OVERVIEW

The state of Jharkhand was created in the year 2000 by bifurcating the hilly and plateau regions of the erstwhile Bihar state. The state has an area of 79714 sq km and is home to 3.3 crore people (Government of Jharkhand, 2009).

Jharkhand is predominantly an agrarian state with 80% of the population still depending on agriculture and allied industries for economic development and sustenance. But the vast mineral resources clubbed with the human resource are shaping the future of the state. The state has proven reserves of 40% of the mineral resources of the country, and it ranks first in the production of coal, mica, kyanite and copper in the country. On top of it, the state is the sole producer of cooking coal, uranium and pyrite (Department of Industries, Jharkhand[8]).

2.1 PHYSIOGRAPHY OF THE STATE

Physiographically Jharkhand state consists of a series of four distinct plateaus, the highest plateau is formed by western Ranchi plateau or the pat region, which is 800 to 1100 meters above the mean sea level. It covers the north-western part of the Ranchi district and southern edge of Palamu district. The next plateau is known as the Ranchi, except the pat region. This plateau is about 600 meters above mean sea level. The Ranchi plateau is separated from the other surface of the same elevation by Damodar trough. The third plateau has an elevation of 300 meters above mean sea level and may be termed as the lower Chotanagpur plateau. The fourth plateau is a uniform surface formed by the river valleys, plains and lower parts of the outer plateau lying between 150-300 meters above mean sea level; Rajmahal hills and the Kaimur plateau belong to this category.

Table 2: Social and economic features of Jharkhand

Indicators	Jharkhand	India
Total Population (crores))(year 2011)	3.3	121.0
Sex ratio (females per 1000 males)(year 2011)	947	940
Tribal population (crores)(year 2011)	0.7	8.4
Total Geographical Area (lakh ha)	79.70	3287.3
Cultivable Land (lakh ha)	38.00	1410
Net Sown Area (lakh ha)	22.38	
Irrigated area (lakh ha)	01.57	570 l
Human Development Indicators		
Literacy Rate (%) (2010-11)	67.63	74.04
Economic Development Indicators		
NSDP/GDP Crores	70309	4493743
NSDP/GDP growth (2010-11)	6.35%	6.8%
Contribution of Agriculture to NSDP/GDP (%) (2010-11)	16.68	14.62
Contribution of Industry to NSDP/GDP (%) (2010-11)	35.82	20.16
Contribution of Services to NSDP/GDP (%) (2010-11)	47.50	65.22

The soil in the state of Jharkhand has been formed from disintegration of rocks and stones. The soil thus formed can be divided into various soil types; including red soil, micacious soil, sandy soil, black soil and laterite soil. Red soil, is found mostly in the Damodar valley, and Rajmahal area; the Micacious soil (which consists particles of mica) is found in the regions of Koderma, Jhumeritilaiya, Barkagaon, and areas around the Mandar hill. Sandy soil, generally found in Hazaribagh and Dhanbad; black soil that is found in Rajmahal area; Laterite soil is found in western part of Ranchi, Palamu, and parts of Santhal Parganas and Singhbhum.

2.2 AGRICULTURE AND ANIMAL HUSBANDRY

[7] Ibid.
[8] www.jharkhand.gov.in/new_depts/ap201011/industries201011.pdf

Despite being an agrarian state, Jharkhand fares very poorly in terms of irrigation of its agricultural land. The state's undulating hilly terrain and soil structure does not support canal based irrigation system, as much as 92% of the cultivated area in the state is unirrigated in contrast, states like Punjab have as high as 95 percent of their sown area under irrigation. The lack of irrigation facilities has restricted the agriculture sector growth of the state, in addition small farm holdings and economic limitations result in low agricultural productivity. However, high seasonal rains ensure that despite constraints, the farmers are able to grow crops and survive.

The favourable agro-climatic conditions also facilitate the year-round production of various types of off-season vegetables and fruits. Just within a period of three years, the state has graduated from a vegetable procuring state to a 100,000 tonnes vegetable surplus state. The soil as well as the climatic conditions of the state is also favourable for the growth of mushroom, tea, ornamental plants and spices (indfy, 2011).

In Jharkhand's agrarian economy, livestock plays an important role in augmenting income, employment and women empowerment. Apart from supporting the agriculture operations, dairying has emerged as an important enterprise to supplement rural economy. At the end of 9th five year plan, the milk production was 7.74 LMT which increased up to 14.01 LMT at the end of 10^{th} five year plan similarly egg and meat production at the end of 9th five year plan was 411 million and 386 lakh kg and increased up to 711 million and 426.36 lakh kg respectively, after suitable interventions of different animal husbandry activities (Department of Animal Husbandry, 2010-2011).

2.3 WATER RESOURCES

The state receives rainfall in the range of 1200-1600 mm per year. Precipitation is rather variable. Winter season precipitation is meagre and highly variable. About 60 percent of the rainy days have rainfall below 2.5 mm. On about 40 percent rainy days, evaporation level is more than 2.5 mm per day. As per estimate out of the average annual precipitation of 10 million hectare meter in the state about 20% is lost in the atmosphere, 50% flow as surface runoff and balance 30% soaks into the ground as soil moisture and ground water.

Despite the fact that the state has a good rainfall, the surface water availability is not sufficient especially for agriculture due to inadequate storage facilities etc. as far as the status of ground water is concerned, it is also in the poor state due to little recharging of ground water by natural process.

Presently, the availability of water resource is only 327790 lakh m^3, out of which 275280 lakh m^3 is from surface water (Second Bihar State Irrigation Commission report – 1994) and rest 52510 lakh m^3 is from ground water (Report of central ground water board – 2004). The total utilization of surface and ground water in the state for irrigation purposes so far is only 47360 lakh m^3 out of which 39640 lakh m^3 is surface water and 7030 lakh m^3 is ground water (Report of central ground water board – 2004).

2.4 ENERGY

Jharkhand being a resource rich state has immense potential and expectation for industrial growth. The large mineral deposits and other natural resources attract industries to state, hence ensuring sufficient energy is a priority of the state for promoting a conducive industrial growth.

Jharkhand is rich in both renewable and non-renewable resources of energy with abundance of water-falls, rivers, nuclear minerals and huge coal reserve. As of March 2012, Jharkhand had a total power generation installed capacity of 3,037.86 MW, which comprised 1,414.00 MW under private sector (this includes captive power generation facilities as well), 1,324.05 MW under the state utilities and 299.81 MW under central utilities. Backed by large coal reserves in the state, about 93 per cent of the total power generation installed capacity in the state is coal-based thermal power (2,828.88 MW) (Department of Mines & Geology, 2011-12). Besides, the state had total 200.93 MW of installed hydropower generation capacity and 8.05 MW is from renewable sources.

The existing power generation capacity utilization in the state is abysmally low, compared to the national average generation of 100 watts per person, Jharkhand's power production is abysmally low at 20 watts per capita (Department of Energy, 2011).There is immense scope for further development of mini, micro hydro power stations and non-conventional energy, apart from mega thermal power stations.

The State Government has encouraged captive power generation in the state and it is expected that the total power generation capacity of the state will go up to 4,500 MW in the coming years (Department of Mines & Geology, 2011-12). In 2009, the construction of the 3,960 MW, Ultra-Mega Power Project (UMPP) at Tilaiya started and is expected to start generating power from the year 2015 (Department of Mines & Geology, 2011-12).

2.5 URBAN SECTOR

Jharkhand has (as per census 2001) 152 small and medium townships and state's 24 percent population lives in urban areas. After the state formation, high rate of urbanization is witnessed and it has outpaced the population growth trend in the state due to migration from rural to urban centres. During 2001-2011, the urban population expanded by 32%, this is in line with the decadal national urban population growth rate of 31.8% (Census of India 2011, 2011).

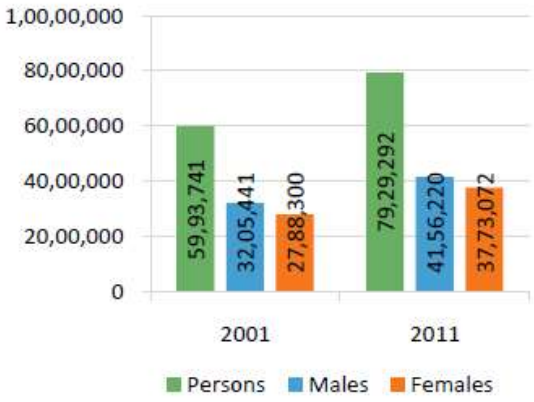


Figure 1: Jharkhand demography: Growth and composition

Urbanisation in Jharkhand is however less than the National Average of 27.78 % and far less than the urbanization in relatively developed states (in Tamilnadu 43.9% and in Maharashtra 42.4% population lives in cities).

2.6 TRANSPORT AND MOBILITY INFRASTRUCTURE

Roads are the major means of transportation in the state. The total length of National Highway, State Highway and others metalled roads in Jharkhand is 8724 km while that of district roads and rural un-metalled roads is 24,300 km (Department of Planning and Development, 2011).

The rise in economic development has resulted in increase in the numbers of vehicles both for private utility and economic benefits. Two wheelers constitute the largest number of vehicles registered in the state (almost 77% of the total registered vehicles), followed by cars and commercial heavy and light duty vehicles (Department of Forests and Environment, 2006).

Railways form the backbone of the mass transportation and catalyst to industrial development as well. The total rail length in the state is 1053 km, thus for every 100 sq km of area, there is 2.5 km of railway route length in the state, compared to Jharkhand, Maharashtra has just 1.8 km whereas Bihar has 3.4 km of railway route length for each 100 sq km of land area. The state although has a well developed rail network but many of the mineral bearing areas still lack evacuation logistics due to absence of railway connectivity. Several last mile railway connectivity projects are underway in the state to connect mineral rich areas to the national corridors to ensure smooth and cheap transportation (Bose, 2011).

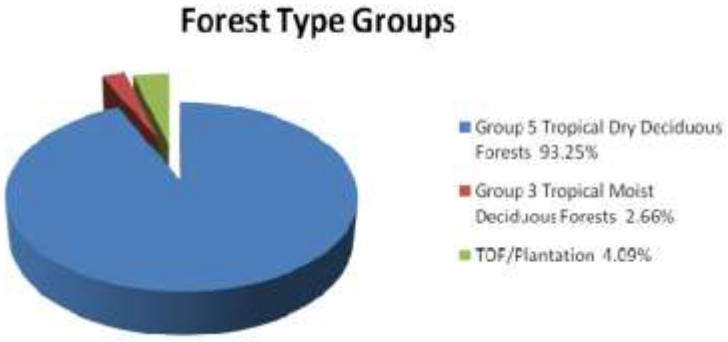
The air-connectivity in the state is poor, although the capital city is well connected to major North Indian cities, other important cities like, Jamshedpur, Dhanbad, Deoghar and Bokaro although have requisite infrastructure (air strips) yet are not well connected. The state's connectivity to major Indian cities although do exists but the overall air-traffic to and from Jharkhand is poor. Total landings and takeoff of commercial flights from the state in 2010-2011 were just 4,508, whereas this number was 297,992 for Maharashtra and 10,139 for Bihar displaying poor air traffic flow in-out of the state (Thadani, Tuli, & Karulkar, 2011).

2.7 FORESTS AND OTHER LAND USE

At present, the State is having 28.82% of its total geographical area under forest cover, the estimations are based on the satellite data of November 2008-January 2009. Forest type mapping using satellite data shows that

the state has five forest types which belong to two forest type groups, viz. Tropical Moist Deciduous and Tropical Dry Deciduous Forests (Forest Survey of India, 2011).

Based on the forest canopy density classes, the forest land of Jharkhand can be classified under three broad categories, 2,590 Km^2 is classified as very dense forest, 9,917 km^2 as moderately dense and remaining 10,470 km^2 as open forest (Forest Survey of India, 2011).



Due to the efforts by the state forest department, the quality of the forest in the state has improved. There has been an increase of 18 km^2 in the moderately dense forest and 65 km^2 in open forest. The estimated tree cover in the state (estimated using TOF inventory data collected over a period of six years, i.e. 2004-10) is 2,914 km^2 which is 3.66% of its geographical area (Forest Survey of India, 2011).

Percentage-wise distribution of forest cover in different forest type groups found in the state is displayed in the pie diagram.

2.8 MINING AND INDUSTRIES

Jharkhand is widely acclaimed as the growth engine of the future, having immense potential for industrialisation with its large deposits of minerals, which could provide a firm launching pad for various industries. It is one of the richest zones of minerals in the world.

The chief mineral resources of the state include iron ore, coal, mica, limestone, manganese, mica, copper ore among others (40 percent of the country's mineral reserves are from Jharkhand). They form the pivot of the business and economy of Jharkhand. It is the only Indian state to produce uranium, coking coal and pyrite, and the state heads the production of coal, copper, kyanite and mica in India. Large deposits of coal and iron ore support concentration of industry, some of the country's highly industrialised locations such as Jamshedpur, Ranchi, Bokaro Steel City, Dhanbad and Ramgarh are there.

In the heavy industries sector, Jharkhand is home to steel and metallurgy plants, power generation facilities, cement manufacturers, fertilizer and explosive factories. The industrial reputation of Jharkhand is established by the fact that India's first Iron & Steel factory was established in Jamshedpur and Asia's largest steel plan is situated in Bokaro. Adding to the list of achievements, country's first methane gas well has been established in Bokaro.

In the MSME (Micro, small, medium enterprises) space, only 5% of the units in Jharkhand are registered with the District Industrial Corporation, and only 26% of the units run on engines. The major SME sector units are into processing of the mineral. In the absence of proper environmental laws and enforcing agencies, these industries never follow pollution check methods and are a big source of pollution.

Post separation from Bihar, Jharkhand's industrial sector has witnessed tremendous growth. As evident from the Figure-2 the contribution of the secondary sector has grown by about 8 percentage points during last decade. Contrary to the growth trends of the country where tertiary sector's contribution is the main contributor to the GDP growth, Jharkhand state has utilized its resource stock to fuel the development in the state.

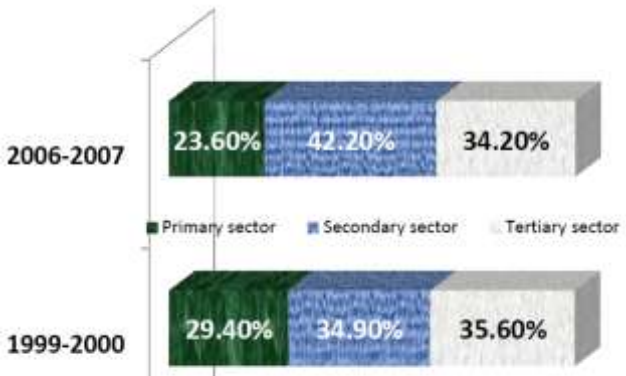


Figure 2: Distribution of primary, secondary and tertiary sectors in Jharkhand's GSDP (Department of Planning and Development, 2011)

2.9 EMISSION FOOTPRINT OF VARIOUS SECTORS IN JHARKHAND:

Jharkhand's high dependency on heavy industries and mining makes it a big emitter of green house gases (GHGs). The emission footprinting of the state is necessary to identify sectoral contribution of such gases.

The GHG numbers derived/ discussed in this chapter are not accurate but indicative. All necessary precautions are taken to ensure that the numbers reflect true picture. It is difficult to assign an accurate GHG number to respective sectors for two reasons; (1) There are gaps in the sectoral information that is required to calculate GHG emissions. For many sectors either numbers are not there, or numbers are not accurate. (2) Partial overlapping between operations/processes of sectors is common. In order to avoid double counting of emissions (due to overlapping) techniques are used that result in shifting of part of emissions to other sector; i.e. transportation linked emissions of mines and industries are captured in 'transport' sector.

The GHG footprint of Jharkhand is calculated using two approaches; in the first approach existing research work is used to extrapolate GHG numbers for Jharkhand. The second approach takes a bottom-up approach to generate GHG emission numbers using sector specific information.

Emission footprint using secondary research work: Garg & Shukla (2012) in their work titled Emissions Inventory of India calculated district level information for each district of the country for years 1990 and 1995. The information for Jharkhand was extracted from the numbers available for undivided Bihar. District wise emission details are listed in annexure 2 and a comparative summary of emissions is depicted in figure below.

		GHG emissions-year 1990	GHG emissions-year 1995
	Name of district	MtCO2e	MtCO2e
1	Deoghar	0.61	0.6
2	Dhanbad	6.03	6.03
3	Dumka +Jamtara	0.97	0.92
4	East Singhbhum	11.13	12.58
5	Giridih	19.63	22.36
6	Godda	0.47	0.67
7	Gumla + Simdega	0.91	0.85
8	Hazaribagh+Ramgarh+ Koderma + Chatra	5.23	4.89
9	Lohardaga	0.24	0.23
10	Palamu+ Garhwa	1.28	1.24
11	Ranchi+Khunti+ Latehar	2.48	2.56
12	Sahebganj+ Pakur	0.78	0.74
13	West Singhbhum+ Kharsawan	2.04	2.44

Table 3: District wise comparative analysis of the emissions (Garg & Shukla, 2002)

The total emissions for the state of Jharkhand as calculated in Emissions Inventory of India (Garg & Shukla, 2002) stood at 51.8 $MtCO_2eq$ in 1990 and rose to 56.11 $MtCO_2eq$ in next five years. The state witnessed increment an increment of 8.3% during the duration.

Considering the fact that the 1991 population of undivided-Jharkhand was 2.18 crores, and the population as reported in 2011 census is 3.29 crores. Using 1991 and 2011 population figures to develop a population series for 1991 to 2011 and generating a population linked GHG emission factor for the year 1995 (Population for year 1995 is calculated to be 2.402 crores and emissions are 56.11 $MtCO_2eq$), finally using the derived population linked emission factor (which is calculated to be 23.35 $MtCO_2eq$ /crore) the GHG emission for year 2012 is estimated to be **76.85 $MtCO_2eq$.**

GHG emissions for Jharkhand using bottom up approach:

During the process of JAPCC development sectoral GHG emissions for Jharkhand are calculated using IPCC guidelines. The emission for major sectors is calculated based on the information available in public (for some subsectors where no information is available, logical estimations are made). The sector specific emissions are described in respective chapters.

2.10 OBSERVED CLIMATE CHANGE AND DEVELOPMENT ISSUES IN JHARKHAND:

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) has confirmed many uncertainties about climate change. The various climate change models predict that it is a great problem that cannot be avoided completely. It is now very clear that the anthropogenic green house gases (mostly CO_2) are responsible for weather pattern shifts and global mean temperature rise (UNFCCC, 2007).

Because of increased GHG concentration, the global surface temperatures have increased about 0.74°C (plus or minus 0.18°C) since the late 19^{th} century, and the linear trend for the past 50 years of 0.13°C (plus or minus 0.03°C) per decade is nearly twice that for the past 100 years (National Climatic Data Center, 2012).

The impact of the climate change (as described by the IPCC) will have implications with severe negative externalities on the whole of state. Sectors dependent on natural resources (i.e. vegetation, water resources, rains and land) will be the worst sufferers whereas other sectors will have to allocate additional resources to adapt to the weather pattern shifts and temperature rise.

As explained, Jharkhand has the biggest reserve if minerals in the country, most importantly coal reserves of Jharkhand are key to India's energy security and economic development. Industrial development in the state has picked up after the bifurcation of the state and the state's GDP is expanding at the rate of 6.35% per annum. Contrary to industrial development, the state lags behind when social indicators are taken into consideration. Agriculture is although backbone of the rural economy but lacks modernization and suffers with low productivity.

Table 4: Jharkhand's comparative ranking w.r.t. to infrastructure and social development indicators

States	India State Ranking (year 2013)				HDI and GDI estimates based on ranking by WCD (States and UTs)	
	GSDP Per Capita	Urbanisation	Road & Rail Infrastructure	Literacy rate	1996	2006
Maharashtra	5	6	9	7	9	11
Goa	1	2	6	4	3	2
Delhi	2	1	1	5	4	4
Tamil Nadu	11	4	6	9	15	16
Karnataka	14	8	13	17	23	25
Kerala	7	5	3	1	1	2

States	India State Ranking (year 2013)				HDI and GDI estimates based on ranking by WCD (States and UTs)	
	GSDP Per Capita	Urbanisation	Road & Rail Infrastructure	Literacy rate	1996	2006
Gujarat	6	7	9	13	18	23
Uttrakhand	9	13	19	12	28	19
Sikkim	3	19	24	8	16	17
Jammu & Kashmir	22	17	26	24	26	27
Jharkhand	**24**	**21**	**19**	**26**	**33**	**29**
Manipur	27	14	26	11	12	7
Assam	29	27	13	20	26	27
Chhattisgarh	19	22	19	21	32	30

**WCD: Women and Child Development*
***HVS is a private research entity*

Compared to other states in the country, Jharkhand fares poorly considering parameters of social development, economic development, infrastructure and other welfare indicators (refer to Table-4). The HVS ranking of Indian states for various social parameters gives a poor ranking to Jharkhand[9]. The composite state ranking based on Human Development Index (HDI) and Gender Development Index (GDI) information of the state for the year 2006 as calculated by the Women and Child Development Department puts Jharkhand at 29th position (among 28 states and seven union territories)[10].
In this scenario, Jharkhand has a dual responsibility of equity centric economic development along with reducing the climate change vulnerability of rural masses. This will only be possible when the state takes a proactive approach by incorporating climate change scenarios in its developmental planning and preferential resource allocation for reactionary and anticipatory adaptation strategies.

The state's ranking makes it clear that Jharkhand lacks essential resources to put it in a fast track climate adaptation mode. Although Jharkhand should plan and bear the responsibility for mitigation and adaptation efforts to be carried out in the state, it cannot be treated or expected to perform as aggressively on climate mitigation and adaptation as the states that enjoy high NSDP. Hence, mitigation and adaptation targets defined and adopted for the Jharkhand will be based on the 'shared vision yet differential responsibility' principle.

[9] http://www.hvs.com/article/6714/2013-india-%E2%80%93-state-ranking-survey/
[10] http://wcd.nic.in/publication/GDIGEReport/Part2.pdf

Chapter 3

CLIMATE CHANGE AND JHARKHAND: STATE ACTIONS

3.1 PUBLIC POLICY INITIATIVES IN JHARKHAND

Jharkhand State Pollution Control Board- Jharkhand State Pollution Control Board (JSPCB) has launched *Vision 2012-2017 and Strategic Planning* report which aligns its role with sustainable use of resources (JSPCB, 2000). JSPCB, being a regulatory body, encourages industries to switch to newer and advanced technology that are environment friendly. The regulatory body has adopted standards that motivate sustainable use of resources with objectives of reduction in water consumption, rain water harvesting, reduced use of wood/coal for industrial purpose by switching over to efficient and cleaner fuel options.

Jharkhand Energy Policy, 2012- In order to reduce its GHG emissions, Jharkhand adopted Energy Policy, 2012 which specifies electricity generation through non-conventional energy sources. It gives a waiver of 50% of electricity duty for a period of 10 years for entities generating electricity from renewable sources and further extends concessional access to Transmission and Distribution (T&D) network. Also to promote renewable energy in the state, Jharkhand Renewable Energy Development Agency (JREDA) was set up in 2001, which is the nodal agency for implementation of programs of Ministry of New and Renewable Energy (MNRE) and Indian Renewable Energy Development Agency (IREDA). Energy conservation is also a major thrust of Energy Policy and has laid down a comprehensive Demand Side Management policy which encompasses improving energy efficiency in industrial, commercial and agricultural establishments (DoE, 2012).

Jharkhand State Water Policy, 2011- Jharkhand has launched its State Water Policy in 2011. It lays down approaches for 'better and more equitable and productive water resources management in an environmentally sustainable manner for promoting growth reduction in poverty and minimizing regional imbalance' (WRD, 2011). It also aims to create incentives for water users' organisations and enables creation of new institutional mechanisms to decentralize water resource planning. The approach of water policy also includes promotion of technologies to improve efficiency in water usage and formulating appropriate legislations to support other approaches.

Jharkhand Disaster Management Plan- The objectives of State Disaster Management Authority are two-fold (a) development and updating of Plans and Strategies to handle any type of disaster (b) undertaking projects for restoration and strengthening of infrastructure damaged by disasters (JDMD, 2011).

Private Initiatives in Jharkhand- Private entities have also taken keen interest in reducing their Green House Gas (GHG) emissions and generating revenues as a co-benefit. CDM registry at UNFCCC has seen many clean energy projects being launched in Jharkhand including waste-to-energy, GHG reduction through use of super critical technologies or biomass based cogeneration project. Apart from these some private entities have been focusing on sustainable use of their resources as part of their Corporate Social Responsibility (CSR) catering to better resource allocation and taking up development projects which ultimately yields environmental benefits.

Central schemes and multilateral initiatives in Jharkhand- Jharkhand has also been receiving Central government support under NAPCC. Seraikela-Kharswan, one of the twenty-four districts of Jharkhand, has been selected for the Green India Mission under NAPCC to improve the quality of over 5000 hectares of land through social and farm forestry, and through participation of *gramsabhas*. This would improve not only the environmental performance of district but it's also a giant leap towards strengthening village institutions. A UNDP funded project titled 'Strengthening Institutional Structures to Implement the Biological Diversity Act' is underway in collaboration with Jharkhand Biodiversity Board with the objective of strengthening of institutional capacities for better management of natural resources in a participatory manner.

State's forestry sector initiatives -Forest in Jharkhand has long been under tremendous pressure due to mining and meeting the demands for fuel. Initiatives have been taken by the State government to increase its forest cover in response to climate change under the Green India Mission to enhance and improve the status of forest

in the state. Forest Resource Surveys are also being conducted at district level for better resource management and planning which also includes utilize the existing scope of social forestry and afforestation, for the wasteland development on activities.

Mining is an important economic activity in Jharkhand and mining activities have high ecological and social impact. To minimize the impacts of mining, the State Government also proposes to bring some legislation in mining in line with Andhra Pradesh model so that resources generated from mining sectors can be used to replenish the development funds available with the local bodies. It also has plans to create a separate directorate of environment.

Table 5: Jharkhand state police vis-à-vis climate change

Initiatives/ policies	Addresses adaptation capabilities of institutions/ community	Reduces/ controls GHG emissions	Reduces vulnerability towards natural hazards	Confirms with business-as-usual scenario	Confirms with climate change scenarios
Jharkhand Industrial Policy 2012/ State pollution control norms	✗	✓	✗	✓	✗
Jharkhand Energy Policy, 2012	✗	✓	✓	✓	✗
Jharkhand State Water Policy, 2011	✗	✗	✓	✓	✗
Jharkhand Disaster Management Plan	✗	✗	✗	✓	✗
Private Initiatives in Jharkhand	✗	✗	✓	✓	✗
National and International Initiatives in Jharkhand	✗	✓	✓	✓	✗
State initiatives in Forestry	✗	✓	✓	✓	✗

However the extensive policies taken by the State government, though relevant in context of climate change, need further strengthening as they are designed keeping in mind the business-as-usual scenario. Hence overarching strategy and institutional framework also accounting for the extreme climatic events needs to be developed. It is, therefore, a viable justification that the State government should prepare a comprehensive State level action plan which is inclusive of above elements and also considers extreme erratic events due to climate change. Such a plan would be an initiative on part of State government to align its economic and ecology development goals with that of central government and it would also act as a tool for the State for assessment, designing and execution of projects aimed at mitigating the effects of climate change on Jharkhand.

3.2 JHARKHAND STATE ACTION PLAN ON CLIMATE CHANGE

JAPCC Vision -*"The underlying principle of Jharkhand's State Action Plan on Climate Change (SAPCC) is achieving economic growth and poverty alleviation objectives and enhancing livelihood opportunities while ensuring ecological sustainability. The strategic approach has to be extensive and has to be based upon identification and use of appropriate technologies for adaptation-mitigation and effective implementation with support from civil society."*

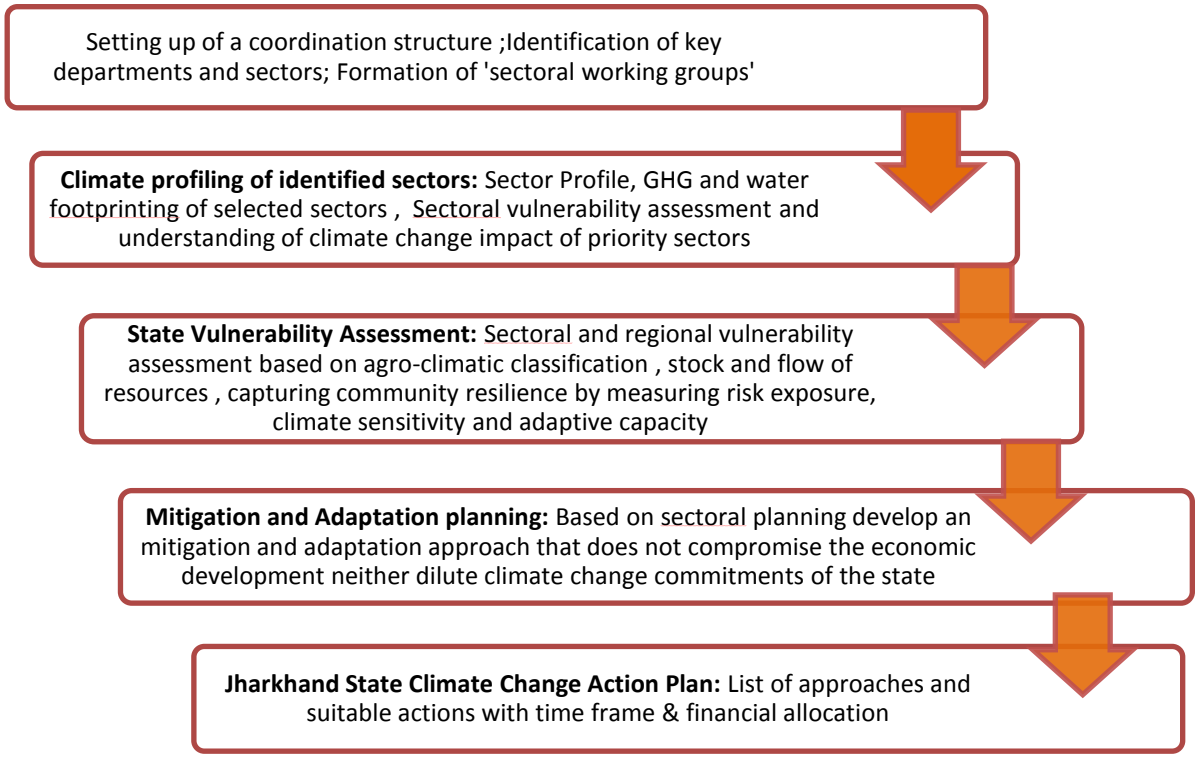
Approach:

Keeping in view the SAPCC principles and state specific requirements, the JAPCC focused on experience of sector experts for developing the sector-approach by utilizing primary and secondary information available in public and state domain. The action plan is finalized by aligning the plan with state adaptive capabilities to strengthen the state response towards climate change.

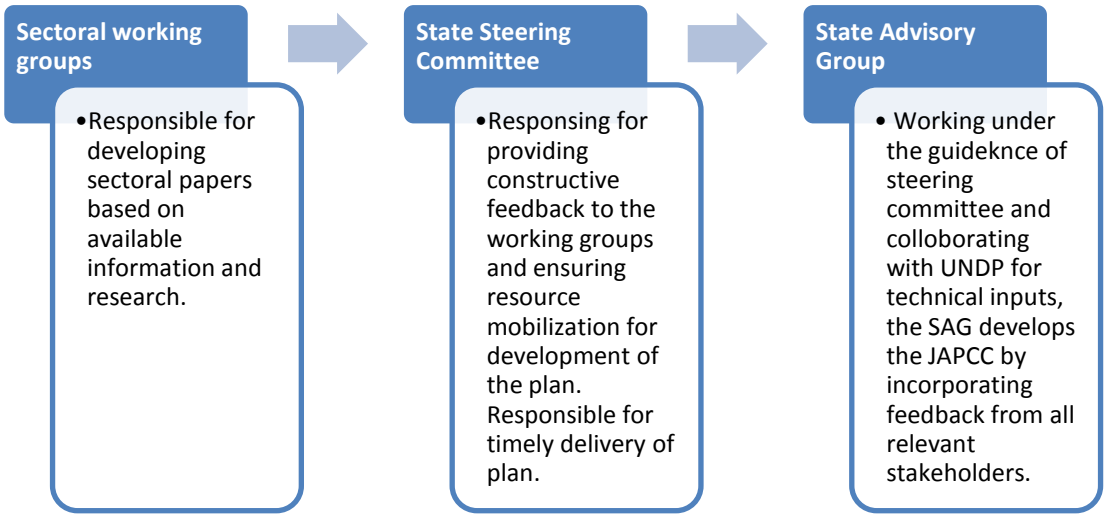
The objectives of the plan are to:

- Identify the climate change risks to various sectors in the state.
- Develop a comprehensive state level vulnerability mapping and risks associated to climate change
- Determine the sectoral resilience to manage the climate linked risks and prescribe measures that help fill the policy and planning gaps
- Identify, assess and recommend specific adaptation and mitigation measures that help define the policy and action framework in the climate change regime. The recommendations have to be tested against the underlying principles of as defined by JAPCC of finding a balance between development and conservation.
- Considering the fact that coal and mineral based industries are going to be the economic drivers of the state for considerable long period , hence mitigation strategies are given emphasis while developing JAPCC
- Identification of appropriate and competent implementing agencies for better coordination and integration to enhance the efficiency of prescribed approaches and actions.
- Assess and recommend specific measures for climate change mitigation and adaptation co-benefits which represent the stakeholders views and concerns and conform with the regional perspective
- The culmination of the efforts will be in finalization of the Jharkhand Climate Change Mitigation Plan that will be acceptable to all the departments and will be able to lead Jharkhand to a green and equity centric development path.

While designing the JAPCC has taken into consideration:



Administrative approach to develop plan: Sectoral working groups were formed by the convener of the JAPCC. The working groups represent all the important sectors in the state. The working groups are responsible for developing the sectoral base papers by investigating the impact of climate change in respective sectors. The 'working group' approach ensures convergence of intellect, technical knowhow, administrative understanding ensuring pragmatic solutions for each sector.



Considering the specific climatic impact, sectoral sensitivity towards climate change due to its degree of exposure to climate change and the adaptive capacity (resilience) of the sector; specific plans have been

developed for all the selected sectors. The sectoral Working Groups (WGs) worked on selected sectors to ensure the convergence of the science, intellect and governance to produce pragmatic solutions. The final plan has been put forth by subject matter experts in active consultation with the state departments.

Supported by UNDP, the state government of Jharkhand initiated process to develop JAPCC. On May 2011 the State Steering Group and State Advisory Group (SAG) were formed through state government notification.

The state level steering committee is headed by the Development Commissioner of the state and included chief secretaries of 13 departments, chairperson of state pollution control board and Member Secretary Pollution control board of Jharkhand. The SAG on the other hand is a 25 member team comprising experts and administrators from government, education institutions and private entities.

The steering committee was to coordinate the whole planning process by ensuring interaction and action between various departments. The committee was mandated the role of overseeing aspects of the state's preparations and initiatives to develop plan on climate change. The SAG on the other hand was to work under the guidance of the steering committee, collaborating with the UNDP for technical support work for the development of JAPCC and also periodically update the stakeholders on milestones achieved.

The Department of Environment and Forests led the preparation of JAPCC in consultation with various line departments. Information and issues on various sectors was shared with the JAPCC through presentations and sectoral reports.

Report development process: Initial rounds of inputs from various departments and subject experts were. Preparation of a consolidated SAPCC report: After the initial rounds of workshops and meetings it was felt to carry out a compilation of the reports submitted to the JAPCC and also carry out document revision and gap filling and updating of the work.

A timeline of events, meetings and workshops undertaken during the JAPCC process is:

Date/ Month	Activity
30th June 2008	National action plan on climate change was released
9th Feb- 10th Feb 2011	Workshop on Role of Forests in Climate Change
6th May 2011	State steering committee on CC -Constituted vide notification no.1706 of the department of forests and environment, GoJ
6th May 2011	State advisory group-Constituted vide notification no.1707 of the department of forests and environment, GoJ dated 6th May 2011
26th May 2011	1st Meeting of the SAG- State advisory committee meeting to identify sectors and develop framework for SAPCC
24th June 2011	Second SAG meeting
20th July 2011	Third SAG meeting
27th June 2012	Fourth SAG meeting
4th July 2012	Fifth SAG meeting
24th July 2012	Jharkhand pollution control board organized inception workshop
30th Jan 2013	First draft report presented by the State Programme Director (Jharkhand Tribal Development Society) to the state officials representing concerned departments
March 2013	Draft JAPCC shared with concerned departments and general public for comments and feedback
April 2013	Draft JAPCC report uploaded on the Department of Environment and Forests website for public comments
December 13rd 2013	First public consultation meeting organized at Ranchi for sharing of draft JAPCC shared with concerned departments and general public for comments and feedback
December 17th 2013	Second public consultation meeting organized at Hazaribag for sharing of draft JAPCC shared with concerned departments and general public for comments and feedback

Date/ Month	Activity
December 23rd 2013	Final public consultation meeting organized at Jamshedpur for sharing of draft JAPCC shared with concerned departments and general public for comments and feedback

The draft SAPCC has been widely disseminated and comments invited from various government departments and civil society in general for comments and feedback. The inputs are collated, examined and, where appropriate, incorporated to produce this final draft version of JAPCC.

1st Regional Public Consultation Meeting Ranchi (13th Dec 2013)

2st Regional Public Consultation Meeting Hazaribagh (17th Dec 2013)

3rd Regional Public Consultation Meeting Jamshedpur (23rd Dec 2013)

3rd Public Consultation Meeting Jamshedpur (23rd Dec 2013)

The outcome: The JAPCC identifies action points/strategies in the context of climate change on the basis of existing scientific knowledge, climate modelling and sectoral experience of the state.

JAPCC endeavours reframing development pathways with low carbon growth, at the same time ensuring that development opportunities are protected, supported and increased.

Chapter 4

CLIMATE CHANGE IN JHARKHAND: OBSERVATIONS AND PATTERNS

Intergovernmental Panel on Climate Change (IPCC) has come out with global and regional emission pathways in its special report. Four CO_2 concentration based scenarios were used for projections (Chaturvedi, Joshi, Jayaraman, Bala, & Ravindranath, 2012). These scenarios predict changes in global temperatures and rainfall.

The climate change impacts are also witnessed and measured in India. The Indian subcontinent is witnessing rise in temperature. The annual mean minimum temperature rose by 0.27^0 C during 1901-2007. However, in the recent decade 1998-2007, the maximum temperature shows stagnation in trend. Further, the predictions show that mean winter temperature in the county will increase by as much as 3.2^0 C by 2050 and 4.5^0 C by 2080. Extreme temperature and heat spells have already become common over Northern India. Like precipitation which is highly dependent on temperature will also show changes. Its predicted that the rainfall in most part of the country will rise significantly in coming years.

In this chapter, the climate change impacts on Jharkhand have been reported. Various climate change scenarios are presented to make the case for immediate climate change actions required in the state.

4.1 RAINFALL TRENDS IN JHARKHAND

The rainfall pattern in the state has witnessed significant changes during past decades. Figure-3 displays the seasonal pattern of rainfall based on the data from 1956-2008 for the Ranchi region, it is evident that maximum annual rainfall (82.2%, with the average of 1149.3 mm) was received during South West monsoon season (June to September) and only 6.5% (average amount of rainfall 92.3 mm) was received during North East Monsoon (October to December) months in the state. The remaining of rain was received in winter (3.7%, with average of 52.4 mm), from January to February and summer (7.5%, with average of 104.7 mm) from the March to May, respectively. Hence the state receives majority of rains during monsoon and only 17.7% of the annual rainfall received during other seasons.

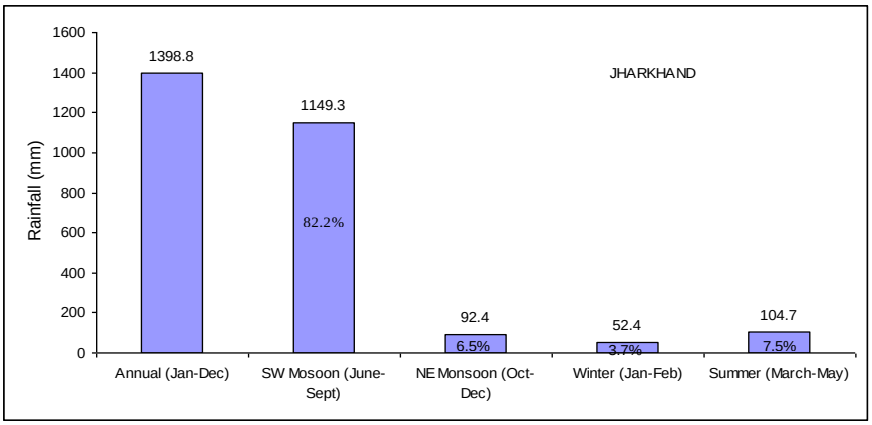


Figure 3: Seasonal precipitation distribution for Ranchi city (data from 1956-2008) (Anil & Manoj, 2010)

Decadal Feature of Rainfall Distribution

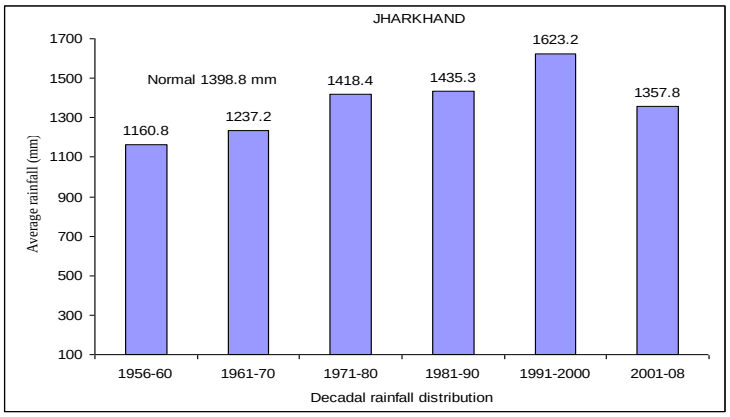


Figure 4: Decadal distribution of rainfall of Ranchi (1956 to 2008) of Jharkhand state

The decadal distribution of rainfall over this state is shown in Figure-4. It is clear from comparison of rainfall during 1956-2008 that the average rainfall didn't follow a range, it was continuously rising during the period. The year 1991 to 2000 received the maximum rains (average of 1623.5 mm) among all the decades whereas minimum average rainfall was received by the state during 1956 to 1960.

In sharp contrast to the observed trend during 1956-2000, period 2001-08 witnessed sharp decline in annual rainfall. The state witnessed severe droughts post 2000.

Inter decadal seasonal precipitation trend

A statistical analysis was carried out to understand the seasonal variation in the rainfall. Rainfall data from 1956-2008 was clubbed in decadal format (average rainfall for every month during the corresponding decade) and statistical analysis was carried out for the respective decade based on the available seasonal rainfall information.

The correlation coefficient deviation for winter and summer rainfall for the duration 1956-2008 was ±0.05 and it was ±0.07 for the SW monsoon (June-September). The NE precipitation (rainfall during October till December) showed statistically high correlation of 1 due to the variations. The variations were less for the monsoon months (June-September). Again, statistically there were high deviations in the Feb-May rainfall.

Table 6: Correlation coefficient (r) of different decades from year 1961 to 2010 between monthly rainfall (mm) with normal at Ranchi

Month	1956-60 (mm)	1961-70 (mm)	*1956-70 (r)*	1971-80 (mm)	1981-90 (mm)	*1971-90 (r)*	1991-2000 (mm)	2001-2010 (mm)	*(1991-2010 (r)*
Jan	21.2	20.01	*0.99*	19.89	19.5	*0.96*	23.2	11.5	*0.95*
Feb	23.1	24.2	*0.99*	41.52	38.5	*0.96*	31.5	33.2	*0.95*
Mar	25	24.1	*0.99*	24	23.5	*0.96*	23.2	30.1	*0.94*
April	25.5	26.2	*0.99*	26.2	26.4	*0.96*	23.2	27	*0.94*
May	26	49.8	*0.98*	83.7	46.2	*0.95*	44	41	*0.93*
June	150	152	*0.98*	198	248.5	*0.95*	263.5	280	*0.92*
July	320	380	*0.99*	420	300	*0.98*	270	240	*0.93*
Aug	285	280	*0.98*	320	300.1	*1.00*	380	252	*0.93*
Sept	200	260	*0.99*	265	263.5	*1.00*	210	200	*0.93*
Oct	98	92.5	*1.00*	54.5	56.5	*1.00*	60	130	*1.00*
Nov	5.4	8.4	*1.00*	9.5	12.5	*1.00*	8.2	3.4	*1.00*
Dec	2	3	*1*	4	6	*1.00*	2	1.4	*1.00*

Decadal Monthly Rainfall Distribution and its Variability

The decadal monthly rainfall for the period 1956-60 to 1961-70, 1971-80 to 1981-90 and 1991-2002 to 2001-08 and its variability (Coefficient of variability or CV%) are presented in the Table-7. The results reveal that the variability is high in case of NE Monsoon (October to November), winter (January to February) and summer (March to May) and comparatively less variation were observed in south west monsoon (June to September).

Table 7: Coefficient of variability of different decadal (1956 to 2010) monthly rainfall distribution with individual month of the year (decadal) of Ranchi, Jharkhand

Month	1956-60 (CV%)	1961-70 (CV%)	*1956-70) (CV%)*	1971-80 (CV%)	1981-90 (CV%)	*1971-90 (CV%)*	1991-2000 (CV%)	2001-2010 (CV%)	*1991-2010 (CV%)*
Jan	21.2	20.01	*10.46*	19.89	19.5	*9.75*	23.2	11.5	*10.07*
Feb	23.05	24.12	*10.33*	41.52	38.5	*9.64*	31.5	33.2	*9.93*
Mar	25	24.1	*10.31*	24	23.5	*9.81*	23.2	30.1	*9.91*
April	25.5	*26.12*	*10.37*	26.2	26.4	*9.81*	23.2	27	*9.98*
May	26	49.8	*10.42*	83.7	46.2	*9.85*	44	41	*10.00*
June	150	152	*10.46*	198	248.5	*9.99*	263.5	280	*10.04*
July	320	380	*10.84*	420	300	*10.28*	270	240	*10.00*
Aug	285	280	*9.66*	320	300.1	*9.56*	380	252	*9.93*
Sept	200	260	*8.58*	265	263.5	*8.58*	210	200	*8.14*
Oct	98	92.5	*6.78*	54.5	56.5	*5.92*	60	130	*6.89*
Nov	5.4	8.4	*7.01*	9.5	12.5	*6.42*	8.2	3.4	*6.92*
Dec	2	3	*7.15*	4	6	*6.87*	2	1.4	*7.07*

4.2 PREVAILING MAXIMUM TEMPERATURE

The temporal temperature figures were analyzed for the city Ranchi. The results of the average long term trend of the maximum temperature for the city of Ranchi for the period 1961-1970, 2001-2006 and the normal average temperature for the period 1956-2006 were plotted in graph to observe temperature trends. The maximum temperature was observed in the month of May, and then gradually decreasing trend was observed with minimum oscillations. Displayed in figure are average temperature variations for ten year period 1961 to 1970 year, current (2001 to 2006) and normal average temperature for the period 1956 to 2006 year.

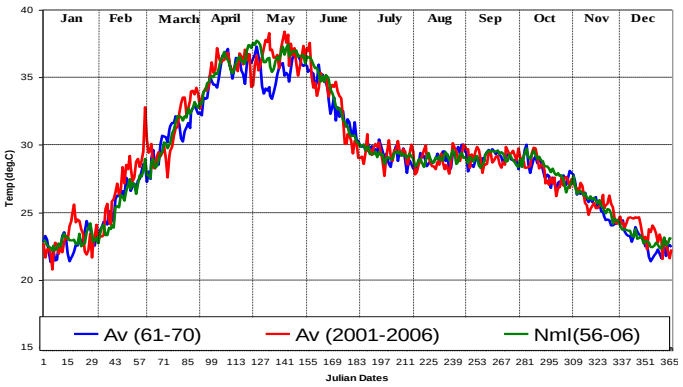


Figure 5: Comparative representation of average maximum temperature trend for the decades 1960-70, average (2001-06) and normal (1956-2006) at Ranchi

From the figure, it is evident that the normal average temperature (nml) is very close to the temperature observed during the period 1961 to 1970 in all the months, while in case of comparison of 1961-1970 and 2001-2006 maximum temperatures a high oscillation or deviation is observed.

For the pre-monsoon period, high variation between the average 2001-2006 temperatures is observed compared to the average for 1961-1970 and nml for the 1956-2006 periods.

It can be concluded from the analysis that the average temperature in the city of Ranchi in recent years (2001-2006) has seen high deviations from normal temperature in comparison to the historic data available. Also the highest annual temperature average (for the month of May) has remained comparatively higher.

4.3 PROJECTIONS FOR FUTURE CLIMATE

Climate variability in the state of Jharkhand: Various study results are analyzed to depict the impact of climate change in the state of Jharkhand. In these studies changes in weather pattern, rainfall and the temperature are captured at the national and regional levels. The climate change projects for the state of Jharkhand are made using interpretations and conclusions from different studies. Most of the studies (i.e. climate modelling) makes projections are the national or regional level, political boundaries of India and Jharkhand are superimposed over such results to identify Jharkhand specific information. Also, district level projection numbers are used from http://www.worldclim.org/ to develop short term and long term temperature and precipitation projections for the state.

4.3.1 PROJECTIONS USING PRECIS MODEL:

Impact of global warming on the Indian monsoon is examined using Hadley Centre's high resolution regional climate model, PRECIS (Providing Regional Climates for Impact Studies). The PRECIS simulations corresponding to the IPCCSRES A1B emission scenario are carried out for a continuous period of 1961–2098. The climate projections are examined over three time slices, viz. short (2020s, i.e. 2011–2040), medium (2050s, i.e. 2041–2070) and long (2080s, i.e. 2071–2098).

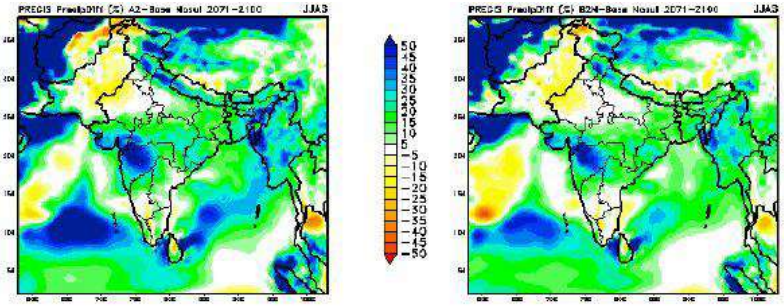


Figure 6: Projected changes in summer monsoon rainfall (upper panel) and surface air for A2 and B2 scenarios for 2071-2100 (Kumar et al (2006)

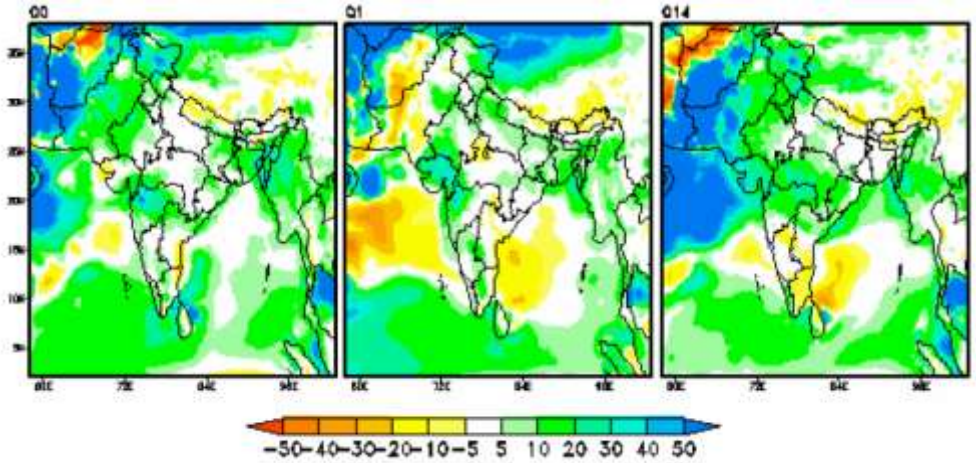


Figure 7: Percentage change predicted in the summer monsoon precipitation by three PRECIS runs in 2030 w.r.t. 1970s

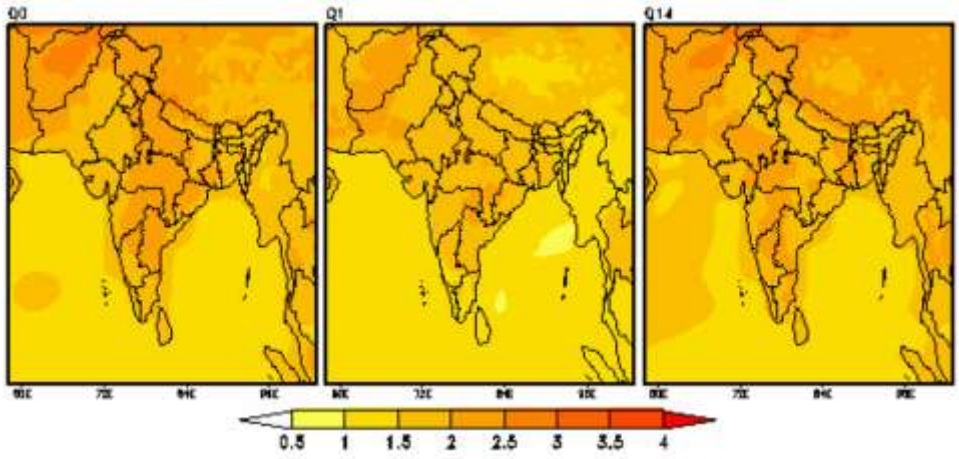


Figure 8: Projected changes in surface air for A2 and B2 scenarios for 2071-2100
(Kumar et al. (2006)

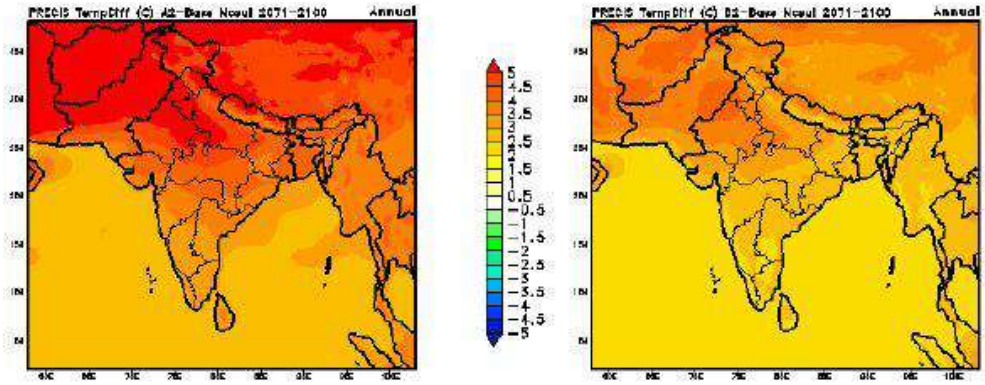


Figure 9: Changes in annual surface air temperatures in 2030 with respect to 1970

Table 8: Characteristics of simulated seasonal and annual rainfall and mean temperature for all-India (baseline and A1B scenario – Q0 simulation) as simulated by of PRECIS

	Rainfall (mm)					Mean temperature (°C)				
Q0	JF	MAM	JJAS	OND	Annual	JF	MAM	JJAS	OND	Annual
Mean										
Obs	27	120	954	132	1234	18.2	26.9	27.5	21.3	24.3
1970s	41	229	879	126	1275	14.7	26.5	24.8	16.8	21.5
2020s	37	219	911	136	1303	16.5	28.0	26.2	18.3	23.1
2050s	51	243	980	146	1421	18.2	29.4	27.1	19.8	24.4
2080s	51	243	1024	153	1471	19.3	30.6	28.3	21.2	25.6
Standard deviation										
Obs	10.3	23.3	97.3	28.8	114.7	0.5	0.5	0.3	0.4	0.2
1970s	18.1	50.6	53.0	27.1	74.0	1.1	0.7	0.6	1.0	0.4
2020s	22.2	49.0	54.8	41.2	79.9	0.9	0.9	0.8	1.3	0.6
2050s	34.2	63.9	67.8	50.4	102.7	1.2	0.9	0.8	1.2	0.6
2080s	25.7	69.0	60.9	43.4	101.4	1.0	0.7	0.6	1.0	0.4

MAM, March–April–May.

Table 9: Characteristics of simulated seasonal and annual rainfall and mean temperature for all-India (baseline and A1B scenario – Q1 simulation) as simulated by PRECIS

	Rainfall (mm)					Mean temperature (°C)				
Q1	JF	MAM	JJAS	OND	Annual	JF	MAM	JJAS	OND	Annual
Mean										
1970s	42	184	637	98	961	15.8	26.5	25.8	17.5	22.3
2020s	37	199	678	95	1009	17.4	28.1	26.6	18.5	23.4
2050s	41	198	669	101	1009	18.8	29.0	27.8	20.5	24.8
2080s	43	199	734	108	1084	19.8	30.2	28.6	21.7	25.8
Standard deviation										
1970s	15.6	31.7	71.5	23.4	79.4	0.9	0.7	0.7	0.9	0.6
2020s	12.3	38.7	61.6	21.1	87.5	0.7	0.9	0.9	1.3	0.8
2050s	14.1	36.6	89.5	23.1	96.3	1.1	0.7	0.7	1.1	0.6
2080s	18.9	31.4	100.2	28.0	107.1	1.1	0.7	0.9	1.2	0.7

Table 10: Characteristics of simulated seasonal and annual rainfall and mean temperature for all-India (baseline and A1B scenario – Q14 simulation) as simulated by PRECIS

	Rainfall (mm)					Mean temperature (°C)				
Q14	JF	MAM	JJAS	OND	Annual	JF	MAM	JJAS	OND	Annual
Mean										
1970s	70	218	864	141	1293	15.4	27.0	25.5	18.1	22.3
2020s	61	242	910	145	1358	17.2	28.5	26.7	19.6	23.8
2050s	64	248	940	148	1400	18.8	30.4	28.1	21.8	25.5
2080s	75	252	941	174	1442	19.8	31.3	29.3	22.7	26.6
Standard deviation										
1970s	37.8	47.2	66.6	39.1	102.8	0.93	0.76	0.53	0.82	0.41
2020s	19.9	39.3	83.7	44.6	90.3	1.1	0.66	0.66	0.85	0.44
2050s	26.1	33.9	79.8	49.4	107.6	1.31	0.7	0.71	1.25	0.6
2080s	39.2	65.0	85.6	46.6	117.2	1.2	1.07	0.69	0.97	0.63

The model projections indicate significant warming over India towards the end of the 21st century. The summer monsoon precipitation over India is expected to be 9–16% more in 2080s compared to the baseline (1970s, i.e. 1961–1990) under global warming conditions. Also, the rainy days are projected to be less frequent and more intense over central India.

Simulated percentage changes in mean monsoon precipitation in the 2020s, 2050s and 2080s with respect to baseline (1961–1990) are shown in Table-8, Table-9 and Table-10 for all the three simulations. Q0, Q1 and Q14 simulations project 16%, 15% and 9% rise respectively, in the monsoon rainfall at the all-India level. However, towards the end of the 21st century the projections indicate a slight decrease in monsoon rainfall over Tamil Nadu and Andhra Pradesh. These three simulations indicate a possibility of higher monsoon rainfall in future for all other states.

PRECIS simulations for the 2020s, 2050s and 2080s indicate an all-round warming over the Indian subcontinent associated with increasing greenhouse gas concentrations. The annual all-India mean surface air temperature rise by the end of the century ranges from 3.5°C to 4.3°C in the three simulations.

In near future, i.e. 2020s, Q0 and Q14 show decrease in the number of rainy days over the west coast, central India and the Indo-Gangetic plains and increase over northwest India and the east peninsula. Q0, on the other hand, indicates increase in the number of rainy days everywhere, except northeast and east central India. In 2050s, Q1 and Q14 depict decrease in the number of rainy days over major part of the country, whereas Q0 shows decrease over Uttar Pradesh, Bihar, Jharkhand and northeast India only. Towards 2080s, the number of rainy days may increase everywhere except northwest India in the Q14 simulations, whereas Q0 and Q1 show increase over the west coast and decrease over central India.

4.3.2 PROJECTIONS USING WORLDCLIM DATA: PRECIPITATION PROJECTIONS FOR 2050 AND 2080

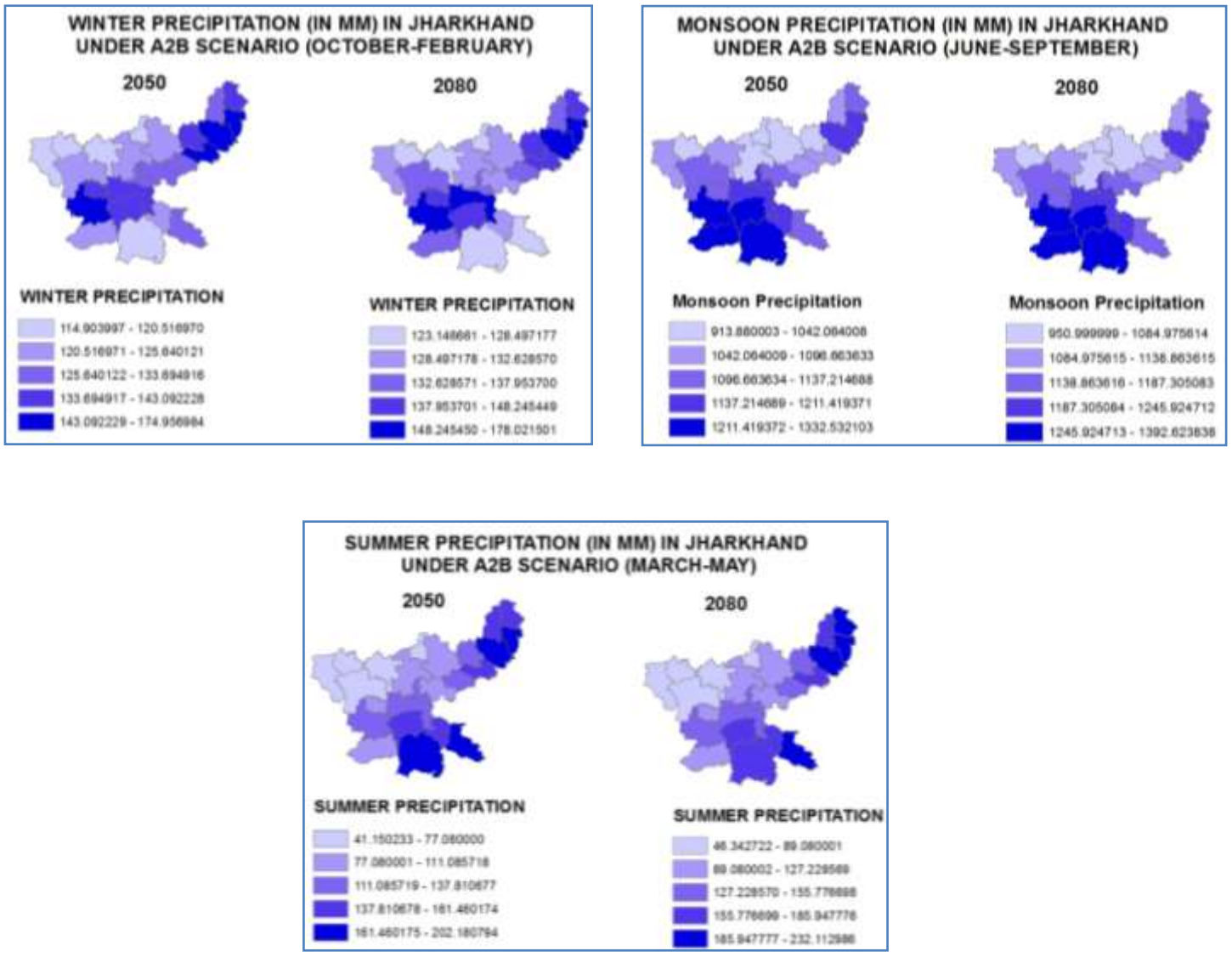


Figure 10: Medium term and long term precipitation projections for Jharkhand

District level climate change scenarios for Jharkhand, generated through WORLDCLIM for A2B scenario indicate rise in average rainfall in all the districts. The projections indicate that the rainfall in all the three seasons will go up in future and this increase will be significantly large for some of the districts. The model does not predict the indicative number of rainy days over the state.

Projections using WORLDCLIM data: Minimum and maximum temperature projections for 2020, 2050 and 2080

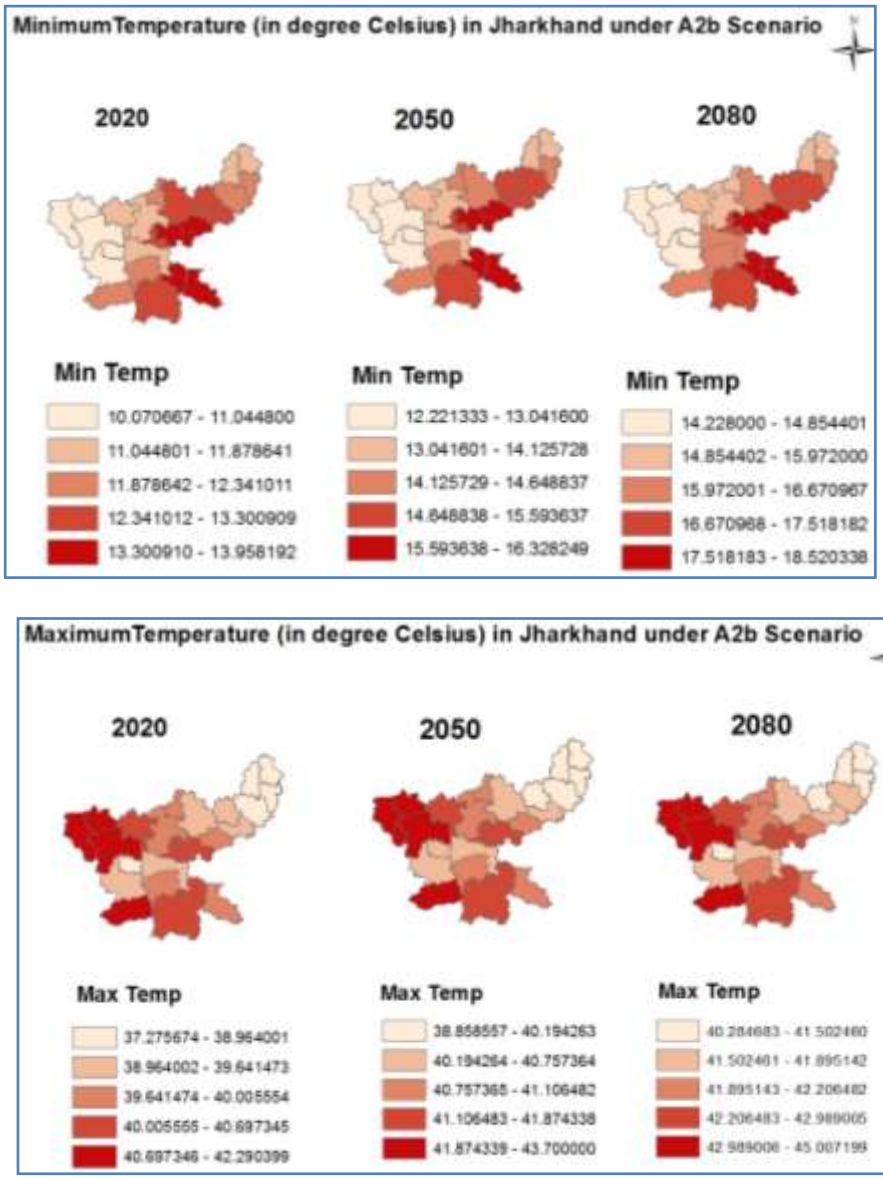


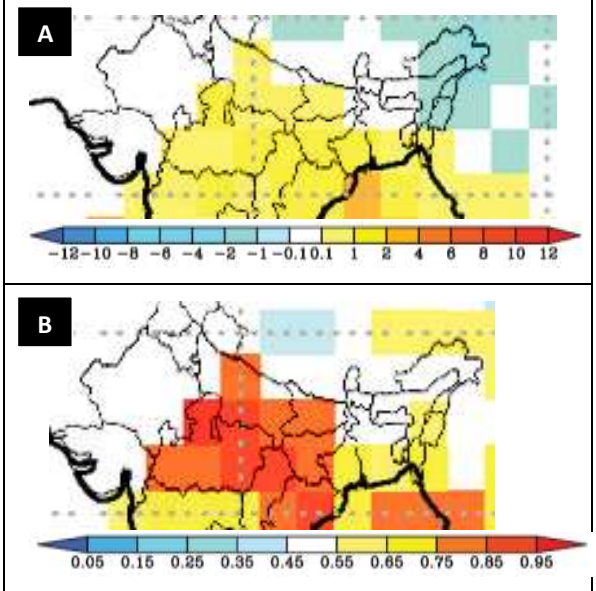
Figure 11: Short, medium and long term temperature projections for Jharkhand (Source http://www.worldclim.org/)

According to the WORLDCLIM projections, in the A2B scenario, maximum temperature will gradually rise in all the districts of Jharkhand during 2020 to 2080. The summer as well as the winter will become hotter by 2080s. There will be rise in average summer maximum temperature as well as average winter minimum temperature. The summer temperature will go up by a maximum of 2.3^0-3.0^0 between 2020-2080, whereas winter temperature will go up by 4.78^0C to 5.2^0C during the same period. To put this in perspective, the winter temperature will rise by such an extent that the lowest minimum temperature in 2080 will be higher than the highest minimum temperature in 2020s.

4.3.3 IPCC SRES EMISSION SCENARIO

The IPCC SRES scenario indicates a rise in annual mean surface air temperature for all parts of India. Temperatures are likely to rise by 2-5^0C and 2.5-4^0C in A2 Scenario by the end of 21st century (2071-2100), with warming more pronounced over the northern parts of India. The warming is also expected to be relatively greater in winter and post-monsoon seasons than in the summer monsoon season. Spatial pattern of rainfall

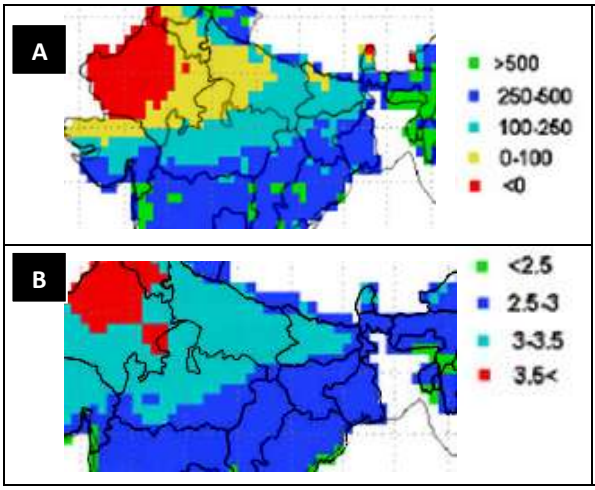
change estimates a 20% rise in all India summer monsoon rainfall for the future in both A2 and B2 scenarios as compared to present.



Based on the A1B scenarios, mean summer rainfall withdrawal are compared for two sets of years 1981-2000 and 2081-2100. A positive value indicates a later withdrawal date in the A1B scenario. For Jharkhand, this implies that the summer rainfall will go up by the end of century and since every unit increase corresponds to 5 days hence the number of rainy days during summer will go up by (upto) 10 days by the end of century.

The adjacent figure projects the consistency in the summer rainfall withdrawal date. For Jharkhand, there is very high probability that the mean summer rainfall will experience a positive change.

Figure 12: A1B Scenario and rainfall projections for Jharkhand (Christensen, et al.)



Under B2 scenario, most of the places in Jharkhand are expected to get more rain by the end of the century. On an average a 20 per cent rise in all India summer monsoon rainfall over all states is expected. Number of rainy days may come down but the intensity is expected to rise at most of the parts of India. Many research works show that extremes in maximum and minimum temperatures are also expected to increase. The average temperature rise in Jharkhand will be between 2.5-3^{0}C by the end of century (Lead International, 2008).

Figure 13: Predicted change in Rainfall (figure A) and Temperature (figure B) and by 2085, B2 Scenario (Lead International, 2008)

It is clear from all the climate change projections that Jharkhand will be witnessing an unprecedented precipitation and temperature variations in coming years. The models clearly indicate that the temperature rise will affect the minimum as well as maximum temperatures. Further, the precipitation will go up significantly in most of the districts. But all the results are indicative, and have not taken into considerations the micro-level variations. Hence its advisable to undertake more detailed temperature and precipitation modelling for the state so that a definitive understanding on weather changes can be predicted for the state.

4.4 PEOPLE'S VOICES ARE OBSERVED WEATHER CHANGES

During the public consultation workshops the public views on weather pattern shifts were captured. Most of the people (farmers, forest dwellers, industrialists, government officials and foresters) were of view that they had observed shifts in the weather patterns including temperature and rainfall. Foresters narrated observations

around the behaviour of insects (lac cultivation and falling production) whereas farmers talked about the rising summer temperature and abrupt rainfall patterns affecting the cropping patterns.

Chapter 5

VULNERABILITY AND ADAPTATION WITH RESPECT TO CLIMATE CHANGE IN JHARKHAND

Climate change linked problems in all likelihood will aggregate further and its effects on natural and human systems will be apparent in coming decades. The IPCC in the Fourth and subsequent Assessment Reports has predicted extreme weather conditions and erratic rainfall patterns in various part of the world along with further cascading effects on every walk of life.

The predicted effects of climate change are likely to pose serious concern to the economy and society of the state of Jharkhand. The stress on the resources is slated to grow further. The state's increasing population and rapid rate of urbanization and poor infrastructure will most likely aggravate the situation.

Resource constraints will be limiting factor when it comes to implementation of Jharkhand State Action Plan, identification of priority sectors for fund allocation to maximize benefits from the state's actions will be a desired condition for the successful implementation of such plans.

5.1 METHODOLOGY FOR PREPARING DISTRICT VULNERABILITY RANKING

Vulnerability indices can be used to ascertain the level and compare relative vulnerability of different districts of Jharkhand. Vulnerability indices are applied for many purposes (e.g., for identifying causal processes and explaining attributes of vulnerable systems, for linking system attributes to vulnerability outcomes, and for mapping, ranking and comparing vulnerabilities across districts), at many scales (from local to global), and with different policy objectives (e.g., more realistic assessment of climate change risks, aiding the allocation of resources across regions, monitoring the progress in reducing vulnerability over time, and identifying suitable entry points for interventions) (Füssel and Klein 2006, Eakin and Luers 2006). Different decision contexts and scales generally require different kinds of information. Based on these general vulnerability indices sector, specific indices can be prepared to understand the climate change effects on different facets of economy and society.

Vulnerability is a dynamic concept, as exposure to climate change and the capacity to cope with those impacts shifts across temporal and spatial scales. Assessment of vulnerability to climate change mainly involves research into the exposure, sensitivity and adaptive capacity of a system in the context of a specific threat. In order to capture the vulnerability issues for Jharkhand, relevant and acceptable proxies were identified and multiple indicators were clubbed under the three subsets, viz. exposure, sensitivity and adaptive capacity. District level information was used to prepare a composite vulnerability index for the state.

Annexure 2 summarizes the methodology which has been used for calculating the vulnerability index. The analysis presented in this report is based on the available secondary data from various sources.

Table 11: Indicators for Vulnerability Assessment

Component	Input: Profile	Input: Indicators	Output
Exposure	Climate change	Precipitation variance (projected rainfall w.r.t. current average rainfall)	Climate Profile
		Temperature variance (projected temperature w.r.t. current average temperature)	
	Demographics	Sex Ratio	Demographic Profile
		Percentage of ST population	
		Child population (0-6 years)	
		Decadal Population Growth	
		Percentage of Population below poverty line	
Sensitivity	Ecosystem	Dense forest	Ecosystem Profile
		Open forest	

Component	Profile	Input Indicators	Output
		Scrub	
	Agriculture	Land put to non-agricultural use	Agriculture Profile
		Barren & unutilised land	
		Permanent pasture and other grazing land	
		Cultivable wasteland	
		Land under miscellaneous trees	
		Other than current fallow(2-5years)	
		Current fallow land	
		Net sown agriculture area	
		Area sown more than once	
		Area under paddy cultivation	
		Area under wheat production	
		Area under vegetable production	
		Area under spices production	
		Area under horticulture plantation	
Adaptive capacity	Socio-Economic Structure	Livestock population	Socio-Economic Profile
		Literacy rate	
		Percentage of household having toilet	
		Percentage of household having TV	
		Percentage of household having motor vehicle	
		Percentage of household having electricity	
		Credit/Deposit ratio	
		Household having concrete roof	
		Number of agricultural Worker	
	Infrastructure	Health Facilities (hospital, PHC, APHS, HCS etc.)	Infrastructure Profile
		Number of School and College	

Adaptive capacity is the capacity of the system to adapt to the changing environment. As applied to the socio-economic structures, the adaptive capacity is captured through household's access to services and facilities. Also society's access to assets (both tangible and intangible assets) is considered as proxy to capture its adaptive capacity. Further availability of quality physical infrastructure also adds to the state's capacity to adapt. Particular to climate change, health and education infrastructure is considered in this study to compare districts.

The climate change exposes the society to vulnerabilities as there are weather pattern shifts and associated feedback loops that change the ecological balance forcing societies to realign themselves to the new conditions. The realignment is a long term process and requires resources. For example, IPCC demonstrates that climate change leads to health consequences through pathways of direct exposures (e.g., extreme heat), indirect exposures (e.g., changes in water, air, and food quality). Thus, climate change produces a dynamic system where a change in one condition exerts influence in multiple pathways with associated health consequence. The climate exposure in vulnerability terms is measured by quantifying the predicted changes in the temperature and precipitation. Whereas the coping capacity of the society is measured by identifying social characteristics that help cope with shift in weather patterns.

5.2 VULNERABILITY INDEX WITH RESPECT TO CLIMATE CHANGE OF DIFFERENT DISTRICTS OF JHARKHAND

The details of the calculation are explained in Annexure-3. The summary of calculations is provided in Table-12.

Table 12: Vulnerability index for districts of Jharkhand

District	Sensitivity	Exposure	Adoptive Capacity	Vulnerability Index { (Exposure-Adoptive Capacity)* Sensitivity }
Purbi Singhbhum	0.68	0.31	0.73	-0.29
Ranchi	0.52	0.41	0.81	-0.21
Pashchimi Singhbhum	0.70	0.39	0.56	-0.12
Saraikela-Kharsawan	0.78	0.26	0.35	-0.07
Palamu	0.60	0.33	0.38	-0.03
Dhanbad	0.34	0.51	0.59	-0.03
Bokaro	0.46	0.43	0.48	-0.02
Giridih	0.27	0.52	0.49	0.01
Dumka	0.25	0.6	0.51	0.02
Deoghar	0.20	0.48	0.36	0.02
Gumla	0.49	0.46	0.38	0.04
Hazaribagh	0.29	0.52	0.35	0.05
Godda	0.23	0.59	0.34	0.06
Khunti	0.72	0.38	0.28	0.07
Kodarma	0.27	0.43	0.12	0.08
Chatra	0.37	0.45	0.19	0.10
Jamtara	0.26	0.59	0.21	0.10
Sahebganj	0.25	0.65	0.21	0.11
Garhwa	0.57	0.38	0.17	0.12
Ramgarh	0.60	0.47	0.25	0.13
Latehar	0.52	0.42	0.15	0.14
Lohardaga	0.38	0.5	0.11	0.15
Simdega	0.66	0.48	0.22	0.17
Pakur	0.30	0.82	0.17	0.20

*(Scaling is done from -1 to +1 indicating low to high vulnerability)

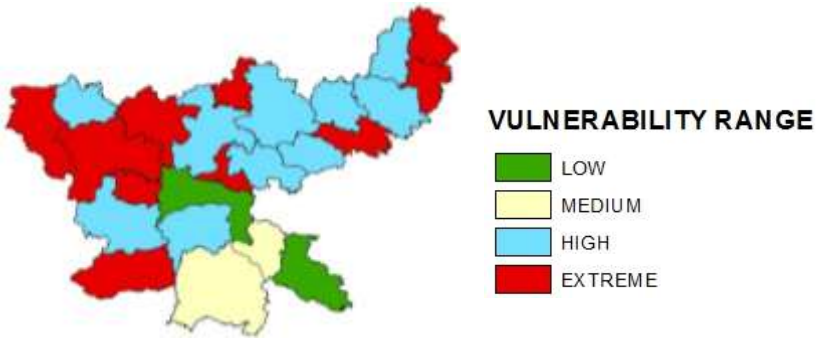


Figure 14: Composite vulnerability mapping of Jharkhand

From the above figure it is clear that districts of Pakur, Simdega, Loharanga and Lather are highly vulnerable to climate change. Lack of adaptive capacity is the main reason of the backwardness of these districts. Whereas districts like Ranchi, Bokaro and Dhanbad have scored much better in respect to adaptive capacity and thereby vulnerability index.

5.3 THE WAY FORWARD

The vulnerability map presented in the chapter is only indicative, the secondary data used for preparing the index and map is not updated and the set of information used may not be representative of the micro variations existing between districts, regions and societies. It is recommended that a comprehensive exercise is carried out to identify the threats and capacity of the state in order to develop a precise vulnerability map for the state.

SECTION B: SECTORAL ANALYSIS

Chapter 6

AGRICULTURE SECTOR AND CLIMATE CHANGE

The total agriculture land in the state is 22 lakh hectares which can be broadly categorized under three agro climatic zones viz. Central and North Eastern Plateau sub zone, Western plateau Sub Zone and South Eastern Plateau Sub Zone. Contribution of agriculture in Jharkhand's GSDP is close to 20% though a large population (approx 70%) depends on it for livelihood support.

Agriculture in Jharkhand is heavily monsoon dependent and irrigation facilities in the state are limited. The state receives 80-82% of the annual rainfall during monsoon hence majority of state's agriculture production is confined to *kharif* season (June-September). Due to poor irrigation facilities (only 6-10% of the agriculture area is supported by irrigation infrastructure) and scanty rainfall, raising *kharif* crop is not an option for a large number of farmers in the state. Hence, 40% of the area in the state is under mono crop (Department of Agriculture & Sugarcane Development, 2009).

Table 13: Snapshot of agriculture sector in Jharkhand (Department of Agriculture & Sugarcane Development, 2009)

Agriculture in Jharkhand		
Particulars	Area	% of total area
Geographical area	79.7 lakh ha	
Cultivable area	38.0 lakh ha	47.67%
Cropped area	22.38 lakh ha	28.08%
Agriculture wasteland	19.32 lakh ha	24.33%
Area under irrigation*	2.05 lakh ha	10.6%

* (Department of Agriculture & Cane Development , 2009)

The topographical, physiographic constraints add to difficulties faced by the agriculture sector in the state, vagaries of climate put greatest limitation before the agricultural production system. The culmination of the constraints is reflected in large scale diversion of rural human resources towards non-agriculture activities. Only 12% of the rural labours make their living from agriculture activities whereas 48% of the labours are engaged in non-agriculture casual wage employment *(Poverty Reduction and Economic Management-India Country Management Unit, 2007)*.

Increase in frequency and severity of extreme weather events like heat wave (unexpected rise in temperature in summer months), hail storm (decreased frequency but increased severity) drastic decrease in pre-monsoon convectional rainfall and cold wave/frost in winter further restricts the agriculture productivity in the state.

The poor agricultural productivity is ultimately reflected in the food deficiency prevailing in the state. The State Department of Agriculture has assessed that the food grain deficiency in the state is 14%, for other nutritional items like fruits, milk and meat this deficiency is 69%, 43% and 35% respectively. For a state where a large population is poor, this deficiency is alarming as households are exposed to market forces to meet their nutritional demand.

Table 14: Food and nutritional Security in Jharkhand State (2008-09) *(Department of Agriculture & Cane Development , 2009)*

Item	Production (Lakh tonnes)	Minimum requirements (Lakh tonnes)	Food Deficiency/Surplus
Food grains	42.2	49	(14%)
Vegetables	34	28	21%
Fruits	3.88	12.5	(69%)
Milk	13.3	23.3	(43%)
Meat	4.33	6.7	(35%)
Fish	0.27	5.3	(95%)
Egg (lakhs)	6,980	8,380	(17%)

The agriculture sector share of GSDP has remained almost constant and has been hovering around 20-22% since 1993-94[11]. But the state witnessed a sharp increase in agriculture growth post 2010 (after formation of Jharkhand). The growth rate of the Agriculture (and allied) sector during 1994-2004 remained at 4% per annum (in comparison to India's 2.2% per annum) (*Poverty Reduction and Economic Management-India Country Management Unit, 2007)*.

Despite all the challenges and limitations, the vegetable sub-sector in Jharkhand has excelled in the recent past. Not only has the state become self-sufficient in vegetable cultivation but also for most of the vegetables, the productivity of the sub-sector is better in comparison to all India average numbers.

As per the analysis carried out by the Council for Social Development (Delhi), Jharkhand's agriculture sector is witnessing a slow shift from agriculture to horticulture species. As is evident from Figure-15 and Figure-16, the area under cereal crop has been dropping over time and so is the share of cereal crops in the total output of the sector (in value terms). On the other hand the rural focus on fruits and vegetables is growing rapidly.

Table 15: Vegetable Production in India and Jharkhand - Area and Productivity (NABARD Consultancy Services , 2007)

	Area under vegetable cultivation (hectares)		Productivity in tonnes/ hectares		Productivity Compared to National average*
Item	India	Jharkhand	India	Jharkhand	
Brinjal	-	98000	-	11.96581	
Cabbage	3861684	82000	17.68324	14.88203	↓
Cauliflower	2473987	136000	11.24412	14.98623	↑
Lady's Finger	4031811	154000	9.364871	10.00975	↑
Onion	4080000	79000	10.36849	14.91692	↑
Tomato	5441967	183000	15.30001	16.49986	↑

**Northward arrow indicates better productivity and southward arrow indicates lower productivity*

[11] http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1181699502708/ch1.pdf

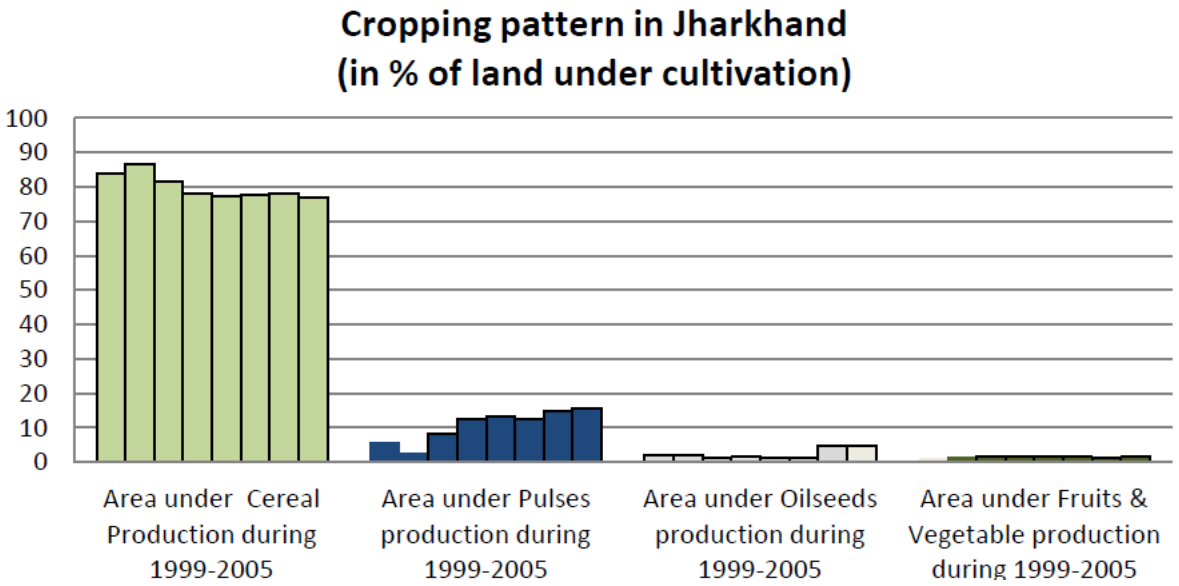


Figure 15: Variation in area under various crops in Jharkhand during 1999-2005 (*Haque, Bhattacharya, Sinha, Kalra, & Thomas, 2010*)

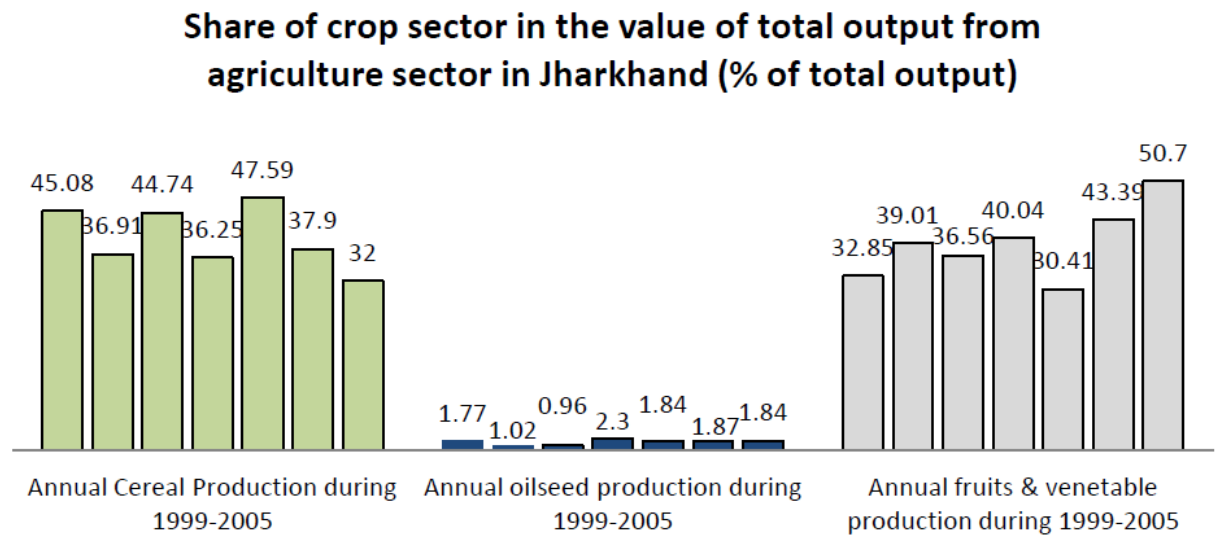


Figure 16: Variation in share of various crops (as % of total output) in Jharkhand during 1999-2005 (*Haque, Bhattacharya, Sinha, Kalra, & Thomas, 2010*)

6.1 CHALLENGES FACED BY AGRICULTURE SECTOR IN JHARKHAND

The agriculture sector is marred with multiple issues, which include:

- Lack of irrigation facility is the major infrastructural bottleneck. Due to slow growth in irrigation, the agricultural sector has not been able to perform to its full potential both in terms of food production as well as crop diversification. However, the expansion of area under irrigation in the state faces a number of techno-economic challenges.

- As agriculture is heavily dependent on rain, and farm productivity falls sharply if rainfall is not adequate. In addition there are certain zones in the state which face water shortage throughout the year.

In the adjacent map, areas marked with dark brown display regions that are affected by drought situation (Gumla, parts of Kodarma and Hazaribagh, Chatra and Palamu are the districts worst affected by water shortage).

Figure 17: Areas affected by drought situation in Jharkhand[12]

- At the national level 76% of the total cultivable area is under net sown area, whereas in Jharkhand only 43% of land is cultivated. Cropping Intensity in the state is 117%, the per capita net sown area is just 0.083 hectare which is quite low in relation to the per capita land holding (0.14 ha approx). (http://rkvy.nic.in/sap/jh.pdf)
- ***Average land holding is small:*** 83% of the agriculture land in the state belongs to small and marginal farmers and only 1% of holdings are above 10 hectares. Agricultural operations are primarily of subsistence type due to the adverse land to farmer ratio (per capita land holding is just 0.14 ha).
- ***Predominance of cereal crops:*** About 92% cropped area is covered under food grains and less than 5% of the area is under commercial crops. Also, 40% of the total cropped area remains largely mono-cropped under rice leaving farmers exposed to risks associated with rainfall and other weather changes.
- ***Poverty:*** High poverty in the state reduces the farm sector efficiency, most of the farmers are poor. Hence rural markets for products and services are less developed. Rural areas neither have reach nor mean to afford modern financial products and agriculture sector goods and services to support and augment the farm activity.
- ***Low productivity:*** The farm sector productivity in the state is low due to:
    - The poor farmers in the state have little access to resources to provide for high cost of inputs required to increase agriculture productivity. The instructional credit flow to the agriculture sector is negligible and agricultural extension activities are minimal.
    - Agriculture is basically dependent on rain.
    - About 50% of the soil in the state has high concentration of minerals and other chemicals that do not support crops. The state faces acute problem of soil acidity, about 4 lakh hectare of cultivated area in Jharkhand faces soil acidity problem.
    - The agriculture land in the region is also vulnerable to erosion; the agriculture field are located on slight to moderate slopes. Also uneven land surface is subject to sheet and gully erosion. It is estimated that about 23 lakh hectare of total land area of Jharkhand are subjected to severe erosion[13].
- ***Low* profitability:** Inadequate or non –existent post harvest management infrastructure at farm level, lack of price incentives, low access to credit and high transaction cost involved in institutional credit are some of the reasons which have affected productivity.
- ***Rising chemical use:*** The chemical use in the agriculture sector is steadily on rise. This is not only resulting in the increase of the input cost but also contaminates the local water bodies and the soil[14].

6.2 IMPACT OF CLIMATE CHANGE ON AGRICULTURE/ ALLIED SECTOR

[12] http://www.nicra-icar.in/nicrarevised/index.php/events?id=64
[13] http://www.advanceagriculturalpractice.in/w/index.php/Farming_in_Jharkhand
[14] Inputs received during public consultation workshop

Climate change is already apparent in Jharkhand, there is reported rise in average rainfall in parts of state and this increase is not only undeniably steady but also significant and has potential of changing the agriculture pattern. The rainfall data available for Ranchi region for last five decades clearly indicates that the average rainfall has been rising steadily and now the state gets 30% more rainfall than what it was getting in 60's (Wadood & Kumari). But precipitation trends of the state as whole show a very different trend. The information available on a 100 year time frame establishes that the annual precipitation in the state have gone down significantly by an average of 150mm, monsoon rains have seen the biggest shift. Although there is an increase in winter rainfall but the change is not very significant.

The seasonal rainfall trends witnessed in the state during last 100 years are depicted in the following table.

Table 16: Rainfall trends in the state of Jharkhand during last 100 years(Guhathakurta & Rajeevan, 2006)

Season	Increase/ Decrease	In mms	Confidence level
Monsoon	Decreasing	-95.7	95%
Winter	Increasing	+4.1	90%
Pre monsoon	Decreasing	-17.1	90%
Post Monsoon	Decreasing	-6.6	Not significant
Annual	Decreasing	-150.6	99%

Impact of climate change: The summary of the impact of change in temperature and CO_2 concentration are tabulated below.

Table 17: Impact of temperature and rainfall variability on agriculture and allied Sector

Crop	Impacts of increase in temperature	Impacts of increase in CO2 concentration
Paddy	Keeping the CO_2 level constant at 380 ppm, a temperature increase of 2^0C will result in yield loss of ~ 18% (Krishnan et al. 2007).	Keeping the temperature rise constant at 0^0C, and an increase in the CO_2 concentration at 400 ppm, the yield is expected to rise by 16.27%.
Wheat	A 0.5^0C increase in winter temperature could reduce wheat crop duration by seven days and reduce yield by 0.45 ton/hectare. An increase in winter temperature of 0.5◦ C could cause 10% reduction in wheat production.	
Maize	Increase in mean air temperature by 3°C above the present ambient conditions would reduce maize yield.	An increase in CO_2 concentration up to 700 ppm has a positive effect on the maize yield. However, temperature rise dominates over the positive effect of CO_2 concentration significantly when it is 3^0C above the current ambient temperature conditions.
Mustard	Rise in temperature by 5^0C would reduce yield by 20.9% (Boomiraj et al.2010)	Increase in CO2 level to 450 and 550ppm respectively would increase the crop yield.
Milk Production	The decline in minimum temperature (>3^0C) during winter and increase (>4^0C) in summers can negatively impact milk production by upto 30% (Upadhaya et al. 2012)	-
Poultry	For ambient temperature $\geq 34^0$C, mortality due to heat stress increases in heavy meat type chickens (8.4%), 0.84% in light layer type, and native type (0.32%) chickens. the temperature rise affects the health and habits of chicken, the feed consumption decreases from 108.3	-

Crop	Impacts of increase in temperature	Impacts of increase in CO2 concentration
	g/bird/day at 31.6°C to 68.9 g/ bird/day at 37.9°C. At shed temperature of 42°C, the mortality rate of chickens will be very high.	
Egg production	For ambient temperature ≥34 °C, the egg production is expected to decrease both in broiler (by 7.5%) and layer (by 6.4%) breeders.	-

Maximum temperature which is increasing in Jharkhand has been found to have adverse affect on rice yield if it coincides with the flowering stages, a yield reduction of 10.2 q ha^{-1} $^{o}C^{-1}$ is possible. Increase in minimum temperature at grain filling stages is expected to have a positive effect on rice yield (2.7 q ha^{-1} $^{o}C^{-1}$). Both the increasing trend of maximum temperature and decreasing trend of minimum temperature are apprehended to reduce the rice yield in particular and yield of most of the other *kharif* crops in general[15].

High rainfall at rice flowering stage has been found detrimental causing a yield reduction of up to 7 q ha^{-1} whereas at grain filling stage the high rainfall is beneficial causing yield increase up to 6.3 q/ ha. High evening RH at emergence-flowering stage can cause rice yield reduction (up to 3 q ha^{-1}) while variation in radiation seems to have no effect on rice yield[16].

High Tmax with High evening RH during vegetative stage has been found to invite Brown spot disease and high rainfall at flowering stage causes chaffy grain of rice. Altogether, a yield reduction of 10-15 q ha^{-1} is reported[17].

Temperature Impact on wheat crop- Above normal high maximum temperature coinciding with the flowering stage of wheat and other *rabi* crops has been found to cause pollen/flower sterility thereby causing appreciable yield reduction of *rabi* crops. However, as per a research result increase in both maximum and minimum temperature during the growing period of wheat has been found negatively correlated with yield[18].

Appearance of new strains of disease/pests- Bristle Beetle in *Arhar*, Sheeth Blight and Rust in *Kharif* maize, Powdery mildew in Lentil, Alternaria Blight in Rapeseed-Mustard, Swarming caterpillar in Rice, root Knot Nematode in Rice[19] have been observed in Jharkhand.

In general, overall predictability of weather and climate will decrease, making the day-to-day and medium-term planning of farm operations more difficult. Increases in the frequency of droughts and floods are likely to affect production negatively, especially in subsistence sectors.

6.3 AGRICULTURE VULNERABILITY INDEX WITH RESPECT TO CLIMATE CHANGE

An agriculture vulnerability index was developed to carry out a comparative study of administrative units of Jharkhand and identify districts where population and agriculture sector is highly susceptible to climate change linked changes. The analysis considered the climatic conditions, demographic features, agricultural productivity attributes and socio-economic structure of the majority of population in the districts.

Table 18: Core Criteria and Indicators for preparing agriculture vulnerability index

Criteria	Layers	Indicative indicators	Rationale	Data type

[15] Communication from, K.K. Soan, Director Agriculture, Government of Jharkhand
[16] Ibid
[17] Ibid
[18] Ibid
[19] Ibid

Criteria	Layers	Indicative indicators	Rationale	Data type
2.Projected vulnerability to climate change		Projected variation in rainfall and temperature	Identify changes from current temperature and rainfall expected due to change in climatic factors- rainfall/temperature patterns	2030 and 2080 projections on temperature (minimum and maximum) and precipitation
2.Demographic features	1a) Population pressure	Population growth and rural population	Demographic features on selected indicators help identify the pressure on the farm land. It is also a proxy for direct agriculture dependence.	Decadal population growth rate, rural population in the district
	1b) Vulnerable population	SC+ST and poor population	Vulnerable population helps identify the demographic strength of the community	SC+ST and BPL population in the districts
3.Stock and capacity	3a) Facilities and services available in rural areas		Help identify the infrastructure status and penetration of services in rural areas. These can become the backbone of the coping mechanism of rural economy.	Number of electrified villages in the district, availability of credit and saving services.
	3b) Features of agriculture land		Agriculture land and its usage is the basic resource stock available to the community.	Agriculture area available in each district, Area sown annually and area sown more than once.
4. Resource quality	4a) Productivity of agriculture resource		Quality of resource defines the quality and quantity of output that can be generated from the resource. In agriculture based economy, land productivity is the defining feature of the quality of resource.	Farm productivity and horticulture productivity

The detailed calculation is explained in Annexure-4. The outcome of the calculations is displayed in table below.

Table 19: Agriculture vulnerability index for Jharkhand

Districts	Climate vulnerability	Demographic features	Agriculture Productivity index	Stock and capacity	Vulnerability index
Pashchimi Singhbhum	0.70	0.48	0.21	0.32	-0.65
Saraikela Kharsawan	0.78	0.38	0.27	0.26	-0.64
Garhwa	0.57	0.39	0.15	0.25	-0.56
Simdega	0.66	0.43	0.40	0.23	-0.46
Latehar	0.52	0.46	0.39	0.16	-0.43
Palamu	0.60	0.48	0.28	0.53	-0.27
Lohardaga	0.38	0.68	0.66	0.17	-0.22
Pakaur	0.30	0.60	0.54	0.15	-0.21
Chatra	0.37	0.25	0.33	0.12	-0.16
Gumla	0.49	0.56	0.49	0.46	-0.10
Bokaro	0.46	0.22	0.27	0.35	-0.06
Kodarma	0.27	0.29	0.39	0.14	-0.03

Giridih	0.27	0.52	0.43	0.41	0.05
Sahebganj	0.25	0.54	0.58	0.27	0.06
Purbi Singhbhum	0.68	0.17	0.27	0.64	0.06
Hazaribagh	0.29	0.48	0.43	0.41	0.07
Godda	0.23	0.49	0.66	0.22	0.17
Jamtara	0.26	0.37	0.60	0.21	0.18
Dhanbad	0.34	0.17	0.53	0.29	0.32
Deoghar	0.20	0.45	0.64	0.37	0.37
Dumka	0.25	0.36	0.68	0.43	0.50
Ranchi	0.52	0.25	0.67	0.79	0.70
Khunti					NA
Ramgarh					NA

*The more positive number indicates less vulnerability

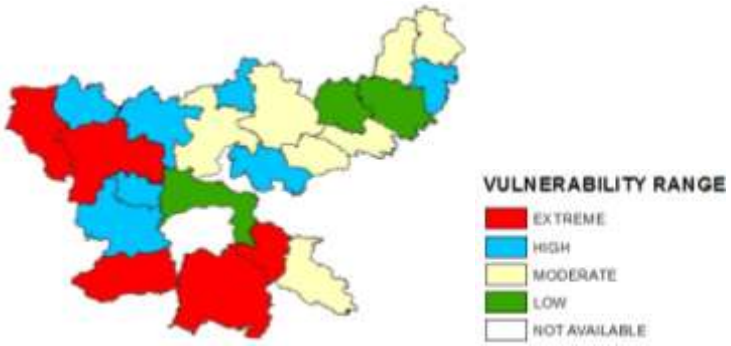


Figure 18: Agriculture sector vulnerability map of Jharkhand

The agriculture vulnerability index is a composite index that captures climate change parameters, agriculture sector capacity, infrastructure and social vulnerabilities. The resultant index predicts that for future climatic changes, the districts with least vulnerability are Ranchi, Dumka, Deoghar and Dhanbad. These are the districts where climate changes (precipitation and temperature change) is comparatively lesser but agriculture productivity is highest.

6.4 AGRICULTURE SECTOR CLIMATE ADAPTATION STRATEGIES

Adaptation measures

Assessing climate risk in detail: Jharkhand is divided into three agro-climatic zones, Central and North Eastern Plateau sub zone, western plateau Sub Zone and South Eastern Plateau Sub Zone. There is need to have accurate weather information at least for each of the climatic zones.

Further, there is need to have more micro level weather prediction system, sub district level weather information and weather advisory services are required to prepare farmers for climate change conditions. For this purpose a network of weather forecasting stations can be established.

Policy Options Agriculture sector adaptation strategies require continuous inputs from technological advances to combat climate change, since majority of agriculture dependent communities are relatively poor residing in villages with limited access to resources hence there has to be a sound and supportive policy framework to facilitate adaptation process. The adaptation framework should address the issues of redesigning social sector with focus on vulnerable areas/populations, introduction of new credit instruments with deferred repayment liabilities during extreme weather events and weather insurance as a major vehicle to manage risk.

The state government should encourage research and identify and prioritize adaptation options in areas with high impact on agriculture sector (micro level seasonal weather forecasting systems, water diversion, storage and distribution, agriculture planning and other infrastructure needs). The focus should be on integrating national development policies into a sustainable development framework that complements adaptation. The action plans based on this should accompany technological adaptation methods.

In addition, the role of SHGs, rural banks and agricultural credit societies should be widened. Role of community institutions and private sector in relation to agriculture should be a matter of policy concern. Also given the gravity of the challenge posed by climate change it is time to display and develop strategies for economic diversification in terms of risk spreading, diversifying livelihood strategies in rural sector, strategies to cope with migrations (arising from crop failures) and financial mechanisms to meet the potential rise in rural requirements to cope with weather fluctuations. Policy initiatives in relation to access to banking, micro-credit/insurance services before, during and after a disaster event, and access to communication/information services are imperative in the envisaged climate change scenario. Some of the key policy initiatives that are to be considered are:

- Mainstreaming adaptations by considering impacts in all major development Initiatives
- Facilitating greater adoption of scientific and economic pricing policies, especially for water, land, energy and other natural resources.
- Considering financial incentives and package for improved land management and explore Clean Development Mechanism (CDM) benefits for mitigation strategies.

Using appropriate traditional knowledge for adaptation: Globally, it has been established that many traditional knowledge is a valuable asset in observing and managing environmental change. Communities living in locations where climatic changes are fast and frequent have survived by traditional knowledge to adapt to biophysical changes in their environment for centuries (McNamara et al. 2010c), and India is no exception.

In this context, this is argued that traditional local knowledge such as local crop varieties (seeds and crops which can tolerate extreme weather conditions), decision on crop sowing time based on traditional understanding of weather pattern (rains, heat etc), use of intercropping to minimize crop failure risks, and use of plants/herds to control weed, insects etc are some very commonly practised mechanism that are purely based on traditional knowledge system.

Further, the traditional practice to regulating and use of water bodies during the time of stress is something that has been found to work effectively. As this traditional knowledge is being used in isolation and in sporadic manner; therefore it can be streamlined into the mainstream agricultural practise by associating all the three tiers of panchayatiraj system –in the planning and execution process.

Institution promotion: Opening new agriculture college and institutions in the country to develop human resource and R&D facilities that can support the advanced agriculture activities in the state. ICAR and other national/international have also already established few centres/schemes to assess the impacts, adaptation and vulnerability of Indian agriculture to climate change. In the state also such centres/schemes can be established with collaboration with ICAR etc in few strategic locations.

Research and development (R&D): The state government can develop a network of institutions within state that can provide necessary research and development support to all the sectors in the state in the context of climate change. In this regard institutes like Birsa Agricultural University and Birla Institute of Technology (Mesra) etc can take a leading role as they have expertise in the field of climate change adaptation. This set of institutions can be used as a platform to interact with national and international institutions working on agriculture specific climate

change issues. A financial support system should be promoted to strengthening research on adaption, mitigation and impact assessment. The specific R&D needs are:

- R&D to increase the agriculture productivity and reduce vulnerability against climate extremities (photo and drought resistant). Use of indigenous techniques to reduce fertilizer use (i.e. crop rotation and mixed cropping) to increase land productivity and reduce nutrient deficiency.
- R&D for each micro agro-climate zones in the state by engaging with the state agriculture universities and other research facilities.
- R&D focuses on improving fertility of the barren lands.
- The agriculture extension facilities should focus on incentive driven approaches to enable technology options at the farm level.

Vulnerability reduction support program: Weather insurance plays an important role in mitigating climatic risks. But this strategy has worked successfully in regions having long term weather data, farmers have large holding and have a business approach for farming. In Jharkhand, the small holders are generally more prone to risks, the government sponsored crop insurance scheme has made some progress but it has a long way to go. Considering the climate trends being witnessed in recent years all over the country, weather based insurance appears to be a better alternative for mitigating risks in agriculture for Indian farmers. The state should work with agriculture research institutes and insurance companies to jointly develop crop wise data on weather sensitivity so that appropriate policies can be designed, which are friendly to farmers without affecting the viability of the insurance companies. The state can also develop a fund to share the insurance premium burden. Sporadic attempts for crops like *lac, tasar* have been made, besides other agriculture crops.

State level seed-banks can be created that can help the farmers select tested and suitable crop varieties. Further, the R&D in the agriculture universities can be translated into development of crop varieties that can tolerate high sun and rainfall.

Increasing resource base through development of wasteland: A pilot study is required to assess the reclamation potential of the waste land in the state. Micro and mini water harvesting programs can be developed for the rural regions which are less costlier yet result in effective water conservation.

Adoption of climate smart agriculture:

The agriculture productivity can be improved and at the same time emission reduction co-benefits can be easily achieved by improving the efficiency of the agriculture operations, this will also reduce the input costs. The efficient use of area under agriculture, fertilizer selection and method of application and water use can help reduce methane as well as NOx emissions.

- **Crop selection:** Switching to rice varieties that require relatively lesser amount of water.
- **Multi cropping:** Adopting multi cropping practices to reduce the crop failure risks.
- **Smart irrigation:** Utilizing water saving techniques, using energy efficient water pumps, sprinkler/ drip irrigation. Smartly locating percolation tanks that help maintain soil moisture reducing irrigation requirements.
- **Reducing irrigation linked energy use:** Discouraging use of energy inefficient water pumps by smart energy pricing and controlling leakage of kerosene from PDS system.
- **Promotion of RE irrigation systems:** Promotion of solar water pumps will not only help the farmers reduce

Technique to reduce Urea use (FAO, 2012)
Urea Deep Placement (UDP) technique, developed by the international Rice Research Institute (IRRI) and International Fertilizer Development Center (IFDC), is a good example of a climate-smart solution for rice systems. The usual technique for applying urea, the main nitrogen fertilizer for rice, is through a broadcast application. This is a very inefficient practice, with 60 to 70 percent of the nitrogen applied being lost, and contributes to GHG emissions and water pollution.

dependence on rainfall but also help control the GHG emissions.

- Increasing resource stock by converting wasteland, barren land into productive land through technical interventions.
- Discouraging sales of adulterated fuel in rural areas can improve the efficiency of the farm equipments and at the same time reduce agriculture sector fuel linked emissions.
- **Fertilizer use management:** Lower usage of fertilizers can be achieved through smarter use of soil testing, precision application and crop rotation or mixed cropping (see box item). Further, organic fertilizer program should be seriously developed for the state.
- Using Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to develop underutilized and unutilized land for agriculture purposes and for maintaining water harvesting structures.

6.5 SECTORAL ACTION PLAN AND BUDGET

For Agriculture sector action plan and budget please refer to Section C: Sectoral Action plans.

Chapter 7

FORESTRY SECTOR AND CLIMATE CHANGE

7.1 JHARKHAND STATE OF FOREST

As per the State of Forest Report (SFR) 2005, published by the Forest Survey of India (FSI) on the basis of satellite data, the forest cover of Jharkhand is 22,591 sq km, which is 28.34% of the total geographic area.

Jharkhand ranks 10th among all the States and Union Territories of India considering the geographical area under forest cover. The dense forest distributed in the northwest and the southeast of the State constitutes about 15%, the open forest areas are evenly distributed in the north, central and south-eastern parts of the State and constitute about 13.6% of the forested area whereas the non-forested area is about 71.6% of the state's geographic area. The total recorded forest area is about 23,605 sq km which contains reserve forest of about 18.6%, protected forest of 81.3% and unclassified forest about 0.1% (Ministry of Environment and Forest 2001). The main forest types in the state are:

(a) Peninsular Dry and Moist Sal Forests,
(b) Hill Valley Swamp Forest,
(c) Moist Sal Savannah,
(d) Moist Mixed Deciduous Forest,
(e) Riverine Forest,
(f) Bamboo and Cane brakes

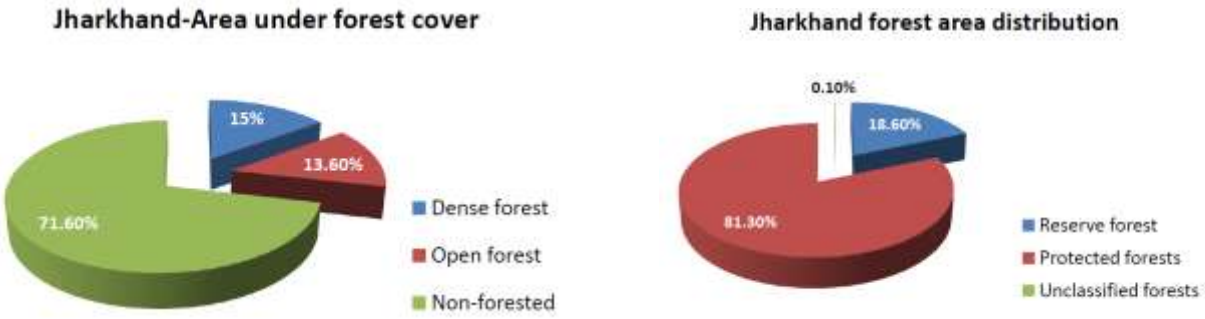


Figure 19: Jharkhand area under forest cover and forest distribution

The state is very rich in biodiversity. To protect and conserve this biodiversity, two reserve areas (one tiger reserve and one elephant reserve) and 10 wildlife sanctuaries have been carved out of the area under forests.

Forest in Jharkhand has long been under pressure from mining and for meeting the demands for fuel. Initiatives have been taken by the State government to increase its forest cover. Forest Resource Surveys are also being conducted at district level for better management and planning. The state has also formed Joint Forest Management (JFM) committees besides forest-based livelihood development, wildlife management, biodiversity conservation, clean environment and waste disposal plans. To tackle the impacts of mining, the State Government also proposes to bring legislation in mining sector so that resources generated from mining sectors can be pumped back for local developmental activities.

The results of state actions are visible in the form of improvement in the health and area under forests in the state. During 2001-2011 about 194 sq km of area was brought under tree cover, similarly vegetation cover in 162 sq km of scrub land has also improved. The net area under very dense forest category witnessed reduction during last decade but no changes in area were seen during last five years (see table below).

Table 20: Forest area trend in Jharkhand[20]

Change during	Very Dense Forest (sq km)	Moderately Dense Forest (sq km)	Open Forest (sq km)	Scrub (sq km)	Non – Forest (sq km)
2001-2003	-106		185	-169	90
2003-2005	0	2	20	0	-22
2005-2007	-5	7	170	7	-179
2007-2009	NA	NA	NA	NA	NA
2009-2011	0	18	65	0	-83
Net change during 2001-2011	**-111**	**27**	**430**	**-162**	**-194**

7.2 FORESTRY VULNERABILITY INDEX WITH RESPECT TO CLIMATE CHANGE

A forest vulnerability index was developed to carry out a comparative study administrative units of Jharkhand and identify districts where population is highly susceptible to climate change linked changes. The analysis considered the climatic conditions, demographic features, ecosystem, agricultural attributes and socio-economic structure of the majority of population in the districts. Landscape level indicators were selected and a composite index was created based on the GIM guidelines for L1 level planning.

Table 21: Core Criteria and Indicators for selecting landscapes at L1 level

Criteria	Layers	Indicative indicators	Rationale	Data type
1.Forest cover and degradation	1a) Forest cover	Forest cover class – Dense, open & scrub	Basic layer – helps identify forest patches by density classes. It is also a proxy for direct biomass dependence. Priority will be given by appropriate weightage for **areas** with higher opportunities for attaining mission objectives, e.g. higher priority for open & scrub forests compared to high density forests.	District level data on forest area
	1b) Wastelands	Degraded areas	Wasteland map helps identify areas of degradation outside as well as inside forest areas and types of degradation in all areas	District area under wasteland
2.Projected Forest vulnerability to climate change -	Vulnerability maps and attribute data	Variation in forest type, rainfall, temperature	Identify level of forest type change expected due to change in climatic factors- rainfall/temperature patterns. Need at multiple scales.	2085 scenario, areas identified as under threat from climate change
3.Vulnerable Population/ communities	3a) Scheduled Caste/Tribe and Total	Ratio of SCs /STs to Total Population	Help identify concentrations of SCs/ STs at district and block level	SC and ST population in the district

[20] Calculated from available FSI data

Criteria	Layers	Indicative indicators	Rationale	Data type
	population			
	3b) Scheduled areas	Presence of Scheduled Areas	Identify whether district/block in landscape is a Scheduled area	Districts categorized as scheduled area

The calculations for developing forestry vulnerability index are explained in Annexure-5. The outcome of the calculations is displayed in table below.

Table 22: Forestry vulnerability index- Districts of Jharkhand

Districts	Forest sensitivity	Degraded areas	Forest Vulnerability to climate change	Scheduled or not	Vulnerable community sensitivity	Vulnerability index
Deoghar	0.35	0.49	0.00	0.00	0.15	0.23
Bokaro	0.31	0.56	0.00	0.00	0.17	0.24
Dhanbad	0.55	0.33	0.00	0.00	0.15	0.24
Lohardaga	0.27	0.00	0.00	1.00	0.70	0.28
Saraikela Kharsawan	0.39	0.22	0.00	1.00	0.41	0.33
Chatra	0.00	0.22	1.00	0.00	0.33	0.35
Kodarma	0.34	0.06	1.00	0.00	0.00	0.35
Hazaribagh	0.69	0.67	0.00	0.00	0.19	0.36
Latehar	0.34	0.25	0.00	1.00	0.81	0.37
Giridih	0.77	0.79	0.00	0.00	0.12	0.40
Jamtara	0.62	0.35	0.00	1.00	0.41	0.42
Pakaur	0.63	0.41	0.00	1.00	0.52	0.45
Godda	0.96	0.35	0.00	1.00	0.27	0.49
Simdega	0.39	0.57	0.00	1.00	1.00	0.49
Purbi Singhbhum	0.77	0.61	0.00	1.00	0.28	0.51
Sahebganj	0.89	0.55	0.00	1.00	0.33	0.52
Garhwa	0.92	0.12	1.00	0.00	0.38	0.56
Dumka	0.91	0.90	0.00	1.00	0.57	0.65
Gumla	1.00	0.79	0.00	1.00	0.88	0.68
Pashchimi Singhbhum	0.85	1.00	0.00	1.00	0.88	0.70
Palamu	0.96	0.28	1.00	1.00	0.34	0.73
Ranchi	0.89	1.28	0.00	1.00	0.51	0.73
Khunti						NA
Ramgarh						NA

(A more positive number indicates higher degree of vulnerability)

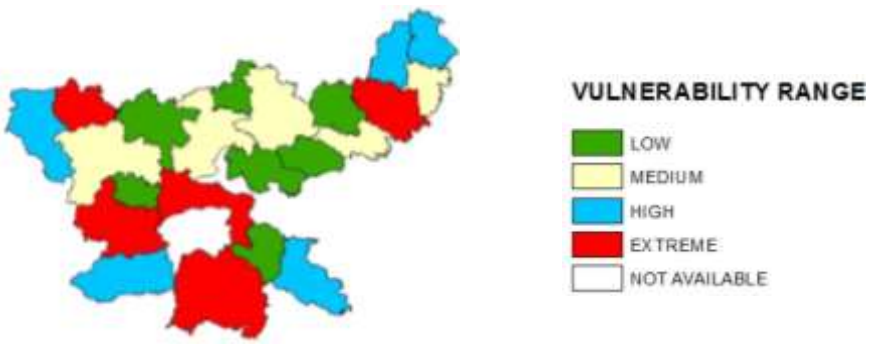


Figure 20: Forestry vulnerability map of Jharkhand

According to the forestry focused analysis, Ranchi, Gumla, Paschim Singhbhum and Gumla districts are most vulnerable to future climate related changes, all the five districts have high tribal and economically backward population and fall under the scheduled areas. At the same time, all the districts falling under the most vulnerable category also possess comparatively lesser forest resources. At the same time, districts like Bokaro and Dhanbad are less vulnerable to climate change due to their high adaptive capacity and less social vulnerability.

7.3 ISSUES FACED BY FORESTRY SECTOR IN JHARKHAND

7.3.1 LOW PRODUCTIVITY

The contribution of forestry sector in the GDP of the State is low, it declined from 2% (2001-02) to 1.5% (2009-10). The productivity of forest land is as low as INR 2500/ha whereas the productivity of pond and agriculture land in the state are INR 1.30 lakhs/ha and INR 30000/ha, respectively. The low productivity has resulted in abject poverty in regions of the state where communities are highly dependent on forest resources (minor forest products) for sustenance and income generation. Overall, the poverty ratio for the poor is as high as 48% which is among one of the highest in the country[21].

7.3.2 FOREST FIRES

Forest fires constitute a major threat, the forests in the state are mostly dry deciduous and are prone to forest fires during summer season. Most of the fires are associated with the activities of the forest dependent communities for *mahua* and *sal* seed collection and the desire to promote better under growth post rains. The fires caused by *mahua* collectors are common in March and April and are the cause of wide spread damage to the forest growth[22].

Table 23: Extent of fire incidents (ha)

Very heavy	Heavy	Frequent	Occasional	No fire	Total
1 %	**0 %**	**9 %**	**62 %**	**28 %**	**100 %**

Source: Jharkhand State Disaster Management Plan, 2011

The forest fire detail as provided by the forest department of Jharkhand is tabulated below:

Table 24: Forest fire incidents-Jharkhand

Year	Observations	Affected forest area
Year 2012(15 Feb-15 June)	307	42.61 hectares (based on data from 37 sites)
Year 2011 (15 Feb-15 June)	195	155.72 hectares (based on data from 71 sites)

7.3.3 DIVERSION OF FOREST LAND

[21] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf
[22] http://www.jharkhand.gov.in/DEPTDOCUPLOAD/uploads/40/D201140003.pdf

In the state, till 31st October, 2012, a total number of 42,003 claims have been filed under the Forest Rights Act (FRA-2006) and 15,296 titles have been distributed[23]. Since the state is predominantly tribal (30% population is tribal) hence in coming years as the awareness on the Act increases, the number of claims and settlement is slated to go up (in the state of Orissa which is also predominantly tribal state, about 13 lakh titles have been distributed so far).

Interestingly, despite mining pressure and other economic development activities Jharkhand does not figure in the list of top 10 states in the land diversion category. Only about 23,000 ha of forestland has been diverted in Jharkhand since 1981[24], of which 9169 ha was diverted till year 2000[25]. Definitely post state formation economic development has picked up and more of forest land has been diverted to make way for infrastructure development and mining leases.

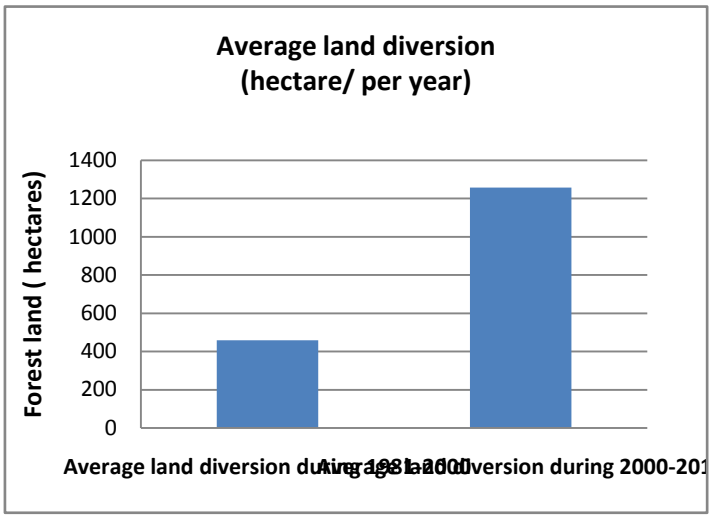


Figure 21: Forest area diversion during last three decades

7.3.4 WOODFUEL DEPENDENCY ON FORESTS

Woodfuel is the largest use for wood in the rural Jharkhand, there are no studies to estimate the exact consumption or source of woodfuel in the state.

Based on NSSO data on the free collection of woodfuel, only 25 percent of freely collected and 20 percent of total woodfuel in India came from forests. Taking this estimate as the most accurate, the production of woodfuel from forests is calculated to be 52 million cubic metres (FSI, 2009b) for India, considering population proportion, approximately 1 million cubic metres of woodfuel in Jharkhand comes from state owned forests.

7.3.5 HUMAN ACTIVITIES ON FOREST LAND

Forest degradation due to pressure from human settlements: The high poverty rate in rural areas has put heavy pressure on forests in Jharkhand as villagers are dependent on forest resources. The human as well as cattle population has been growing in villages and this pressure is resulting in forest degradation[26].

[23] http://www.parimalnathwani.com/images/in-the-parliament-mr/forest-rights-act-in-jharkhand-17-12-2012-eng.pdf
[24] http://cseindia.org/userfiles/Forest%20clearance.pdf
[25] http://www.jharkhandforest.com/files/forest%20Diverted%20Upto%2014.11.2000.pdf
[26] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf

Mining activities damaging forests and biodiversity: Mining activities and mineral transportation takes place in close vicinity of forests. As discussed in mining and mineral section of the report, this results in damages to forest resources. Rampant mining for decades has turned large tracts of forests in Jharkhand into wastelands[27].

Open cast mining, particularly in Jharkhand (and Odisha), has dealt a severe blow to elephant conservation efforts as the movement of elephants has suffered[28]. The tiger habitats have also come under threat, from the FSI-CMPDI map of Auranga coalfield, it is apparent that a significant portion of the coalfield, over 57 sq km, actually lies within the 10 km buffer of the Palamau Tiger Reserve.

7.4 CURRENT POLICIES, PROGRAMMES AND PROJECTS TO PROTECT FORESTS AND BIODIVERSITY

Some of the policies and programmes to govern the forestry sector of the state are as follows:

1. ***Tenancy Act. (Bihar, Santhal Paragana and Chotanagpur):*** These Acts have provisions for the protection of trees and also some provisions for regulating unhindered destruction of trees. These Acts also support the promotion of TOF (trees outside forests).
2. ***Joint Forest Management:*** JFM Regulations are meant for eliciting the response of community in conserving the forest. As an adaptive social process, JFM is striving to create sufficient future forest production opportunity to satisfy potentially competitive/ conflicting interest that would diminish the forest if left unresolved, benefiting lakhs of population in the process.
3. ***Jharkhand Forest Policy and Wildlife Management Plans:*** The State Govt. envisages a forest sector contribution of 3% to SGDP. Rehabilitation of degraded forests, afforestation of public wastelands, plantation on private fare/fallow lands, use of appropriate technology, environment for efficient use of forest produce, integration of JFMC with PRIs and effective benefit sharing and urban forestry are some of the measures the state Govt. is going to take up. Besides, forest based- livelihood development, wildlife management, biodiversity conservation, clean environment and waste disposal plans are some planned measures for the management of environment.

   The new forest management planning includes eco-development schemes and also incorporates ecotourism that helps manage the forests on scientific lines.

   The State Government also proposes to bring some legislation in mining in line with Andhra Pradesh Model so that resources generated from mining sectors can be pumped back to the local bodies. The State Govt is intending to make the rights of the forest dwellers available to them through the Forest Right's Act, as it will enable them to start production of agricultural crops on the forest land which will add to the GSDP of the state.

State interventions to improve forest output and community benefits: Under this scheme, plantations of desired species, including fruit grafts, are taken up on non-forest land, such as *gair-majarua* land, land belonging to government institutions and *raiyats*/ farmers. In 2010-11, the works on new plantations on non-forest land are proposed besides carrying out the works under on-going work programmes approved under the scheme in previous years. Further, it is proposed to help villagers form SHGs to pursue forest produce based clean employment collectively, train them and provide necessary equipments for improvement of their livelihood[29].

Development and Value Addition of Lac and other Gums and Resin: Enhancing rural income by facilitating widespread cultivation of lac and value addition through processing by villagers through SHGs in lac growing areas of the state (to be marketed through state marketing federation) will be the focus of this scheme[30].

[27] http://www.rulnr.ac.in/display.asp?fn=1
[28] http://www.greenpeace.org/india/Global/india/report/How-Coal-mining-is-Trashing-Tigerland.pdf
[29] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf
[30] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf

Augmenting rural income by facilitating processing of MFPs, such as sal seeds, mahua seeds, bamboo, medicinal plants, etc. (other than *kendu* leaves) as well as edible fruits/ flowers (mango, *jamun, kathal, mahua,* etc.) for value addition by providing requisite training and equipments to primary collectors/ SHGs will be the focus of this scheme. It will be complemented by policy interventions in the form of Minimum Support Price regimes and an alternative marketing arrangement through JHAMCOFED/ JSFDC. Another policy intervention through rationalization of transit rules for forest produce is also proposed in order to make it conducive[31].

This scheme aims to augment the growing stock in the degraded forests by raising quick growing species to meet the future household/ industrial/ commercial demand of timber by raising plantations of timber species, such as *shisham, gamhar*, teak etc. Besides this, special efforts are made to plant fruit trees and other fuel wood species[32].

7.5 FORESTS IN JHARKHAND AS CARBON SINKS

Forests are a source as well as store of carbon and other GHG gases. When forests grow, they act as store of carbon as during the photosynthesis process they absorb CO_2 from the atmosphere. Whereas during deterioration process (due to forest fire, decaying process or other form of erosions of carbon stock), forests release CO_2 and other GHG gases in the atmosphere.

As discussed in the state of forests in Jharkhand, the forests in the state are growing hence they are acting as carbon sink. Based on the data available for years 2009 and 2011, the forests in the state were able to sequester 136.03 and 145.86 million tonnes of carbon.

Table 25: Carbon sequestration by the forests of Jharkhand

Year	Carbon stock	Growing stock (m cum)[33]	Million tonne-C sequestered
2011	In forest	116.308	145.86
	In TOF	51.308	
2009	In forest	103.78	136.03
	In TOF	53.32	

At the same time, there were damages to the forests of the state due to forests fires, since these fires are limited to the forest floor hence their net impact on the carbon sequestration by forests has not been discounted (also, data to calculate carbon release from forest fires is difficult to calculate due to limited information available).

7.6 CONCERNS OF FORESTS, WILD LIFE AND BIODIVERSITY IN JHARKHAND DUE TO CLIMATE CHANGE

There are 1148 FSI grids in the state, its projected (based on the A1B scenario) that due to climate change about 24.30 grids will get affected in 'long term' period, though there is no short term threat perceived for the forests in the state. As reflected in following figure, there is no negative impact predicted in medium term (by year 2035), whereas by the end of century (projections for year 2085) the forests in the north-western districts will come under severe stress.

[31] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf
[32] http://www.jharkhand.gov.in/New_Depts/ap201011/Forest201011.pdf
[33] Data for BEF, root:shoot ratio, specific gravity and carbon fraction taken from IPCC 2006 guidelines

Vegetation change by 2035 **Vegetation change by 2085**

Areas marked by RED depict negative impact on vegetation

Figure 22: A1B SCENARIO-Climate change and its impact on vegetation in Jharkhand

The A2 scenario (Figure-23) predicts similar results projecting that by 2085 the forests in the north-western part of the state (displayed using red colour) will become highly vulnerable due to temperature and rainfall variations.

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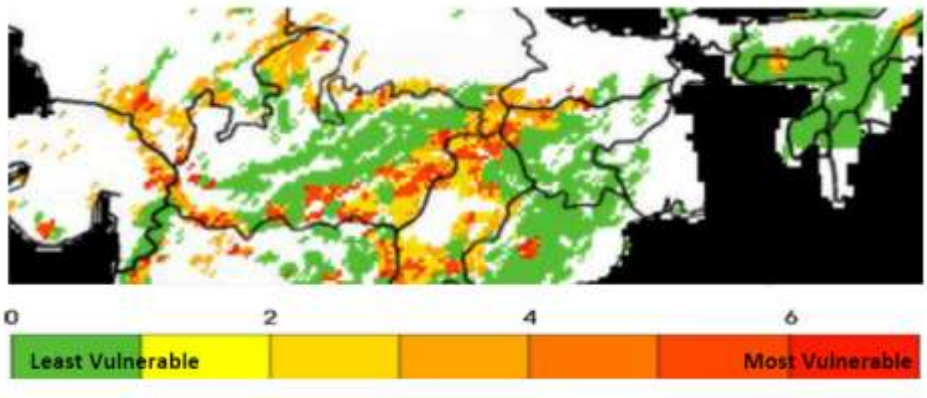


Figure 23: A2 SCENARIO (year 2085) -Climate change and its impact on forests in Jharkhand

The maps depict the scale of vulnerability of the forest in India. This vulnerability has been measured by using the Density of the forest Biodiversity and vegetation type change as indicators. According to the Figure-23 north western part of Jharkhand i.e. Garhwa, Palamu, Chatra, Koderma and northern part of Hazaribag will be exposed to moderate to high vulnerability. Except this region overall Jharkhand is less vulnerable compared to other states of India.

Both the scenarios predict the stress based on temperature and precipitation only, other factors that affect the forest health (human activity) have not been considered.

Increase in incidences of Forest Fires: As the climate warms, the soils are likely to be drier in the summer months, leading to less evaporation, less recycled moisture in the atmosphere, and hence less rain during

summer. Further fire mediates the responses of forests to climate change, either by accelerating species turnover or by selecting fire-adapted species (Overpeck et al. 1990). In the same way, changes in species composition may alter fire occurrence by changing the concentration and arrangement of flammable fuels (Bond and Keeley 2005). The strong potential for interactions and feedbacks between fire and its controls suggest that fire occurrence over long periods may reflect indirect (i.e. vegetation and human land use) as well as direct climatic controls (Bergeron et al. 2004).

Impact on Livelihoods: Climate change leading to degraded biodiversity of forests, is likely to impact the quality and quantity of forest products and hence adversely impact the associated livelihoods of communities.

Impact of climate change on Forest products –A CASE STUDY

Tribal women in Khunti are involved in the production and sale of Lac, a natural polymer produced by a tiny insect *Kerria lacca* that is cultivated on the shoots of several species of trees mainly *palash (Butea monosperma), ber (Zizyphus mauritiana), peepal (Ficus religiosa)* etc. For the past 3-4 years, *lac* host trees have been affected by unseasonal, short and heavy rains followed by extreme cold weather and week - long fog and frost around mid-March, when the insect is ready to produce *lac*.

As a result of extreme cold, the insects tend to die. This has occurred since 2006, reducing the production of lac to 25% of what was harvested in 2004-05. Consequently, the local lac industry has started importing lac from Thailand. People are greatly affected due to this, but they have adapted to these challenges by shifting their livelihood to commercial logging and agriculture. (*UNIFEM Report, Adivasi women engaging with climate change, Govind Kelar*).

7.7 STRATEGIES TO ADDRESS CONCERNS DUE TO CLIMATE CHANGE IN FORESTRY SECTOR

The overall sectoral vision and commitment will be to improve forest and biodiversity management practices through multiple strategies and initiatives in the state to minimize the impacts of climate change and for the overall well-being of the state and its people.

Research and development:

1. *Development of Sustainable Forest Management Plans for different forest types in view of Climate Change:* Detailed studies are recommended to understand impacts of climate change on forest productivity in different forest types using different climate and biodiversity models. This would help in developing climate resilient forest management plans. Revival of preservation plots, sample plots and yield plots is also recommended. To move from business as usual scenario, adaptation plans for each forest type of Jharkhand according to their biophysical be developed and maintained.
2. *Promote Research to Understand the Impacts of Climate Change on Forest Ecosystem*- The forest department should invest resources on developing 'centres of excellence' to undertake regional analysis for the climate change related threats analysis using climate models. Researches to forecast the likely impact of climate change phenomenon in forest areas, to assess the vulnerability, carbon sequestration potential and adaptability of indigenous tree species should be undertaken on high priority.
3. *Development of baseline methodology of carbon sequestered in the state forests*- State should develop methodologies for inventorization of the carbon stock available to take advantage of the REDD+ and other forestry carbon initiatives.
4. *Vulnerability Mapping of Forest of Jharkhand*-Detailed vulnerability mapping of the forest ecosystem and livelihood of forest dependent community with reference to climate change should be taken up and accordingly the adaptation plans should be made and implemented in the state.

Capacity enhancement:

1. *Capacity Building*-Orientation of the forest managers, officers and workers to the implications of climate change on forest ecosystem as a whole with emphasis on impact of forest growth, carbon sequestration, water balance and overall effect on the productivity of different ecosystems. Imparting

training to communities on various schemes/programmes associated benefits of social forestry, PPA, water conservation, market instruments etc so that they could participate in such initiatives and build their adaptive capacities.

2. *Promote use of alternate source of energy in forest villages and adjoining revenue villages*-So far the forest dwellers have been mostly dependent on forest biomass for lightning, cooking and heating. They need to be encouraged for the use of non-conventional source of energy (e.g. solar) for these purposes. Interventions like green livelihoods to promote ultimate fuel use and mechanism to support these interventions need to be done.

Change in forest management approach:

1. *Enhancing the levels of forest conservation, afforestation, reforestation activities through viable models*: Most forest areas of the state are well demarcated on the ground and on map. However in view of implementation of FRA, 2006 there may be some honey -combing and fragmentation required. Proper demarcation of forest boundaries in view of the vulnerability of remaining forest areas from further encroachments is needed. Similarly for sustainable protected area management the forest/wildlife corridors need to be identified connecting different National Parks and Sanctuaries of the state. This will allow conservation and migration of gene pool from high concentration areas to lower concentration. Carbon Revenue based project on Artificial Regeneration may be undertaken to harness the market based opportunities for forest conservation like REDD+, Forest-plus, etc. Regular plantation activities as a measure for restoration of degraded ecosystems should be continued in a well planned manner. To avoid the conflicts on the issue of biodiversity conservation and livelihood, effective implementation of "*care and share*" mechanism should be adopted.
2. *Prioritise Soil and Water Conservation in Forest Management*- The role of forests in conserving the biodiversity and the hydrological function performed by forests needs to be re-emphasized to prepare for meeting the challenges posed by climate change. The catchment area treatments need to be taken on high priority basis with some scientific approach. An integrated approach is required to treat the landscape irrespective of its current uses (forest, grassland, agriculture, etc.). Integrated Watershed Management with the help of silvi-pasture development should be promoted in the forest fringe areas. Identification of critical areas within forests for soil and water conservation should be under taken. Similarly, water harvesting and storage structures in the form of water bodies, wetlands should be created in the forest areas also. This would help in soil moisture conservation and would also provide drinking water to wildlife.
3. *Protecting and Enhancing sustainable forest based Livelihoods*- These is need of NTFP focused forest management to help forest dependent communities adapt to climate change. Traditional sources of livelihood dependent on lac shall also be enhanced and related skill building programmes should be undertaken. Ecology linked programmes like ecotourism have emerged as potential for enhanced employment and income to local people, these should be built in proper way so that real aim of these programmes could be achieved. Involving the communities in the conservation of the forest and providing opportunity for forest based livelihoods like silviculture, lac culture, honey collection, etc. need to be taken up on high priority basis.
4. *Enhance green cover outside Forests*-To create good forest cover it is necessary to bring the non-forest areas also under green cover. This could be achieved by giving impetus to social forestry, agro forestry and under trees outside forests (TOFs) mainly along roads, canals, railways, etc.
5. *People's Participation*-The state has already been engaged in promoting people's participation in sustainable forest management. Over 10,903 JFMCs (FPCs, VFCs and EDCs) have already been formed in the state. These need to be strengthened and actively involved in sustainable forest development activities. Community participation in conservation and monitoring activities should be encouraged in order to resolve the conflict between forest and people. This would inculcate sense of ownership among the communities.
6. *Forest productivity enhancement:* Forest is a big resource for the locals and the state. A renewable source of timber and firewood, forests also support the local livelihoods. It is suggested to plan forest resource development strategically so that it augments the rural livelihoods; and also supports rural energy requirements.

7. *Water harvesting in forest areas:* Water harvesting practices are integral to forestry management, focusing on small check dams soil erosion can be checked.
8. Using Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to develop forest plantations and water harvesting structures in jointly managed forests.

7.8 SECTORAL ACTION PLAN AND BUDGET

For Forestry sector action plan and budget please refer to Section C: Sectoral Action plans.

Chapter 8

HUMAN HEALTH AND CLIMATE CHANGE

Climate change affects social determinants of health-clean air, safe drinking water, sufficient food and secure shelter. With projected temperature fluctuations and changes in rainfall patterns along with extreme weather events including droughts climate change will significantly challenge the public health. With changing climatic conditions the burden of diseases in central India including Jharkhand is slated to go up.

While the whole of state is projected to be vulnerable to climate induced health risks, the low income groups residing in cities and rural areas with poor affordability and limited access to health services will be most affected. Reducing vulnerabilities and increasing resilience to help people cope with health effects of climate change will have to be priority for the state, and this will require new innovative and cost effective approaches to reach all sections of populations. This chapter aims to assess the impact of climate change on human health in the state and how adaptation measures need to be designed well in advance so that to reduce pressure on state's resources.

8.1 HEALTH INDICATORS AND INFRASTRUCTURE

As already discussed in previous chapters, in Jharkhand a large population lives in villages and is extremely poor. On top of it, the health infrastructure in the state is underdeveloped (Table-27). The result is that Jharkhand's performance on health parameters is extremely poor (Table-26).

Table 26: Health indicators and Jharkhand's performance

Indicators	Status	Source
Infant Mortality Rate (IMR)	42 per 1000 live birth	SRS, 2011
Maternal Mortality rate (MMR)	261 per 100000 births	SRS 2011
%Full Immunisation	59.7	CES 2010
Crude Death rate	7 per 1000 population	SRS 2011
%Households with no latrine facilities	77.96	Census 2011
%Households without no drainage for wastewater	70.5	Census 2011
% HHs without access to clean drinking water	40.8	Census 2011

Table 27: Existing health infrastructure and shortfall

Establishment	Available	Required	Shortfall*
Sub Centres (as on March 2010)	3958	5057	1099
Primary Health Centre	330	806	476
Community Health Centre	188	201	13
Sub Divisional Hospital	6	-	-
District Hospital	21	-	-
Mobile Medical Units	66	-	-

Poor infrastructure and facilities is aggravated by the fact that the state does not have enough trained health professionals. The RHS bulletin presents a very alarming picture. Apart from doctors at PHCs, other health facilities face an acute shortage of professionals (Table-28).

Table 28: Human Resources (Source: RHS Bulletin-March 2010)

Positions	Numbers required as per norm	Number in position	Shortfall	Shortfall %
Total Specialists (Surgeons, OB&GY, Physicians & Paediatricians)	752	84	668	88.83 %
Radiographers at CHC	188	23	165	87.77 %
Health worker (male) at Sub Centres	3958	648	3310	83.63 %
Doctors at Primary Health Centres	330	404	NA	0%
Health Assistants (female)/LHV at PHCs	330	90	240	72.73 %
Pharmacists at PHCs & CHCs	518	344	174	33.59 %
Nursing Staff at PHCs & CHCs	1646	578	1068	64.88 %

8.2 HEALTH ISSUES FACED BY THE STATE

Malaria and Dengue: Jharkhand is considered to be endemic to malaria and is also affected by other vector borne diseases. A large number of malaria cases are reported every year across the state. The numbers of reported malaria cases have decreased in recent past (Bhattacharya, 2006), the decline is mainly attributed to an increase in better health infrastructure and large population coverage under the Mass Drug Administration (MDA). On the other hand, the state has seen a sudden rise in number of dengue cases which is worrisome. Heavy rainfall is one of the reasons attributed to transmission of such diseases.

Table 29: Malaria and Dengue cases (Jharkhand)

Year	Malaria Cases	Dengue Cases
2007	184878	0
2008	214299	0
2009	230683	0
2010	199842	27
2011(Provisional)	134814	32

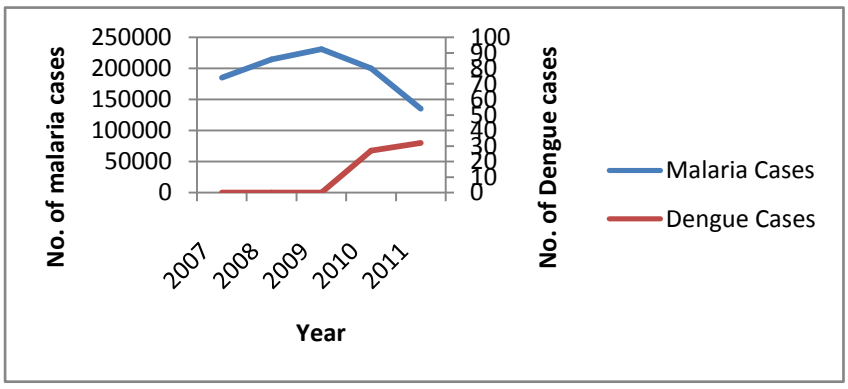


Figure 24: Cases of Malaria and Dengue in Jharkhand (Source: Jharkhand State Disaster Management Plan, 2011)

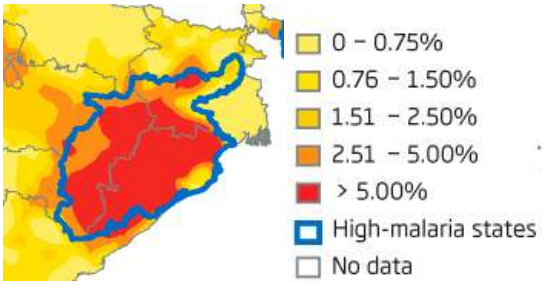


Figure 25: Concentration of deaths from Malaria diagnosed in Lancet survey[34]

Chikungunya: This disease re-emerged in the state in 2011 with a reported case of 816 till December. This is also a weather linked disease and transmission of chikungunya virus depends on the ambient temperature and occurs in areas not experiencing severe winters.

Respiratory Infection and Diarrhoea: In Jharkhand, 22% of children below age three have acute respiratory infection, 22% of children suffer from Diarrhoea at a given point of time and another 3% have Diarrhoea (source).

Malnutrition: The state witnessed multiple droughts or drought like situation during the last decade. In 2010 rainfall deficit in the state was 47%, this resulted in food production falling by more than 50%. Such conditions can create huge malnutrition problems for the population. Currently, 54% of children under age three are underweight, 49% are stunted. Based on the body mass index, 41%, of women are undernourished and 73% women have some degree of anaemia. Young children, older adults, people with medical conditions and below poverty line families (BPL) are most vulnerable in Jharkhand[35].

The malnutrition and other deficiencies increase the vulnerability of population making them susceptible to health problems.

Vulnerable population: 46.3% of rural Jharkhand (10.3 million people) was below the poverty line in 2004-05, with a figure of 20.2% for urban Jharkhand (1.3 million people). Overall, 40.3% of Jharkhand was below the poverty line (BPL). This figure represents the most vulnerable people in the State in terms of exposure and low resilience towards diseases.

8.3 HEALTH POLICIES AND INTERVENTIONS

The Department of Health, Medical Education and Family Welfare has set forth certain short-term and long term objectives which are relevant in context of climate change and are mentioned below:

1. Short term objectives
    - Enhancing Micro-Nutrient and Routine immunisation coverage in the State of Jharkhand.
    - Create capacity, both physical as well as human
2. Long term objectives
    - Increase complete immunization coverage from 9% in 1999 to 40% by 2005, and reach 100% of population by 2015
    - Reduce deaths due to acute respiratory infections and diarrhoea among children.

[34] http://www.newscientist.com/data/images/ns/cms/dn19619/dn19619-1_1070.jpg
[35] www.jharkhand.gov.in/new_depts/healt/healt_intervention2.html

The State has adopted certain plans to achieve the above targets through:

- **Strengthening of regular immunization services**: improving the cold chain system for vaccines and mobilising support for immunization programme by involving community members and grass-roots workers. Taking effective steps for increasing Vaccine coverage and reducing drop-out rates for children.
- **Plan to control Acute Respiratory Infection (ARI) like Pneumonia**: Government measures include mass education to inform mothers, *anganwadi* workers, female health workers, and other community-based volunteers, training of Paramedics in standardized diagnosis and treatment of pneumonia, and availability of medicines particularly at block PHCs.
- **Diarrhoea control**: For management of acute Diarrhoea, Government plans to take measures on proper procedure for preparing and administering ORS, dietary fluids and foods. Government also plans to introduce, cheap but effective ORS packets, approved by World Health Organisation. Role of Village Health Committee is explored to make ORS packets available in rural areas.
- **Malnutrition management:** For managing malnutrition, the Government plans to design Community-based interventions. It is in process of identifying appropriate complementary and supplementary foods for children, adolescents, and pregnant women. Strengthening of government programmes, such as the food for work programme, ICDS, and the public distribution system (PDS) to ensure that the need and hunger are eliminated through equitable distribution of food and dietary supplements. Setting up of Malnutrition Treatment Centre (MTCs) in every CHC to cover severely acute malnutrition children is planned.
- **Urban Health Systems:** Jharkhand has 20% of its population in urban areas and nearly 40% of the urban population lives in slum areas. For providing services to meet the health needs of urban slum population, Government plants to launch a public and private partnership and initiate mapping of urban slums in each town of Jharkhand. Further, Primary health care institutions would be set up with an emphasis on the care of women and children.

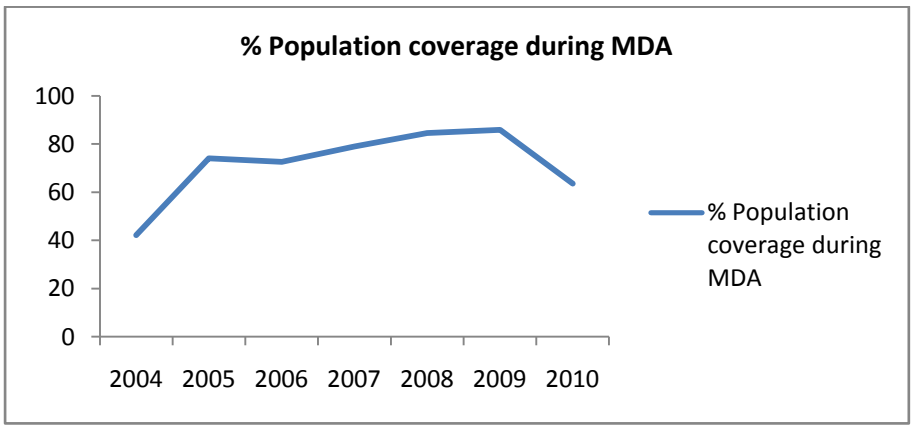


Figure 26: Percent population covered during Mass Drug Administration (MDA)

- **Malaria control**: 79582 cases of malaria were reported in 2012 which was lower than 160653 in 2011. Jharkhand has plans to strengthen malarial and other vector borne disease testing facilities at CHC and PHCs.
- **Interventions to develop heath sector resources:** the State government has prepared concept notes for establishing Super-specialty hospitals, medical college, nursing schools/college for filling the existing human resource and infrastructure gap.

8.4 CLIMATE CHANGE AND HEALTH ISSUES

Climate change will constrain the availability of clean air, drinking water, sufficient and safe quality food and also expose the human shelters to physical risk (due to extreme weather events).

Climate change impacts have direct bearing on availability of 'clean' water. As projected in the chapter on water, temperature rise and weather pattern changes will put additional strain on water resource of the state. Provisioning of clean water for consumption purpose will over time become more difficult and costly for the state and on the other hand consumers will have to allocate additional resources to ensure supplies of potable water.

Rainfall pattern shifts, temperature swings towards warmer side will make provisioning of clean water difficult, exposing communities with lesser purchasing power to water borne diseases. Further, warmer temperatures will also increase the spread of waterborne communicable diseases, and malaria and dengue fever.

Jharkhand has witnessed extreme weather events during past 4-5 years (tabulated below). Such extremities will increase over time exposing the population to health problems and other associated vulnerabilities.

Table 30: Extreme weather events in Jharkhand during 2008-2012

Event	Observations
Heat Waves	100 incidences in 2010
Highest temperature recorded	46.5° C in June 2010
Lowest temperature recorded	3.2°C in January, 2008
Highest rainfall recorded	338.1 mm in June 2008

Climate change will reduce the agriculture productivity in the state; nourishment levels in the state are already among the lowest in the country, reduced food-grain availability will further deteriorate the public health. The rising use of chemicals (fertilizer, insecticides, pesticides) to enhance agriculture productivity will rise to boost agriculture output which will further deteriorate human health by becoming part of the food cycle(due to chemical concentration and its ill effect).

The climate change linked natural disasters due to heavy rainfall, floods can damage the human settlements (in urban as well as rural areas) thus causing losses to human welfare, in addition the surge of water can also temporarily spoil the clean water sources.

Table 31: Projected health impacts of climate change

Health outcome	Contribution of Effects of climate change	Climate Change and Health Impacts for Jharkhand
Cardiovascular and respiratory diseases	• Heat waves cause short-term increase in mortality • Deaths from heat stroke increase during heat waves • Weather affects concentration of harmful air pollutants	The most prominent climate-linked health impacts in Jharkhand include • Malaria • Dengue • Acute respiratory infections • Water borne diseases • Malnutrition due to reduced agriculture productivity • Heat stress • Air quality deterioration due to reduced soil moisture (during hot season) • Poultry and animal
Allergic rhinitis	• Weather affects the distribution, seasonality and production of aeroallergens	
Deaths and injuries, infectious diseases and mental disorders	• Floods, landslides and windstorms cause death and injuries • Floods may provide breeding sites for mosquito vectors • Floods may increase post-traumatic stress disorders	

Health outcome	Contribution of Effects of climate change	Climate Change and Health Impacts for Jharkhand
Starvation, malnutrition and diarrheal and respiratory disease	• Drought reduces water availability for hygiene • Drought increases the risk of forest fires which adversely affect air quality • Climate change may decrease food supplies (crop yields and fish stocks) or access to food supplies	husbandry linked diseases that can make way to Jharkhand
Mosquito, tick and rodent-borne disease	• Malaria is strongly influenced by climate. The Aedes mosquito vector of dengue is also highly sensitive to climate conditions. Studies suggest that climate change could expose an additional 2 billion people to dengue transmission by the 2080s (WHO, 2012). • Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases and to alter their geographic range (WHO, 2012). • Higher temperature shorten the development time of pathogens in vectors and increase the potential of transmission to humans	
Water borne and food borne disease	• Climatic conditions strongly affect water-borne diseases and diseases transmitted through insects, snails or other cold blooded animals (WHO, 2012). • Survival of disease-causing organisms is directly linked with surrounding temperature • Climate conditions affect water availability and quality • Extreme rainfall can affect the transport of disease-causing organisms into water supply	

Table source: Kovats, K., L., Ebi, and B. Menne. 2003. *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change.* Geneva: World Health Organization cited in *Accounting for health impacts of climate change*, Asian Development Bank (2011)

An INCAA report developed a district wise map to display the malaria specific transmission window (TW) for the baseline year 1970 and for year 2030. Considering changes in temperature, precipitation the analysis predicted changes in the TA for whole of country. Specific to Jharkhand, the study predicts that TW will reduce significantly in most of the state.

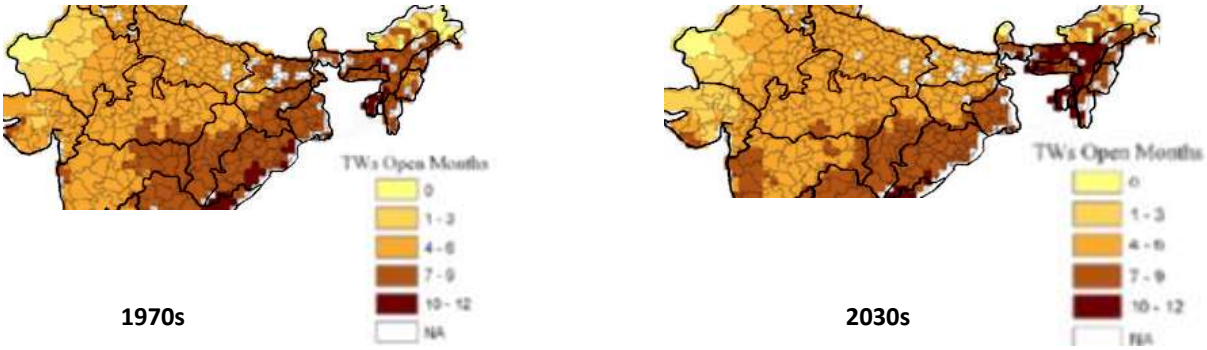


Figure 27: Change in incidence of malaria due to shift in transmission windows (Sharma, 2010)

These findings are nevertheless subject to a number of uncertainties related mainly to the presence of various environmental and socioeconomic factors, other than climate, which influence the transmission of the malaria and other diseases. (Sharma, 2010)

8.5 HEALTH SECTOR CLIMATE ADAPTATION APPROACH FOR JHARKHAND

Unless Jharkhand systematically plans and prepares responses to the health effects (projected) resulting from the climate change, the state bodies won't be able to cope with the additional burden on health system of the state. The logical approach expected from the state is preparation and integration of health concerns into state adaptation policies and actions.

The goal of the adaptation plan is to prepare a robust public as well as private health system in Jharkhand which addresses the health consequences of climate change in an integrated and coordinated manner. The Department of Health, Medical Education and Family Welfare, local health departments will have to work together to prepare and put an effective plan in place. The broad plan may include:

Health Hazards	Possible Adaptation action
Water-stress (Drought and Heat Stress)	**Short term Adaptation Actions** • Pre-defined plans for response to diarrhoea outbreaks • Promotion of water reuse and prevention of water contamination • Updating current statistical and meteorological models, and connecting environmental and disease outcome data **Long Term Adaptation Actions** • Contingency funds for upgrading health infrastructure and man power • Establishing an early-warning system for drought monitoring • Developing responses for emergencies related protective especially towards vulnerable populations • Developing communication plans and materials for public education focusing on Vector-borne diseases
Diarrhoea, malaria, Dengue (climate sensitive diseases)	**Short term Adaptation Actions** • Increasing the number of localized automatic weather stations for setting up of a robust weather monitoring system and use of Geo-spatial technologies for identifying the hot-spots of climate-sensitive diseases using the data obtained from the weather monitoring system • 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 • More robust data collection and increasing capacity for improvement in data analysis. **Long Term Adaptation Actions** • Filling up the existing shortfall in the health infrastructure of the State and increasing the percentage of population covered under the health drugs • Increasing the full immunisation to 100% from the current 59.7 % • Strengthening of current Health Schemes of the State • Developing communication plans and materials for public education focusing on Vector-borne diseases • Integrating climate change in State's water policy and encouraging water conservation • Improving inter-agency discussion, coordination, and communication

Research and data collection:

A detailed and systematic study on the climate sensitivity of diseases outbreak with focus on both vector borne and water borne diseases is required. The study should focus on historical data availability in different climatic

zones and identify trends and also find a link between climatic conditions and spread of diseases. The international research on disease outbreak and climate patterns should be studies to develop state specific hypothesis and test the same using ground data.

Identification of communities and regions that fall under the most vulnerable category is necessary. The climate vulnerability and disease outbreak linkage can be assessed and validated using geospatial analysis.

Identify data gaps, create guidelines for sampling, quality and periodicity on data collection. Standardized reporting system for reporting and periodic sharing of state health reports with relevant departments.

Awareness and capacity building:

Awareness building for the decision makers: Awareness generation and training programs to sensitize them on the climate change and its impact on human health.

Training programs for the health sector staff.

Senior officers of the health department should be sensitized on climate change impact on short and long term human health and climate change linked disease spread patterns.

Disease monitoring and early warning system:

A geospatial tool to maintain location wise disease outbreak and robust enough to predict disease outbreak well in advance. Tie-ups with likes of Google and other IT companies operating in similar areas can be explored for information sharing and capacity building requirements.

Rapid response system:

A close network of laboratories for testing and reporting of diseases is required to accurately identify and report outbreak of diseases. Also a strict protocol to be developed to ensure active tie-ups with national level laboratories. A rapid response mechanism needs to be in place to address diseases outbreaks. Close tie-ups with central and international health institutions and a protocol to quickly mobilize resources to control disease spread should be in place and put to test at frequent intervals to not only check readiness of the concerned departments and associated staff and also it can act as feedback for improvement of such mechanism.

Training of human resources at each level (right up to the *anganwadi* workers and lab technicians) is required to ensure early detection of disease and smooth flow of information between hierarchies and stakeholders. Further, aligning state health sector efforts with that of central schemes will be necessary to avoid duplicity of work and also to efficiently utilize the apparatus in place.

Corporate participation in health care management:

In order to promote and modernize health care facilities in rural areas private sector and PSU participation should be motivated. CSR guidelines for the private and PSU players can be designed to streamline the CSR fund flow to systematically fill the health sector gaps in the state (specifically for the tribal regions).

8.6 SECTORAL ACTION PLAN AND BUDGET

For Health sector action plan and budget please refer to Section C: Sectoral Action plans.

Chapter 9

INDUSTRIES IN JHARKHAND AND CLIMATE CHANGE

Jharkhand's economy is based on industries (including mining). The rich mineral deposits including coal make it one of the most preferred locations for a range of industries in the country. The state has one third of country's mineral reserves, particularly 'coal' and 'iron'[36]. The abundance of coal supports the mineral based and the steel industry forming the back-bone of the state economy (Source CII). This is the reason why some of the country's highly industrialized cities such as Jamshedpur, Ranchi, Bokaro and Dhanbad are located in Jharkhand.

A number of heavy engineering companies and consulting organizations located in the state produce equipments and provide turnkey and consulting services to the existing metal and mining industry. The state also has an expanding automotive industry, which includes original equipment manufacturers as well as auto component production units.

9.1 INDUSTRIAL DEVELOPMENT AND CHARACTERISTICS

Early industrialization in the state of Jharkhand started with Tata's investment into the iron industry during the first decade of 20th century. Availability of raw material and cheap labour attracted more numbers of heavy industries to the state and some of the biggest ones now operate in Jharkhand. Tata Steel, Tata Motors, Heavy Engineering Corporation and Bokaro Steel Plant are the biggest industries based in Jharkhand. On the public sector domain renowned names include Steel Authority of India (SAIL), Hindustan Zinc Limited, National Mineral Development Corporation (NMDC), Pyrex Phosphate and Chemical Limited and Indian Aluminium Company Limited. There are a number of medium and small-scale units in the state manufacturing a variety of products. Besides, a number of business giants like Rungtas, Jindals, Birlas etc. are associated with the state. Many foreign and national industry leaders like Posco, JSW and Arcelor Mittal are already operating or interested in associating with the state.

To facilitate industrial development process, there are three industrial development authorities that are operational in the state, these are Adityapur Industrial Area Development Authority (AIADA- Adityapur), Bokaro Industrial Area Development Authority (BIADA-Bokaro) and Ranchi Industrial Area Development Authority (RIADA-Ranchi).

Close to half of the state DSDP (Gross State Domestic Product)comes from industry with mining, quarrying and registered manufacturing contributing nearly 78 percent of the state's industrial output, with mining and quarrying accounting for 14.3 and manufacturing contributing 27 percent (compared to the national average of 17%)(Source: CII).

Industry contribution to Jharkhand's GSDP (Gross State Domestic Product) in 2009-10 stood at 35.82%. Since the inception of its Industrial Policy in 2001, almost 26 mega industries, 106 large and medium industries and 18,109 micro and small industries have been set up with an approximate investment of Rs 28,424.06 Cr. In individual category of industries, during the 11th Plan Period, steel production increased from 8 MT to over 12 MT per annum. The production of alumina also witnessed an increase from about 80,000 metric tonnes to over 200,000 metric tonnes.

[36] Minerals ranging from (state's rank in the country) from Iron ore (1st), coal (3rd), copper ore (1st), mica (1st), bauxite (3rd), Manganese, limestone, china clay, fire clay, graphite (8th), kainite (1st), chromite (2nd), asbestos (1st), thorium (3rd), sillimanite, uranium (Jaduguda mines, Narwa Pahar) (1st), gold (Rakha mines) (6th), silver and several other minerals are found in the state
(http://www.jharkhandonline.in/About/profile/economy/index.html).

Small enterprises (commonly referred to as micro, small and medium enterprises) act as economic equalizer as they provide employment and benefits in urban as well as rural areas and employ a large population. As of March 2007, there were about 163220 small scale industries that were operating in the state, of which about 28,000 were registered. The organized sector units mostly operate as ancillary units operating close to big industries, the activities in rural areas are largely unregistered. Steel rerolling, coke oven plants, brick kilns, foundry units, ceramics and agriculture processing form major units. In addition, a large number of cottage and tiny industry operate in the state, the contribution of the small scale industries can be understood by the fact that Jharkhand produced a record 716 metric tonnes of *Tasar* Silk during the period 2010-11.

9.2 INDUSTRIAL SECTOR IN JHARKHAND- ENVIRONMENTAL FOOTPRINT

As discussed, Jharkhand is home to many heavy industries (due to mineral reserve). The industrial emissions are considered as a proxy to environmental footprint of the sector and to arrive at the emission footprint, emissions associated with three sources are considered; the energy that goes into operations, from the production process and the waste generated in the process.

OVERVIEW OF GHG EMISSIONS FROM INDUSTRY

The industrial production and respective CO_2 equivalent emissions from selected very-heavy industries are displayed in Figure-28. From the figure it's clear that steel manufacturing contributes the largest percentage of emissions (38.8%) whereas the CO_2 intensity of copper industry is the most.

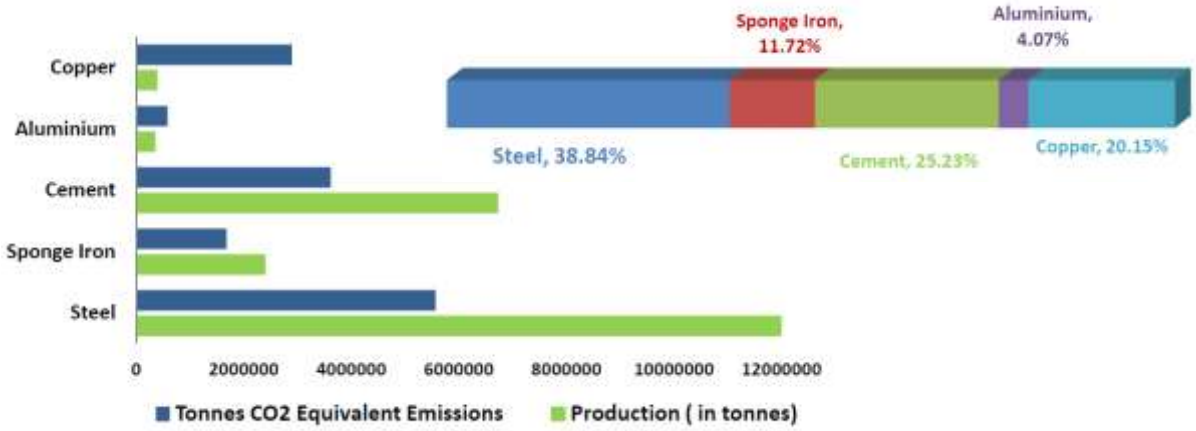


Figure 28: Industrial production and GHG emissions of selected products in Jharkhand (year 2011)

The SME sector emissions are calculated only for selected energy intensive industries including brick kilns and coke oven. Due to lack of data, any emission estimation for other SME sub-sectors is not possible. For brick kiln and coke-oven sub-sectors too the information available is scant, hence logical estimations are used to generate relevant numbers.

The brick kilns are spread across the state, there is no data available on the number of brick-kilns or the amount of energy consumed by such units. But single brick industry is one of the biggest consumers of coal/fuel wood,

hence this sector cannot be ignored. Based on the brick production in India[37], the annual GHG emission of the brick kiln sector is estimated at 2.33 lakh tonnes of CO_2.

Apart, the annual GHG emission from Beehive coke industry is estimated at 18000 tonnes of CO_2.

9.3 INDUSTRIAL GROWTH IN JHARKHAND-ISSUES

Among 28 states, Jharkhand ranks 22nd on the aggregate infrastructure index which covers the power, communications, and transportation sectors. Competing states such as Chhattisgarh, Orissa, and West Bengal rank 17th, 14th, and 11th. Given that labor force participation rates are roughly similar (32.9 percent for the state against 33.6 percent for India), lower per capita GSDP in the state can be largely attributed to lower productivity across different sectors (see Figure-29). In 1999/2000, nearly 90 percent of the state's workforce was employed in sectors where productivity levels were lower than those for India. These sectors included agriculture, mining, utilities, construction, trade and hotels, and storage, transport and communication; they contributed close to 60 percent of GSDP. Manufacturing accounted for 30 percent of GSDP but employed less than 10 percent of the workforce.

Access to finance is a major hurdle faced by industry in Jharkhand. The problem of access to finance for entrepreneurs appears more severe for Jharkhand's firms than those in most other major states. The ICS 2005/06 survey reveals that far fewer firms in Jharkhand had active bank credit lines as compared to firms in other states. As an additional indicator of the level of access to finance for firms based in Jharkhand, the per capita credit to deposit ratio is considerably lower in Jharkhand than in states like Maharashtra, Tamil Nadu, Karnataka and AP, the all-India average and even some of the other "lagging states" like UP, Rajasthan and MP.

Availability and quality of infrastructure is a critical constraint faced by firms operating in Jharkhand, and this may also be resulting in withholding of investments. Jharkhand does not perform better than the all-India average on most infrastructure availability indicators. This has direct implications on the performance of the state. As depicted in figure below, productivity level of the state is well below the average national values (except for manufacturing industry).

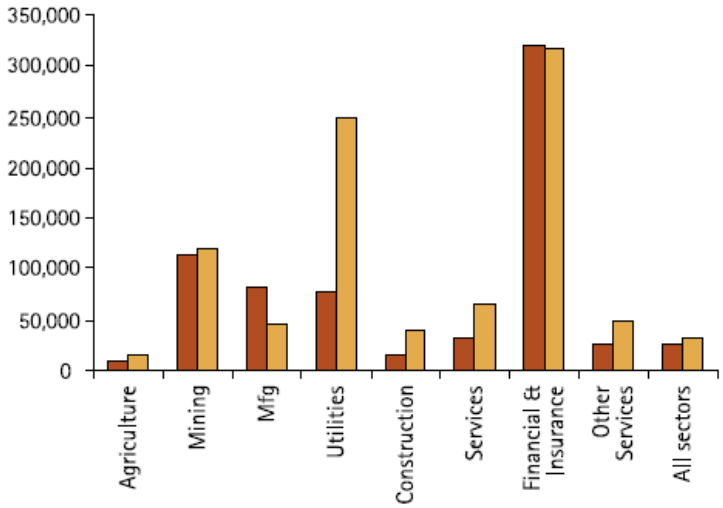


Figure 29: Productivity levels- Jharkhand and India

[37] A population based (per capita production of bricks) estimation is made for the number of bricks that are consumed in the state, considering the fact that a large population is poor and urban population is small hence a multiplier is used to reduce the total emissions by the sector by 50%.

9.4 IMPACT OF CLIMATE CHANGE ON INDUSTRIES

The climate change is expected to have direct implications on the industrial performance. In a study conducted by Indian Institute of Ahmadabad (IIMA), it was concluded that the impact of Climate Change on industries would be mostly through impacts on associated infrastructure including transport, machinery and water and wastewater systems (Department of Energy and Climate Change, 2011).

Various factors that can have bearing on the industrial performance are described in the following section.

1. Climate change will have impact on certain elements of the industrial processes that are sensitive to temperature. Power plant cooling using river water is an example of a process that is sensitive to climate variables: if the temperature of the water rises beyond a certain level, the efficiency of the (though not significantly).
   The impact of climate change on captive energy production by industry is depicted in figure below. The analysis assumes that the captive power generation stabilizes in 2035 and average annual temperature goes up.
   Three temperature rise scenarios (linked to low, medium and high GHG emissions (globally) are considered to derive at the respective temperature rise for respective scenarios. The figure represents the reduction in the electricity produced for three scenarios during the period 2036-2050.

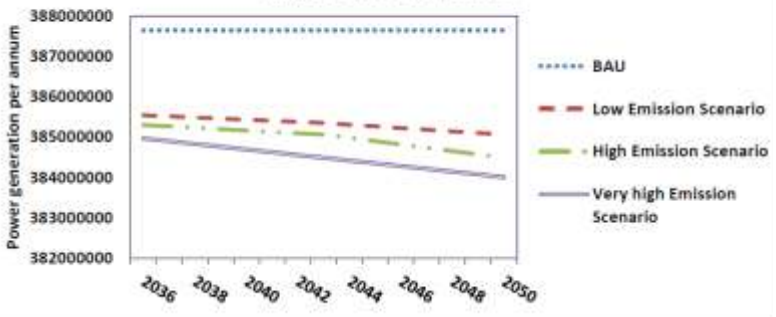


Figure 30: Impact of temperature ruse on power output of captive power plants in Jharkhand

   Clearly, the impact of climate change on power generation is not huge, the overall productivity for a 2^{o} rise in temperature reduces the output only by 1% but as we will see in the following section, the impact of the temperature rise on water use of the plant is huge.
2. The climate change will affect the heating and cooling demand of the industries (depending on the nature of operations). There will be huge financial implications for such shift in demand as this will be industry wide phenomenon which will be witnessed across the country.
3. Natural resource use pattern: Climate change will impact availability of resources to the industries; industries relying on agriculture and allied sector will be worst affected and so are the industries that use high amount of water.
   Temperature rise will reduce the power production efficiency of the captive power plants owned by industries (effect of temperature rise on efficiency of power plants explained in Chapter on Power (page 92)). To achieve same level of productivity, the power plants will have to increase their water intake (for cooling).
   The demand of resources required for energy production will rise. This will put pressure on existing coal and water resources. Small and medium enterprises are going to be the first to suffer when coal demand of power plants and industries goes up across country.

4. The climatic changes may force the state (and also the nation) to adopt industrial performance standards that are more stringent in terms of environmental performance, in addition the cost burden of environment management may be shared with the industries. Industries may be required to incur heavy investments in modernize operations to meet the new standards.
5. The climate disasters (storms, flood, droughts and cold waves) may cause direct or indirect damage to the industrial base, leading to escalation in the cost of the products.

For Jharkhand, specifically the following anticipated impacts are of relevance:

Table 32: Climate change and impact on power sector

Climatic Parameter	Impact Parameter	Impacts
Temperature Increase	• Reduced efficiency of thermal power generation facilities • Increase in use of indoor cooling systems	• Energy prices will rise • Energy demand will go up • Energy production will shrink especially during dry season
Rainfall pattern shifts	• Changes in the water availability in dams • Ground and Surface water level change • Rainfall may damage communication	• Power generation will get effected • Industry will have to alter their water use approach • Rain will affect transportation which will have impact on productivity and efficiency

9.5 CLIMATE CHANGE VIS-À-VIS GAPS : JHARKHAND INDUSTRIAL POLICY, 2012

Though the state industrial policy does not explicitly talk of any activities/ plans for adaptation or mitigation of the impacts of climate change, its chief objective is promoting the sustainable growth in state and facilitating optimal utilization of state's minerals and natural resources. For achieving sustainable growth and consequent natural resource use, it does lay down some guidelines:

Water use efficiency

• The policy is designed to promote minimum water consumption technologies. The policy guidelines provides for periodical review of allocation of water to industries/power plants and also relevant state departments are empowered to issue directives to industries to reduce/reallocate the water on actual requirement keeping in view the limited availability.
• Industrial Area Development Authority (IADA) will ensure the implementation of rain water harvesting, storm water harvesting and recycling and re-use of waste water in industrial units under their command area.
• Compliance monitoring by Department of Water Resource for areas outside the command area of IADA for industries other than MSME. Suitable guidelines would be laid regarding use of underground water by the Industries in different areas / zones of the state. Industries would also be encouraged for adopting in-house storage interventions, to meet their industrial water demand during non-monsoon period.

Energy Efficiency

Though the policy does not lay any specific guideline for the industrial energy or operational efficiency but it provides incentive for promotion of the nationally adopted efficiency guidelines/ standards. As per the policy, industrial units wanting to obtain certificates from ISO, Bureau of Energy Efficiency (BEE) or

LEED Certification would be given high priority and would be provided financial assistance by the State government.

Renewable Energy

The Industrial Policy 2012 also promotes renewable energy and environmental friendly sources of energy. It also proposes to purchase 10% of state's total power purchase from renewable. It also offers incentives, by providing waiver of 50% electricity duty for 10 years for power plants generating power from renewable sources. It also promotes technological up-gradation of industrial units for improved productivity.

Infrastructure development

The industrial policy lays emphasis on development of quality infrastructure which is key to industrial efficiency. Development of road, water, land, power and provide it at the doorstep of especially for steel, automobile, food and agro-processing, electronics, information and communication technology are the agendas laid down by the policy.

9.6 ADAPTATION APPROACHES FOR INDUSTRIAL SECTOR IN JHARKHAND

The major climate mitigation strategies suggested for the industries in Jharkhand include:

Adaptation measures for Industries: The climate change adaptation measures for industries are not fully independent of the mitigation measures as 'energy' is one of the most critical inputs to the industrial processes and the biggest direct impact of climate change on industries will be on the availability and economics of energy. In order to survive and remain competitive in changed weather scenario, industries will have to use their existing resources efficiency to immune the bottom line from price rise due to scarcity of resources.

In climate change scenario, the vulnerability exposure of industries can be reduced by adjusting the industrial policies and performance gradually putting prime focus on energy and natural resource management.

Issues to be addressed at the state level planning include:

- Inclusion of risk assessment and vulnerability studies in infrastructure planning, specifically in mining regions and areas which are flood prone.
- Involving industries in energy planning, promotion of energy efficiency by gradually replacing the old technologies and processes by more efficient ones. In addition, promotion of investment in renewable and other green energy sources will not only help reduce dependency of industries on grid but also (partially) isolate them from power shortages.
- Protection against extreme events would require development of adaptation options such as ensuring high design standards for new infrastructure.
- Integration of climate change adaptation strategies into policies that promote industrial growth and urban development.

Industry specific adaptation strategies:

Diversification: To promote inclusive growth as well as reduce emission footprint, the state will in long term have to shift focus towards broadening of the manufacturing base beyond mining and mining industries. There are already multiple industrial clusters focusing on steel and steel products, auto ancillary units, rubber component manufacturers and other small and medium sized plants are operating in the state. There is further potential to develop clusters of ancillary units in vicinity of mega projects.

Green Performance standards: There is need to revise the environmental performance standards of the existing and new industries. The new industries, whether small or big should be motivated to introduce best operational practices in the local production environment. Thus economising on resource input and reducing pollutant outputs.

Supply chain management: The industries in the state should also revisit their raw material supply chains. For example, import of basic materials (including coal) should be considered. Some of the big industrial players have already started diversifying their raw material sourcing. For example Tata is considering improved coal procurement from blocks in Africa.

Smart energy options:

1. Industries are highly dependent on coal for electricity as well as for kiln firing. Burning coal emits harmful gases and wastes such as CO_2, SO_2, NO_X, arsenic and ash. CO_2 emission from coal alone is twice that of what is emitted by natural gas to produce same amount of heat energy (http://fossil-fuel.co.uk/coal/the-disadvantages-of-coal).
   Jharkhand will have to adopt carbon smart energy options and also improve the energy efficiency of the existing plants to reduce emission footprint of coal fired process.
2. Carbon free energy: To reduce dependency on grid electricity and also reduce carbon emissions the industries would have to invest in renewable energy options. The technologies adopted by industries could be as simple as solar heating for small enterprises, whereas waste to energy and more complex options like solar and wind energy options can be evaluated by the industries with financial implications w.r.t. climate change scenarios.
   Jharkhand government (as well as central government) has developed on incentive systems that captive power plants and this is reflected in the number of CPPs operating and in pipeline in the state.
3. Efficiency improvement: The industrial efficiency in the state is low, specifically in the metal processing and SME sector. The poor energy efficiency is a technological issue and any efficiency transitions require overall overhauling of the manufacturing operations. The BEE-NPC joint study indicated that coke oven plants alone have the potential of saving 20% of the energy.

Table 33: energy saving potential of energy intensive SME clusters in Dhanbad

Energy saving potential in identified energy intensive coke oven plants (BEE & NPC, 2009) **State**	**Cluster**	**Units**	**Energy Consumption (MU)**	**Energy saving potential (%)**
Jharkhand	Dhanbad	36	21.16	20

4. Smart carbon management: Reducing carbon emissions add to industrial competitiveness. Carbon emission reduction through process and technology modernization is directly linked to industrial efficiency whereas GHG emission reduction makes the project eligible for carbon revenue.
   As developed countries shift towards low carbon regime, barriers to reduce flow of products with high carbon footprint are set to rise (through carbon taxation).

SME specific interventions: While a number of policy recommendations concerning access to finance are being dealt with at the Central Government level, particularly with regard to the policy, regulatory and institutional framework for SME financing. Similarly enabling policies at the state level can create a more conducive environment for market-based financing of energy efficiency and environmental friendly technologies in SMEs by the formal financial sector. Some of the medium to long-term actions could include:

- Improving the credit evaluation and risk management skills of banks and other financing institutions to improve lending practices. This will involve building institutional capacity to reduce transaction costs, reduce and manage risks related to SME lending. A risk sharing facility (by state agencies through NABARD, SIDBI) to accelerate commercial bank lending to SMEs could be explored wherein the facility could provide partial credit guarantees for commercial bank loans to SMEs.
- Strengthening business development services and market linkage programs for SMEs thereby helping SMEs improve profitability and competitiveness, and become more credit-worthy.
- **Other interventions should include:** Establishing a monitoring, evaluation and communication system for environmental performance of SMEs. Facilitating adoption of improved performance standards for SME sector is required to guard them from potential change in national/international binding regulations for product process standards (eq. Carbon taxes).

9.7 SECTORAL ACTION PLAN AND BUDGET

For Industries sector action plan and budget please refer to Section C: Sectoral Action plans.

MINING SECTOR IN JHARKHAND AND CLIMATE CHANGE

Jharkhand is a state endowed with a rich natural resource base. It possesses about one third of the country's iron ore reserves, huge quantities of precious minerals like uranium and most of the coal reserves. The abundance of mineral puts Jharkhand in a unique position to realize inclusive development using the mining industry as a stepping stone.

10.1 MINERAL RESOURCES IN THE STATE

Jharkhand is rich in minerals and holds 40% of country's mineral wealth. At present, it has approximately 27.6% of total estimated reserves of coal of India[38]. Table-34 shows the number of mines of some of the important minerals.

Table 34: Number of mines in Jharkhand (Jharkhand State Disaster Management Plan, 2011)

Mineral	No. of mines
Coal	198
Iron ore	45
Bauxite	45
Lime Stone	41
Copper ores	2
Mica	4
Kyanite	7
China clay	28

The mining sector has given a major boost to the economy of the State. The various kinds of minerals found in Jharkhand include iron ore, granite, coal, copper, mica, bauxite, and chromite. Mineral based economy in the state is on rise and every year capacity has been added to meet the domestic and international demand. Jharkhand also exports its mineral products to various countries such as Saudi Arabia, Bangladesh, South Africa, and Nepal.

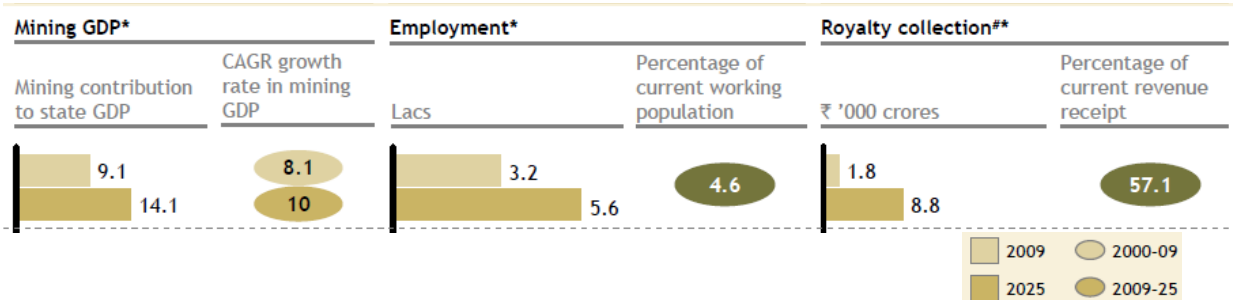


Figure 31: Contribution of mining sector in State GDP, employment and royalty collection (Ministry of Mines, 2011)

As per the mining sector projections, the mining sector will be contributing close to 14% to state's economy and will be creating additional 2.4 lakh job opportunities by 2025 (refer Figure-31).

[38] Source: www.indiastats.com

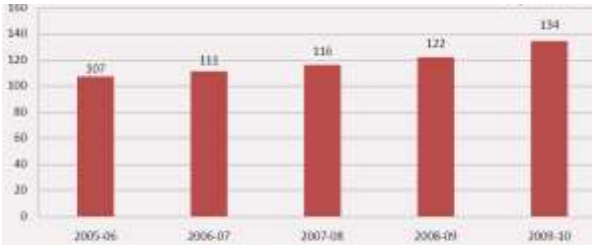


Figure 32: Mineral production (in million tonnes) in Jharkhand during 2005-2010 (Department of Mines and Geology, 2011-12)

10.2 MINING SECTOR ASSOCIATED ISSUES IN JHARKHAND

The state has a strong mining sector program but it is riddled with numerous issues. Moreover, the lack of infrastructure and environmental considerations act as significant deterrents for investments in the sector. The major issues and challenges faced by the mineral industry in the state are:

Inefficiency: The mining industry in India loses approximately INR 9000 crores every year due to logistical issues (Ministry of Mines, 2011); the poor infrastructure including power and road connectivity are the major deterrents. It is expected that the situation is not going to improve in coming years.

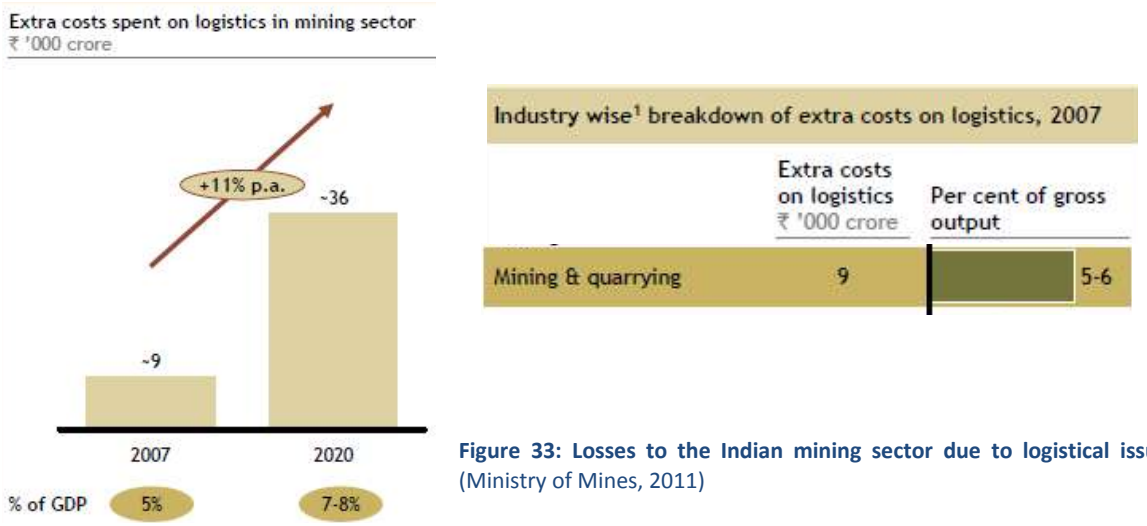


Figure 33: Losses to the Indian mining sector due to logistical issues (Ministry of Mines, 2011)

Pollution: Mining activity pollutes the local surrounding, the extracted minerals and soil (overburden) is piled on land; exposed to natural forces this flows into water bodies and surrounding land. It is estimated that in 2006 alone 1.6 billion tonne of waste and over burden from coal, iron ore, limestone and bauxite was generated. In addition air pollution from mines and mineral transport deteriorates the surrounding environment.

The mineral belt in the state falls in watershed of the major rivers (see Figure-34). Hence water related problems are common issues faced by the mine managers and the community.

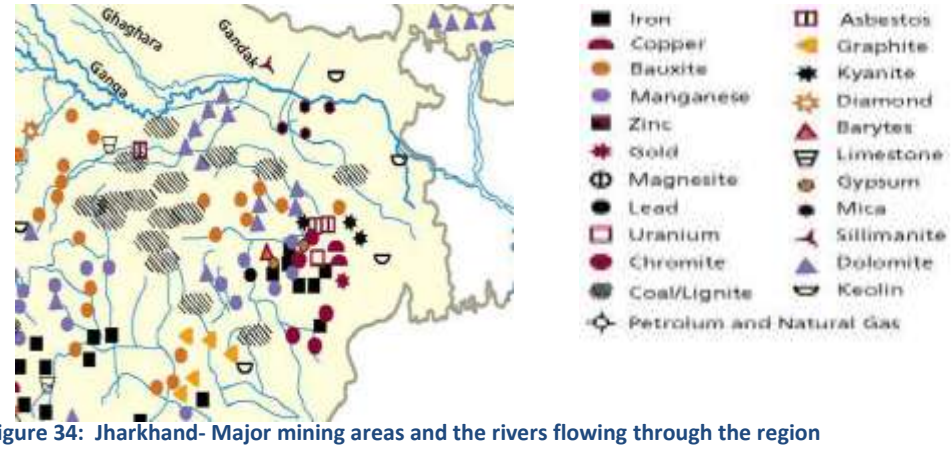


Figure 34: Jharkhand- Major mining areas and the rivers flowing through the region

Environmental impact of mining: The impact of mining on forests is captured in detail in Chapter on Jharkhand forest. A study on impact of coal mining carried out in the district of Ramgarh indicated that there was an apparent decrease on forest cover of 15.50 % during the 1981- 1996 and 11.05 % during 1996-2004. It has been observed that major loss of forest areas occur in the vicinity of coal mining areas. Total destruction of forest cover has been noted in the certain coalmines. Similarly, the coal mining area, which was 10.16 sq km in 1981 (2.92 %) increased to 20.08 sq km in 1996 (5.78 %) and further spread over to 26.33 sq km (7.58 %) by the year 2004. it was observed during the study that the spread of coal mining activity leads to total destruction of forest cover within the mine area and also leads conversion of surrounding agricultural lands into wastelands dominated by open and dense scrub. (Mishra, Singh, & Jeyaseelan, 2009)

Large bodies of stagnant water accumulated in the depression areas of mine due to accumulation of surface and ground water over a period of time indicating a changing geo-hydrological regime with possible threat of ground water contamination in potential aquifer passing through the area or located at lower stratigraphic level.

Emissions from mining activity: Mining activity is a big source of global GHG emissions. For example in Australia alone the methane emissions from coal mining accounts for about 6% of the national GHG inventory[39]. The GHG emissions from mining are due to the energy used in extracting the minerals. Specific to coal mining, methane emissions take place during the extraction process (fugitive emissions). Since Methane's GHG emission potential is 21 times more than that of coal, hence the total emission from coal mining is huge. Specific to mining activity in Jharkhand, emissions from coal and iron mining are considered for calculating carbon footprint of the sector (for remaining minerals required data does not exist) as shown in Figure-35.

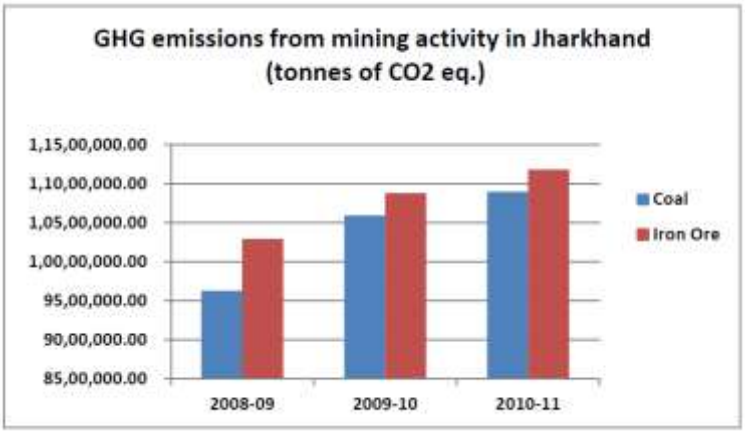
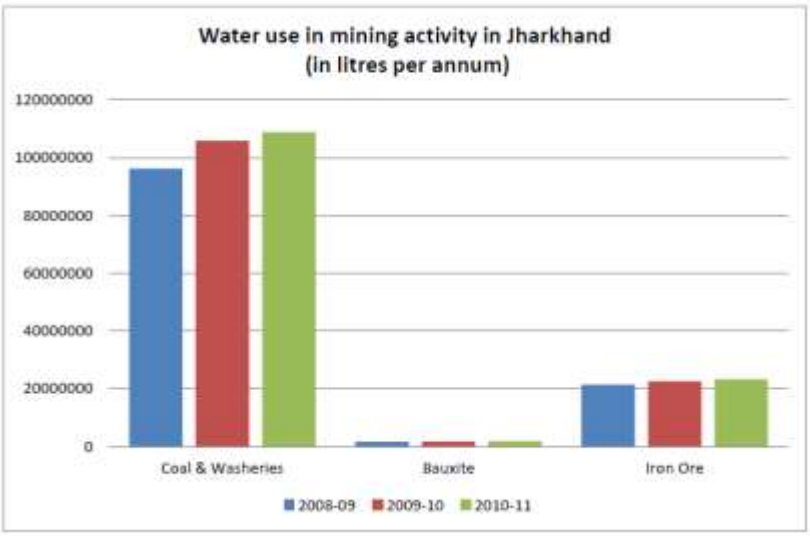


Figure 35: GHG emissions from coal and iron ore mining activities in Jharkhand

[39] http://www.ccsd.biz/publications/files/TA/TA%2035%20Mitigation_of_GHG-final.pdf

The above graph shows that the emission from the mining sector is on rise and has been growing at the rate of 5% per annum.

Water use in mining: Mines not only use the precious land but also directly consume lots of water in different process. The water use in mines is to gain access to minerals, metal and non-metal by dewatering using pumping wells, diversion techniques and near-horizontal drainage passages. In mining operations water is also used to extract and process the ore at the mine site. This water is often reused and recycled, and water cascading is put to use and as a result many mines are able to minimize water discharge during operation; however the concentration of contaminants increases. Water is then discharged into freshwater bodies post primary treatment. After ore recovery is complete, previously drained underground mines and open pits are refilled with water, further diverting ground and surface water flows. Precise estimates of water intake and discharge associated with mining activities are difficult to obtain due to uncertainties associated with evaporative losses, and gains and losses through subsurface flow during both the active and inactive stages of mining[40].



The water use footprint of the mining activity is huge. Water footprint calculation of mining activity becomes important due to the fact that through seepages and surface runoffs, mines contribute to damaging (temporarily or permanently) the water bodies in vicinity.

Figure 36: Water use of mining sector in Jharkhand

The Figure-36 displays direct water use footprint of coal, bauxite and iron mining in Jharkhand, the calculations are based on the secondary information on water use. Most conservative estimations are used to develop a representative picture of water use in the sector.

10.4 CLIMATE CHANGE AND MINING ACTIVITIES IN JHARKHAND

The following section highlights the vulnerability and risk of mining sector of Jharkhand in light of impending climate change impacts. Generally, climate change effects will be associated with reduced efficiency, increased operation cost and slowing of mining expansion into new areas.

Climate change impacts can be categorized in two forms: natural hazards and changing weather patterns. Natural hazards include flood, droughts and forest fires while the changing weather pattern includes increased temperature and rainfall (along with increased erraticity).

[40] http://www.nrcan.gc.ca/sustainable-development/freshwater/2347

10.4.1 NATURAL HAZARDS

Flood:

- Mining activities are highly vulnerable to heavy rain and erosion and their accessibility might be affected due to extreme events such as flood. The 7% area of state is flood prone (during 2000-04, 11 districts were affected by flood and in 2008 Sahebganj district was hit by a massive flood. The 11 affected districts are also home to large number of mines). Flooding can cause interruption in mineral production and increase energy requirement to treat flood water. It also poses threat to the life of mine workers (A recent flooding accident in a mine in Bokaro left 2 people dead)[41]
- Disruption of land transportation routes and supply of raw materials (construction material, fuel) which might delay extraction and dispatch of minerals.

Forest fires:

22 districts of Jharkhand are currently at forest fire risk, with rising temperature and reduced top soil moisture (due to lesser rains) the forest fire risk will go up in future. This could pose a threat to mining operations and facilities since majority of these districts are also rich in minerals and subjected to huge mining activities.

Table 35: Districts with important minerals and frequently affected by forest fires

Districts affected by forest fires	Main minerals
Garwha	Dolomite, Limestone
Palamau	Dolomite, Limestone, Graphite, Fireclay, Gold ore, Quartz, Magnetite, Baryte
Latehar	Coal, Bauxite, Laterite, Dolomite, Graphite
Chatra	Coking coal, uranium and pyrite
Hazaribagh	Limestone, Fireclay, Quartz, Mica
East Singhbhum	China clay, Gold ore, Kyanite, Quartz, Cobalt. Magnetite, Bartye, Pyroxenite, Magnesite, Soap stone,
West Singhbhum	Coal, Apatite, Asbestos, China clay, Limestone, Gold ore, Chromite, Kyanite, Manganese ore, Quartz, Ocher
Simdega	Gold ore, Beryl
Gumla	Bauxite, stone

[41] http://www.indiavideo.org/news/india/2012/08/28/jharkhand-mine-floods-one-killed-35661.php

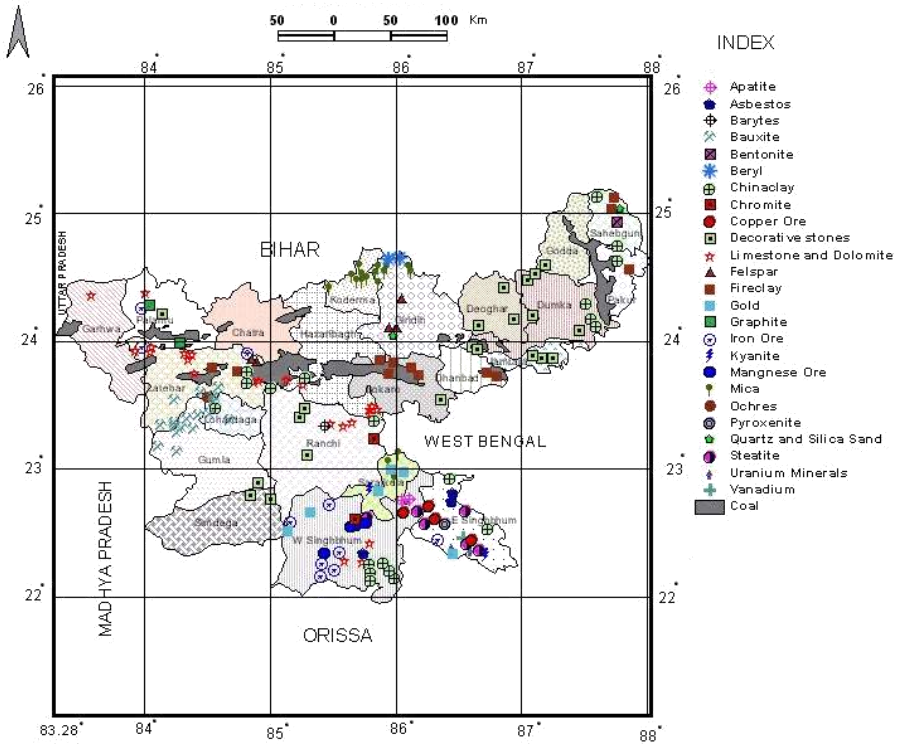


Figure 37: Mineral map of Jharkhand (Source: Jharkhand State Mineral Development Corporation Ltd)

Figure 38: Districts under Forest fire risks (Source: Jharkhand State Disaster Management Plan, 2011)

Droughts:

- Water consumption in mines depends on size, method of mining and equipment used. Generally underground mining require water which is used for cooling the mining machinery and for inhibiting friction induced ignition of coal fines and gas. This consumption is lower than consumption of open cast mining

where majority of water is used for dust suppression. For Jharkhand, average water consumption (excluding domestic) in iron ore mine of Tata Steel is about 600 liters per tonne of iron ore[42].

Minerals	Specific Water Consumption (water required per tonne of mineral extracted)
Coal	NA
Iron ore	600 litres (Jharkhand specific)
Bauxite	87.6 litres (based on Orissa reading)
Limestone	20 litres (India average for large companies)

Changing weather patterns

Rising temperature:

- Mining process require power to cool underground mines and surface facilities. A rise in temperature increases power demand and associated costs. This could also constrain future expansion of mining operations
- The temperature fluctuations can increase strain on transmission and distribution facilities due to shifts in power demand.
- Increasing temperature might increase cases of malaria, dengue, heat stress or other health-related illness, thus causing health hazards among the mine workers.
- Increased mineral extraction requires removal of top soil. Top soil is later required in abandoned mines for vegetation and reclamation. Increased temperature can reduce soil moisture which affect plantation. Heavy rainfall can also lead to runoff of top soil and causing heavy silting as well as pollution downstream (Ghosh and Banerjee, 2012).

Extreme rainfall

- The geology of the state has predominantly hard rocks (East and West Singhbhum, Ranchi, Gumla, Dhanbad, Lohdarga, Palamu, Giridih, Hazaribagh, Chatra, Ramgarh, Godda, Deogarh, Dumka)[43] Mining on hard rock requires use of sulphur which increases the possibility of release of sulphuric acid when the mine tailings (the material left over after separating minerals from the ore) come in contact with water. Changing rainfall especially extreme rainfall can cause the release of sulphuric acid if the tailings are not managed properly on site and create environmental problems for the local population.
- Heavy rainfall also causes other environmental impacts which include heavy silting downstream. Damodar River Basin, which is the repository of 46% coal reserves in India , is one of the most industrialized and mineralized regions. Damodar River, which runs through the mineral rich regions of Jharkhand Coal Fields (JCF), Dhanbad, has witnessed heavy pollution load caused by the mining industries. Heavy rainfall combined with faulty waste management practices on site can lead to an enhanced increment of pollutants in the river. A study by Sundararajan and Anand (2011) discovered increased concentration of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) during post monsoon season as compared to pre monsoon in the Damodar River stretch in Dhanbad and this was attributed to soil erosion and surface run off. In the event of uncertain rainfall and especially heavy rainfall, management of surface runoff would become more difficult and huge pollution load can cause the rejuvenation of river difficult with time.

10.4.2 OTHER RISKS

- Hazards (due to heavy rainfall, flashflood) might discourage insurers and investors in investing in mining in areas that are mineral rich but hazard prone, thus slowing down the growth of mining activities
- Revegetation measures in the adjoining areas might be affected due to water shortage and increased temperature.
- Climate change can also lead to conflicts of mining industries with other sectors which are explained in the following table:

[42] http://www.scribd.com/doc/21951305/7-Hydrology-Mining-and-Water-Resource
[43] Department of Mines and Geology, Jharkhand, 2012

Table 36: Impact of mining activity on surrounding resources

Sector	Conflict with mining industry
Agriculture	Competition for land for crop cultivation and grazing. Mishra and Pujari (2008) [44] provided evidences that there is loss in agriculture productivity due to mining activities and a shift in livelihood activities to mining.
Biodiversity	With increased impact of Climate change on biodiversity and wildlife, it has been difficulty for granting environmental clearance to mining projects. In Central India (Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha, Maharashtra), existing and proposed mines near wildlife reserves threaten habitat destruction and habitat fragmentation.
Water	Conflict can occur over access to water resources and quality deterioration of water due to mining activities especially in areas with limited fresh water resources
Human Resource	Farmers engaged in agriculture might shift to mining work to supplement their income and might also abandon agriculture all together.

10.5 ADAPTATION PLAN

Climate change adaptation strategies for mining sector: The mining sector will see tremendous pressure due to climate change. The demand for resources (such as agriculture land) will go up as well as the energy demand will rise. This will put pressure on the mining sector to improve not only efficiency (to meet the power sector demand) but become more environment friendly so that the pressure on land resources is minimal.

Adaptation measures:

- Private sector initiatives leading to changes in standard operation procedures which are aligned towards reducing risks to mining operations due to climate change impacts. This can include improved facilities management and climate change concerns in the annual plan of individual companies.
- Formulating a localized climate model and conducting a vulnerability mapping of current and future mining operations towards natural hazards through data obtained from the model.
- Regular auditing of water consumption and energy requirement for all operations associated with mining.
- Developing access to new water resources and initiating water conservation strategies, reducing water evaporation in the mining townships and facilities and improving water use efficiency.
- Public-private partnership to develop legislation and policies promoting adaptation.
- Social & Environmental Compliance: The industry has a huge social & environmental impact. Adequate measures have to be taken to ensure environmental compliance which will be a key factor on the sustainability of the sector in the state. Along with environmental measures, land rationing & rehabilitation measures also have to be put in place for ensuring minimum quality of health for the people in the mining affected regions of the state.

10.6 SECTORAL ACTION PLAN AND BUDGET

For Mining sector action plan and budget please refer to Section C: Sectoral Action plans.

[44] http://intl-sae.sagepub.com/content/9/2/337.abstract

Chapter 11

POWER SECTOR AND CLIMATE CHANGE

State of Jharkhand is endowed with both conventional and non conventional sources of energy. Thermal power plants (mainly coal fired) dominate the existing energy mix of the state. In unorganized sector too, coal is the major source of thermal energy (purely for heating purposes). Big hydro and renewable sources add to the power generation capacity of the state. In renewable sector, apart from biomass and small hydro, state is also promoting solar power generation facilities.

A significant amount of power is generated by industries to support their respective operations through captive power plants, part of which is fed into the national grid after meeting the industry demand.

This chapter focuses on mitigation-adaptation issues related to electricity generation by public and private sector utilities in the state. Other form of energy, i.e. directly produced for transport requirements and domestic cooking and lighting requirements are discussed in Chapter 12 on 'Urban and Transport Sector'.

11.1 ELECTRICITY GENERATION

Electricity is the major driver of economic development; it fuels the industrial growth and promotes favourable environment facilitating individual's participation in economic development process. The With rise in agro-processing industries in the hinterland and ever increasing dependency of agriculture on irrigation, dependency on electricity for economic development in Jharkhand is at all time high and growing.

Total installed capacity of the Power Plants of Jharkhand State Electricity Board (JSEB) and *Tenughat Vidyut Nigam* Limited (TVNL) is 1336 MW, out of which 1190 MW is thermal 130 MW is hydro-electric and about 16 MW is solar. Thus the share of hydro-electric power in the state is only about 9.4% of total capacity against the national average of about 24%.

As per the data available with CEA, the electricity generation in the state has steadily increased overtime as both public and private entities have invested in adding electricity generation capacities. The electricity production in the state is displayed in the figures below.

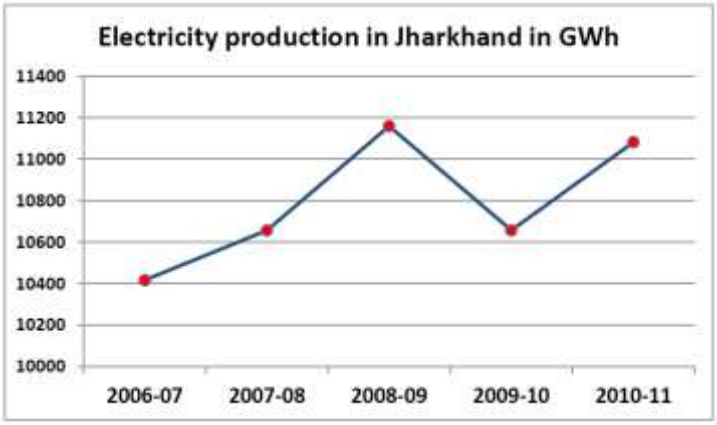


Figure 39: Electricity Production in Jharkhand (2006-2011)

The power generation in Jharkhand is dominated by state owned power plants, apart there are large power plants owned by centre and private entities. The private entities have invested in power generation both to meet their operational demand as well as for commercial electricity trading. The adjacent graph shows the installed capacity in Jharkhand state by State sector, Private sector and Central sector and other installed powers in the state.

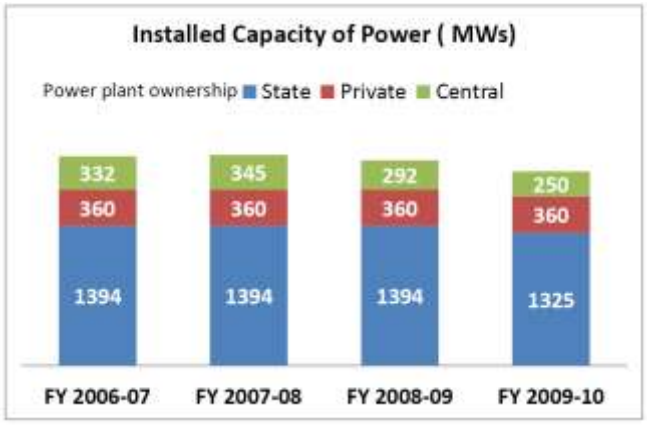


Figure 40: Electricity generation and installed power capacity in Jharkhand

A large amount of power is generated by private sector players to support industrial operations, such captive power plants (CPP) are promoted and supported under state industrial policy. An estimate indicates that in 2012, the total installed capacity of the thermal CPP in the state was approximately 4172.8 MWs and 22 such facilities were operational in the state[45] (this includes coal and waste heat recovery based plants) (see Annexure-6 for detail list of CPP projects).

Renewable energy in Jharkhand- The major sources of renewable energy in Jharkhand are biomass, small hydro and solar. Significant progress is made in power generation from renewable energy sources because of efforts put by ministry of New and Renewable Energy-Government of India and Jharkhand Renewable Energy Development Agency Ltd (JREDA)[46].

Jharkhand has an installed capacity of about 17 MW of Solar power, about 1.2 MW of biomass power and it has been proposed to install nearly 300 MW of Solar energy in the state in the next two years. At present total installed renewable energy is 1.19% of total installed energy capacity of state. The topography and climatic conditions of the state offers enormous potential for harnessing the biomass and solar energy. The vast river stretches also offers huge potential for small hydro plants[47].

Energy Department has also initiated work on promoting energy efficiency in the state. There are sectoral demand side management initiatives under way as also initiatives in industrial clusters to promote energy efficiency, opportunities are being explored for realising the potential of coal bed methane.

11.2 ELECTRICITY SECTOR ISSUES IN JHARKHAND

The state's per capita power consumption in the state is 552 units/pa, this is very low in comparison to national average of 720 units. Power consumption by high tension (HT) consumers is about 46.65% of the total consumption, whereas agriculture consumption is about 1.20%[48].

Although power demand of the state is low, still the state faces power deficit situation. The demand supply gap has been widening every year (the electricity demand-supply mismatch is displayed in the table below).

Table 37: Power availability and shortage in Jharkhand (Source: CEA)

[45] Secondary research, list of captive power plants provided in Annexure-6
[46] JREDA (Government of Jharkhand agency under Energy Department) has been entrusted with this task to promote development of renewable energy in the state.
[47] Communication from Chief Engineer, Energy Department, Ranchi
[48] Communication from Chief Engineer, Energy Department, Ranchi

	2009-10		2010-11		Apr 2011- Feb 2012	
	Energy (MUs)	**Peak** (MW)	**Energy (MUs)**	**Peak** (MW)	**Energy (MUs)**	**Peak** (MW)
Requirement	5867	1088	6195	1012	5,619	1030
Availability	5407	947	5985	1012	5,439	842
Shortage	-460	-141	-210	0.00	-180	-188
% Shortage	-14.4	-13.0	-3.4	0.00	-3.2	-18.3

The current deficit of power is to the extent of 200-400 MW. Clearly the state is struggling to meet the electricity demand in the state. At this juncture when Jharkhand is trying hard to pursue investment, the rural and urban consumption is set to move northwards, the power deficit has the potential to derail the economic growth.

The major cause of power deficit in the state is transmission and distribution (T&D) losses. The national level T&D losses range between 22-27% during 2007-2012 whereas for the same period Jharkhand's T&D losses ranged between 41.99-30.89%. The state is investing in reducing the T&D losses and for the year 2012-2-13 the Jharkhand State Electricity Board's (JSEB) T&D losses will be lower than the previous years and estimated to be at 29.25% (FeedbBack Infra, 2012).

To achieve the national average per capita consumption, the State would require over 2400 MW of new capacity with an investment requirement of over Rs. 12000 crores. To match supply and demand, the state has planned many initiatives to increase the energy generation and to reduce the transmission and distribution losses. It is expected that by 2015-16 Jharkhand will be able to match the supply and demand of the state and would be able to generate energy in surplus.

11.3 ENERGY POLICY OF JHARKHAND

In order to contain the energy issues and put the state on accelerated growth track, Energy Policy 2012 for the state was designed. The key objectives of the Energy policy include providing access to electricity to all households as well as fully meeting the power demand by 2014, increasing the per capita availability of electricity to 1000 units by 2017, optimization of power generation of existing plants, encouraging eco-friendly generating units, encourage efficient use of electricity and efficient transmission networks among others.

Renewable energy focus of energy policy: The energy policy of the state envisages that for areas where grid supply will be uneconomical, power supply through renewable energy is proposed. Specific to renewable, a separate solar policy for the state is in process of development.

Access to energy: The policy envisages to increase rural penetration of electricity use by encouraging households to switch to grid supplied electricity. Incentive mechanism are in place to achieve 100% rural electrification, specifically this includes 100% household coverage and a minimum of 10 hours supply to rural areas.

Focus on energy conservation through demand side management: The energy policy proposed for compulsory audit for all major industrial and large commercial establishments. It also puts thrust on initiating measures to increase efficiency of agricultural pump sets and electrical installations, promoting use of energy efficient equipment and energy efficient buildings and organizing awareness campaign.

Capacity addition through plant modernization: The energy policy of the state focuses on improving capacities of the existing plants by investing in plant modernization. It is projected that by modernization alone, the state will be able to add 200 MW of power generation capacity by the end of 2012.

11.4 GHG EMISSIONS OF ENERGY SECTOR IN THE STATE

Thermal power plants in the state of Jharkhand mostly run on coal. The GIG emission foot printing of the coal based power plants in Jharkhand is displayed in following figure, the actual GHG footprint is based on the numbers available at the CEA website.

Considering the fact that the state's Energy Policy (2012) favours coals based power plant, it's assumed that the coal fired power plants will generate majority of power in the state in years to come. Based on such assumption, the GHG footprint of the state power sector is estimated for next four decades.

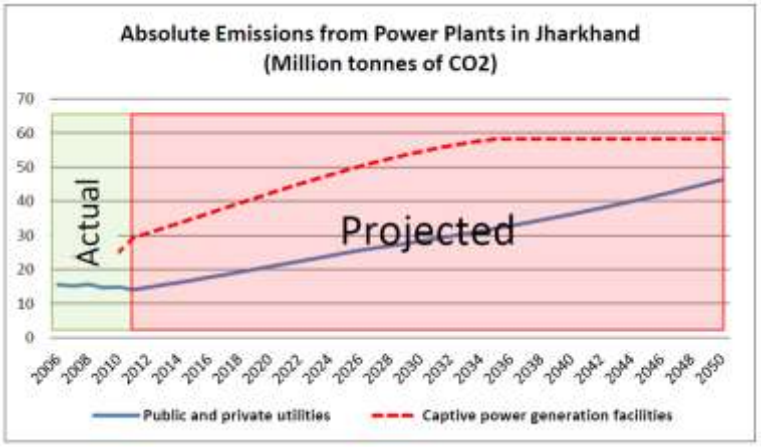


Figure 41: Actual and projected GHG emission trajectory from power plants in Jharkhand

Keeping state's power scenario and growth trends in consideration, emission footprint of the power plants is projected till year 2050. And it is estimated that the net GHG emissions will reach almost 105 million tonnes of CO_2 equivalent from the current 44 million tonnes of CO_2 (estimations refer to year 2010-2011)

Apart from the direct emission from electricity generation, a large amount of emissions take place from fuel (especially diesel) to meet the power deficit situation. The findings of the survey of private firms in Jharkhand, as part of the 'Third Investment Climate Survey -2005/06' indicates that on average, firms in Jharkhand face over 38 power outages every month, this number is more than double the number of outrages faced by firms in rest of India. To manage the operations during times when electricity from grid is unavailable, the firms have to depend on generators running on petroleum and this result in huge GHG emissions (Poverty Reduction and Economic Management-India Country Management Unit, 2007).

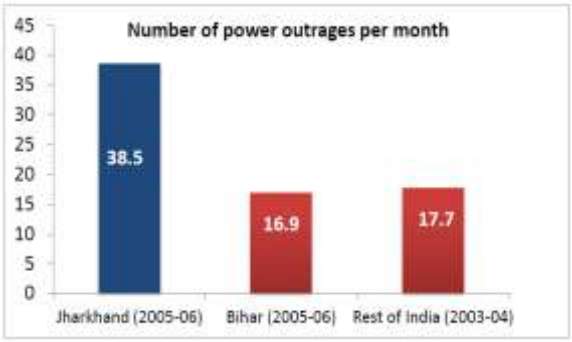


Figure 42: Number of power outrages-Comparison of situation in Jharkhand

11.5 IMPACT OF CLIMATE CHANGE ON POWER SITUATION

Power sector is sensitive to temperature changes and water availability; the shift in temperature not only influences the power demand but also affects the efficiency of the power generation facilities. The impact of climate change on the performance of electricity generation facilities is described in following section.

11.5.1 IMPACT ON POWER CONSUMPTION

A study by Filippinia & Pachauri (2004) based on the NSSO data measured the impact of temperature rise on domestic electricity use in Jharkhand predicted that with rise in temperature the cooling demand in the state will

go up thus resulting in high electricity demand during summer month as during the summer months, because of the high temperatures, the use of air conditioners and air ventilators is very intense and necessary (Filippinia & Pachauri, 2004).

Increase in summer temperatures will most likely increase the summer peak electricity demand, excess power will be required to meet the cooling requirements of the office and residential spaces and commercial establishments. Since summer season demand surge will be witnessed across the country hence regional generation facilities will have to be promoted in order to maintain the quality and quantity of electricity reaching consumers. This would require investments to promote facilities that can support additional electricity during peak demand periods.

Based on the results of Filippinia & Pachauri study results for Delhi region (Filippinia & Pachauri, 2004), climate change linked power demand projections are made for the state of Jharkhand. Three climate change scenarios are considered, in scenario 1 (which is the most conservative estimate), its projected that the average temperature in the state will go up by 1.5°C by the year 2050, and this will increase the domestic electricity demand for cooling by almost 2.5% (with respect to the baseline consumption). In scenario 2 and 3, the average projected temperature rise will be 1.8°C and 2.1°C and the resulting electricity demand for cooling will go up by 3.1 and 3.5% respectively.

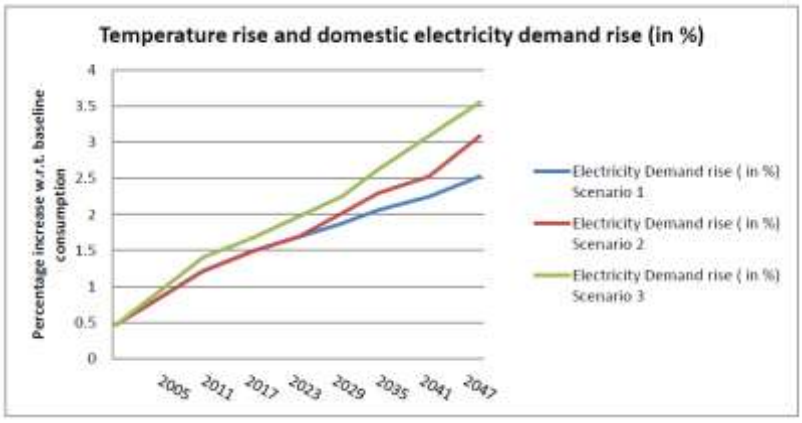


Figure 43: Projected impact of temperature rise on domestic electricity demand in Jharkhand

Further to it, the rising temperature will also increase irrigation frequency, this will surge demand of energy for water management. Temperature rise will result in high water evaporation and this will result in increased irrigation frequency to maintain soil moisture at levels that support plant growth.

11.5.2 WATER AVAILABILITY

Among various sectors, power generation depends heavily on water and is one of the largest consumers of water. Water shortages result in power generation losses; in summer of 2010, not only hydro capacity but also over 6,400MW of thermal capacity was adversely affected by water shortages in the country. A joint study by World Resource Institute (WRI) and HSBC[49] indicated that 79% of the new generation capacity to be built by three key power generation companies in India is located in water scarce or stressed areas. Hence in future water crisis will have severe implications on the power management in India (FICCI-HSBC, 2012).

The following figure depicts the IPCC Scenario A1B, according to this by 2025 the state will face extreme stress having repercussions on the operational performance of the power generation facilities.

[49] The joint report by WRI and HSBC is titled as 'Over Heating'

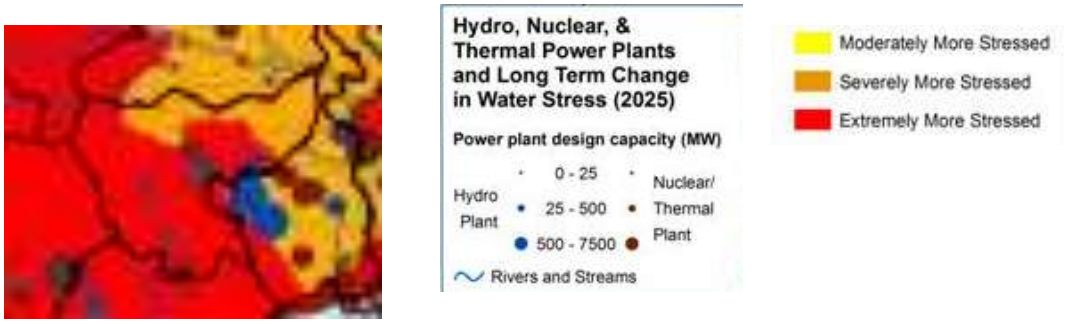


Figure 44: Long term change in water stress and power plants (2025 IPCC Scenario A1B)[50]

11.5.3 HIGHER TEMPERATURE LEADING TO REDUCED EFFICIENCY

Higher temperatures tend to reduce the efficiency of thermal power stations, of particular interest in the state of Jharkhand given its overwhelming reliance on thermal technologies for power production. Heat engine performance is fundamentally driven by the temperatures of the hot source and the cold sink to which heat is rejected. The rising temperature will decrease the electricity production efficiency of the fossil fuel based power plants. Water is used in these plants for cooling purposes, the colder the water, the more efficient the generator. The thermodynamic cycles in the power plants are inherently inefficient, the water temperature difference have the potential to further reduce efficiency of the power generation units. Thus, higher air and water temperatures could reduce the efficiency with which these plants convert fuel into electricity.

The 4th Assessment report of the IPCC reports that "Climate change could have a negative impact on thermal power production since the availability of cooling water may be reduced ...". The main finding is that the power output decrease by about 0.45% and the thermal efficiency by approximately 0.12% for 1°C increase in cooling water extracted from environment (Held, Strepp, Patt, Pfenninger, & Lilliestam, 2012).

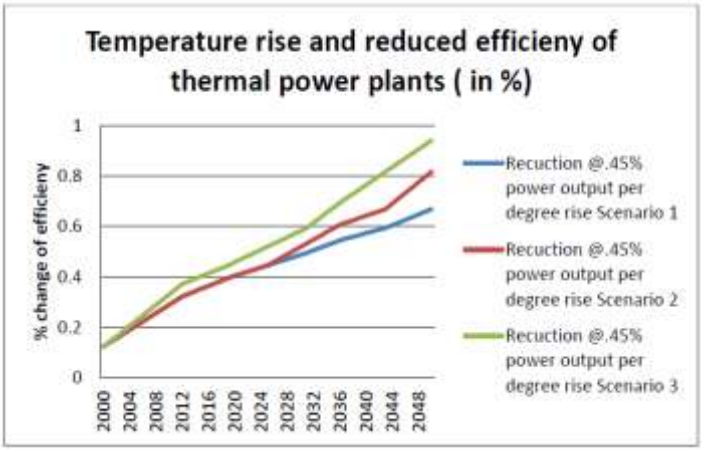


Figure 45: Temperature rise and its impact on energy output from thermal power plants

11.5.4 RAINFALL EFFECT ON FUEL MINING AND TRANSPORTATION

Going by precedents, too much rainfall can degrade the quality of coal stockpiles by increasing moisture content. It can also affect mining and transportation of coal. In August- September 2011, heavy rainfall caused enough damage to roads and mines in Jharkhand, Orissa and West Bengal to disrupt large scale coal production and transportation operations. Coal transportation came to a halt as bridges and rail lines were damaged (PTI, 2011). There are concerns that changing weather patterns may spread rain more equally throughout the year, with no dry season to make up for wet season losses (Bose, 2012).

[50] http://insights.wri.org/aqueduct/2012/08/4-ways-water-connected-indias-blackouts[50]

11.5.5 CLIMATE CHANGE'S IMPACT ON HYDROPOWER PLANTS

Hydropower plants will also be directly affected by any changes in precipitation and temperature. As reservoir capacity gets affected because lower river flow, hydropower generation will dwindle. Power generation from the Damodar Valley Corporation's Tilaiya, Maithon and Panchet dams suffered badly due to draught like conditions during the period 2009-2011 (PTI, 2011).The impact is more severe on small hydropower projects as they depend on seasonal rivers, which can dry up quickly with higher temperatures and recurring droughts.

11.5.6 IMPACT OF CLIMATE CHANGE ON RENEWABLE ENERGY SOURCES

There is little evidence based studies on impact of climate change on efficiency of wind and solar energy.

Impact of climate change on Solar power plants: The electricity generation from Solar PV system depends on intensity and wavelength of spectrum of solar radiation reaching the Earth's surface which in turn depends on the location's latitude, cloud cover, air borne particles, smog, soot and time (time of day and year).

The climate change models predict rising temperature's impact on cloud cover. Under cloud cover, solar-thermal and photovoltaic (PV) systems deliver only a fraction of their energy compared to that under clear sky conditions. The operation of PV-devices is also dependent on meteorological parameters such as ambient temperature, wind, and relative humidity (Clouds, aerosols, and increased ultraviolet radiation alter the sunlight spectrum, which may mean that adjustments to the PV-cells are necessary.

Impact of climate change on wind power plants: As wind turbines are highly dependent on wind speed, any change in wind variability and intensity would influence the wind-energy potential and this will have an effect on the degree to which wind resources are economically viable. The impact of rain may also be important as wind-turbine efficiency will be reduced, by as much as 20%, with only light rainfall (Lundahl, 1995).

11.5.7 ENERGY FROM RENEWABLE SOURCES

Current climate models provide little detail on future changes in wind and solar insolation. Hence, the discussion here is more of a speculative nature than the discussion on hydropower and bio energy. The intensity and wavelength spectrum of solar radiation reaching the Earth's surface are governed by the degree of latitude, cloudiness, atmospheric aerosol composition, and time of day and year. Greenhouse-induced changes in cloud cover are uncertain. The picture is further complicated by atmospheric aerosols affecting cloud reflectivity and lifetimes. Aerosols also change the radiation balance through their direct backscattering effects. The speculative impact of climate change on renewable energy sources is captured in table below.

Figure 46: Climate change impact on various energy sources (Bull, Bilello, Ekmann, Sale, & Schmalzer, 2008)

RE Power generation facility		**Impact of climate change**
Renewable	Hydropower	Water availability and quality, temperature-related stresses, operational modification from extreme weather (floods/droughts)
	Wind	Wind resource changes (intensity and duration), damage from extreme weather
	Solar	Insolation changes (due to clouds), damage due to extreme weather

11.6 CLIMATE CHANGE ADAPTATION MEASURES FOR POWER SECTOR IN JHARKHAND

Adaptation measures: In view of the expounded challenges to thermal power stations that arise from future climate change impacts, the question arises how power plants can be adapted in order to deal with anticipated future developments. Some adaptation measures that can help the power sector to cope with the changing climate are as following:

Alternate and cleaner sources of electricity:

Focus on renewable for power generation: Jharkhand is highly dependent on thermal and partially on hydro energy. The state has some RE portfolio, but given the fact that the country has aggressive RE targets and strategies. Jharkhand can work on increasing the contribution of RE in the state's energy mix.

Strategies to encourage RE based energy projects may include-

- **Promoting and incentivizing renewable energy:** Jharkhand Government realizes the potential of renewable energy and has formulated energy policy for solar and biomass energy to promote investment in the state. Though Jharkhand Government has set ambitious renewable purchase obligation (RPO) targets; the implementation of projects in the long run need to be ensured by bringing in more investment through policy incentives.
- The state with many small rivers and streams offers good opportunity for small hydro project. To increase hydro power generation, 66 potential sites have already been identified in the state. Private entities, non-governmental organizations and local bodies shall be encouraged to tap energy from mini/micro hydro projects wherever feasible[51].
- **Awareness and capacity Building:** Capacities of different stakeholders need to be built on renewable energy aspects i.e. generation handing, maintenance, operations research and development activities. The renewable energy can be effectively developed as an off-grid power solution for the remote villages. Cost effective handy RE products also have huge potential in urban areas, public buildings and institutions can be used as a demonstration projects for RE options (e.g. solar lighting, solar water heating etc).

Power Generation from 'Coal Washery Rejects': Jharkhand has large reserves of coal and consequently there are a large number of coal washeries operating in the state. Rejects from the coal washeries can be used for power generation in Jharkhand. Coal washery rejects have calorific value as low as 1500 Kcal/ kg and also create serious environmental and disposal problems. As a step to mitigate the environmental problem, washery rejects can be gainfully used as a fuel for power generation. The washery rejects can be burnt in a specially designed fluidised bed boiler to generate steam for producing power. This has already been successfully implemented in a number of coal washeries of Coal India Ltd such as Rajarappa, Gidi and Madhuban. The low calorific value of rejects is offset by the low price of handling of rejects thus making the power project a viable option. New technologies of burning such low value rejects are being adopted in countries such as China which can be gainfully used in Jharkhand washeries.

Coal Bed Methane (CBM) in Jharkhand: CBM can be used in new thermal power plants on count of lower capital investment and higher operational efficiency. It can also be used as a fuel for co-generation power plants to bring in higher efficiency. On the basis of predicted per day recovery from the identified CBM blocks in Jharkhand, 800MW of power generation is possible.

Table 38: Coal Bed Methane resources available in Jharkhand

Coalfield / Block	Area of delineated Block (sq km)	Prognosticated CBM Resource (billion cubic meter)
Jharia	69.20	68.16
East &West Bokaro	93.37	45.02
North Karanpura	340.54	61.75
TOTAL	503.11	174.93

There is also a demand of 50,00,000 Nm^3 of natural gas/CBM in the state for industrial purposes. CBM can also be used in the production of steel, fertilizer and methanol. Currently, ONGC is producing 5,000 cubic meters of gas from the Jharia block and is in the process of raising it to 15,000 cubic meters.

[51] Communication from Chief Engineer, Energy Department, Ranchi

Improving efficiency of existing facilities:

Jharkhand's electricity generation is dominated by inefficient coal based power plants which constitutes about 53% of the generation capacity. Since most of the coal power plants in the country, including Jharkhand, use sub-critical technology, which have low efficiencies. The net efficiency of coal plant fleet in the country in 2003 was just 29 percent (compare this with 33 percent efficiency in the United States (Rao, Sant, & Rajan, 2009)).

At the country level, several measures are being taken to increase the efficiency of these coal plants. Several Renovation and Modernization (R&M) and life extension programs have led to the overall improvement of the Plant load factor (PLF) of Thermal Power plants. Hence there is huge potential of improving performance of the power plants in the state.

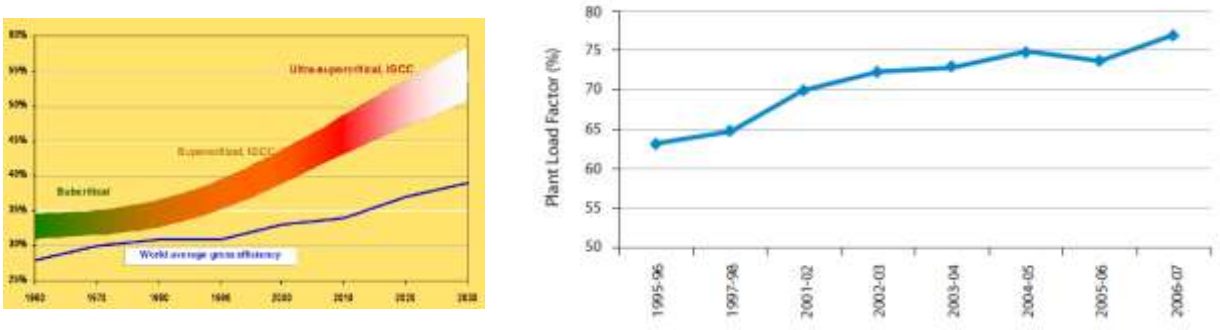


Figure 47: Efficiency of coal fired power plants and plant load factor

Renovation and Modernization of Existing Power Plants: For existing power projects, renovation and modernization of the plants requires to be undertaken for upgrading capacity and improving efficiency of the plant. If the state doesn't see much value in investment in technology up-gradation, it is suggested to opt for a success fee model wherein the private developer takes over existing facilities of the power plant and brings in fresh investments, technology and expertise to renovate and modernize the power plant.

Reduction of T&D losses: Electricity losses during Transmission and Distribution process in the state have ranged between 46.77 -32.87% during the period 2003-2012, although the losses are declining but they are still very high. Other electricity utilities operating in the state JUDCO and TSL have achieved T&D loss of 7.79% (year 2010-11) and 2.61% (proposed for 2012-12) respectively (FeedbBack Infra, 2012). There is huge potential of reducing the T&D losses through technical measures and appropriate legislation.

Pumps with higher capacity for thermal power plants- Thermal power plants using water pumps with higher capacity could significantly reduce warming-up of cooling water flowing through the condenser by pumping higher volume of cooling water.

However, the water withdrawal is limited by the naturally available amount of water. On the other hand environmental regulations stipulate how much water is needed bypassing the power plant without passing through it. Furthermore the pumping capacity is determined when constructing the power plant and an upgrading with a new or enlarged cooling system is difficult and expensive. Therefore, the increasing of withdrawal capacities can be a possible adaptation measure, but should rather be considered, similar to the choice of the location, mainly for the construction of new power plants.

Improving water footprint of the power plants:

Alternative cooling systems in thermal power plants: Water use efficiency will be critical for performance of the power plant in scenarios when water availability is under stress. With regard to long term adaptation approach, switching of cooling systems from 'once-through' to 'closed loop systems' is recommended. Systems with cooling towers are considered to be much less vulnerable towards temperature increases and the involved impacts of climate warming such as declining water availability and increasing stream water temperature (Koch and Vögele, 2009).

Source of cooling water for thermal power plants- Another measure to improve water-efficiency in power plants could be the reuse of secondary/treated municipal waste water and ash pond effluent. Further it is recommended to enable power plants to produce some of their own water, i.e. by using the thermal discharges.

Energy demand management:

Peak Demand Management: With changing temperature, peak demand for power is also expected to rise. Hence a robust peak demand management approach is required to reduce pressure on power generation facilities.

Demand side energy management: In Jharkhand immense amount of energy saving potential exists as energy use in households and industries is highly inefficient. The estimated magnitude of such saving potentials will be addressed in chapters on industry and domestic sectors focussing the demand side of electricity. It is suggested that various demand side energy (DSM) management instruments are applied for containing the rising energy demand in the state[52].

Other options:

Different choice of location for establishing thermal power plants: New power plants coming up in the state have the advantage of choosing locations that are less vulnerable to climate change linked impacts. The new plants can be located at places where temperatures are relatively lower, such sites will help the power generation facilities to isolate themselves from water temperature linked efficiency issues. For site selection of renewable power sources (wind and solar) elaborate site selection guidelines already exist that consider existing and future weather pattern shift during the project design phase itself.

11.7 SECTORAL ACTION PLAN AND BUDGET

For Power sector action plan and budget please refer to Section C: Sectoral Action plans

[52] DSM approach essentially reduces the power demand by improving efficiency of the appliances through technological innovations or process modifications.

Chapter 12

JHARKHAND- URBAN AND TRANSPORTATION SECTOR AND CLIMATE CHANGE

12.1 POPULATION CHARACTERISTICS OF THE STATE

As per the 2011 India census, Jharkhand's population is close to 3.2 crores which is 3.5 percent of India's total population. This population resides in 32,394 villages and 228 towns[53]. About 76% of state's population lives in rural areas[54] (in comparison nations 69% population is rural[55]). Most importantly, state's 28% population is tribal in comparison all India average of tribal population is just eight percent[56].

The urbanisation however has picked up after the formation of new state due to increase in economic activities in the urban areas. The rural urban population divide in the state is fast filling up and the urban population has increased by 32.29 % in last 10 years. It is estimated that the urban population of Jharkhand will reach 93 lakh by 2026[57].

Table 39: Decadal growth of population in Jharkhand[58]

	Yr 1981-1991	Yr 1991-2001	% Decrease
Urban	29.86%	28.99%	0.87%
Rural	22.54%	21.62%	0.92%
Total	24.02%	23.19%	0.83%

Table 40: Urban population trend in Jharkhand (Kundu, 2006)

	Percentage urban population					Annual exponential growth rate			
	1971	1981	1991	2001	2011	1971-81	1981-91	1991-01	2001-11
Jharkhand	16.01	20.29	21.25	22.25	24.05	4.61	2.61	2.55	-

The recent population figures indicate that there is 'negative decadal growth' in urban and rural population. From annual exponential population growth numbers in Table 87 and figure 88 in next page it's clear that the growth rate of urban population is declining. The data from the National Sample Survey (NSS) confirms the above observations. Also there is declining trend of migration of males, both in rural and urban areas (Kundu, 2006).

[53] http://censusindia.gov.in/2011-prov-results/data_files/jharkhand/leaflet.pdf
[54] http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/Jharkhand/4-CHART_PAPER-II.pdf
[55] http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf
[56] http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1181699502708/fullreport.pdf
[57] http://www.uhrc.in/downloads/Jharkhand_wall_chart.pdf
[58] http://www.jharkhand.gov.in/new_depts/ap201011/Urban_Devlop201011.pdf

Figure 48: Urbanisation Trend in Jharkhand (Source: National Family Health Survey, 2005-06)

A large urban population in the state resides in slums, estimates by the Jharkhand government puts the slum population at around 40 per cent of the total urban population. However planning commission estimated slum dwellers to be 12% of total urban population in 2011. With rise in migration from rural localities, the slum population is slated to go up in future and its estimated that it will increase to 1.037 million by 2017 from the current 0.932 million (Planning Commission, 2011).

Table 41: **Jharkhand's Projected Slum Population from 2011 to 2017 (in millions)** (Source: Planning commission 2011)

State	2011	2012	2013	2014	2015	2016	2017
Jharkhand	0.932	0.949	0.966	0.984	1.001	1.019	1.037

The rural demography and trends are discussed in Chapter on agriculture.

12.2 TRANSPORT SECTOR IN JHARKHAND

Figure 49: Vehicles on Jharkhand roads

The vehicles on the roads of Jharkhand are growing at rapid rate, between 2001 and 2006 alone the vehicles in the state have gone up by 165% (from 9 lakhs to 15 lakhs)[59]. It is expected that the trend will continue in coming

[59] http://morth.nic.in/writereaddata/linkimages/SSL_RoadTransport2006_07_Book292768426.pdf

years and stabilize overtime. Using exponential growth function post 2020 it is projected that there will be about 46 lakh vehicles on state roads by year 2050.

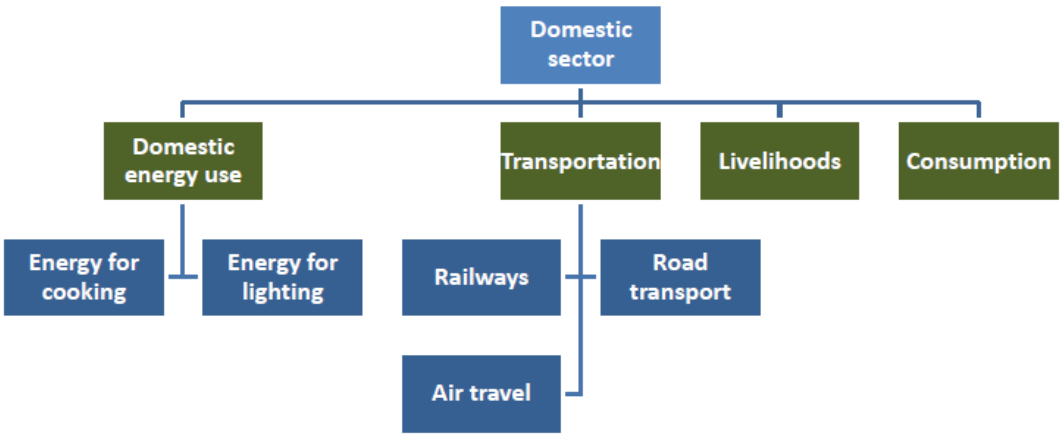
Roads are the major means of transportation in the state. The total length of National Highway, State Highway and others metalled roads in Jharkhand is 8724 km. While that of district roads and rural un-metalled roads is 24,300 km (Department of Planning and Development, 2011).The total rail length in the state is 1053 km, thus for every 100 sq km of area, there is 2.5 km of railway route length in the state.

The air-connectivity in the state is poor, although the capital city is well connected to major North Indian cities, other important cities like, Jamshedpur, Dhanbad, Deoghar, Chakulia and Bokaro although have requisite infrastructure (air strips) yet are not well connected.

12.3 IMPACT OF HUMAN SETTLEMENTS ON CLIMATE CHANGE

12.3.1 URBAN SECTOR EMISSION FOOTPRINT

The urban sector is one of the largest contributors of GHG emissions; services and products used by the population result in emissions during the consumption as well as during the disposal process. The various emissions that are considered for calculating the GHG footprint of the urban sector for Jharkhand include:



In order to account for the contribution of urban areas to climate change, Jharkhand's urban sector (restricted to urban areas) emissions of GHGs are calculated.

The emissions from urban energy sector are calculated by considering the energy that is used for lighting and cooking at home. The other major GHG contributor is transportation sector; fuel used in road transportation, emissions by railways and air traffic are considered for calculating the emissions from state transportation.

There are numerous other economic activities that result in GHG emissions, not all activities are considered for emission calculation due to paucity of information; direct methane emissions from cattle rearing activities by the urban cattle population is used for calculating the livelihood sector emissions. To calculate consumption linked emissions, total households waste generated in Jharkhand is used as proxy to represent resource consumption.

The livelihood linked emissions (from agriculture, agriculture-allied and enterprises has been discussed in Chapter on agriculture and Chapter on industries).

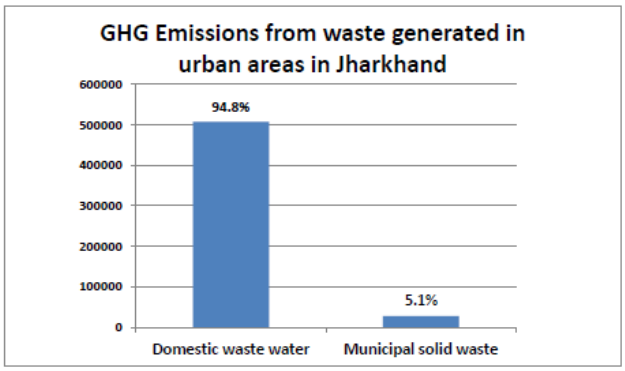


Figure 50: Urban sector GHG emissions from MSD and waste water

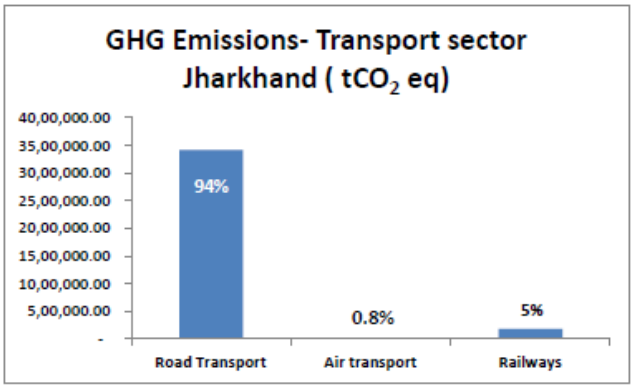


Figure 51: GHG emissions from transport sector in Jharkhand

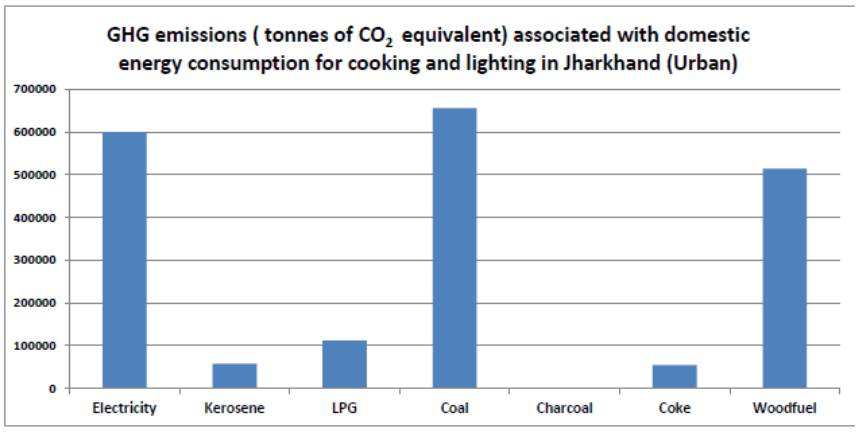


Figure 52: Urban sector GHG emissions from fuel used during cooking and lighting (pertaining to year 2005-06)

The net emission of the urban sector in Jharkhand is ~25 million tonnes of CO_2 equivalents. Urban cooking and lighting is the biggest contributor with 58% sector emissions, this is followed by the transportation sector that contributes to approximately 39% of the sectoral emissions (see Figure-53).

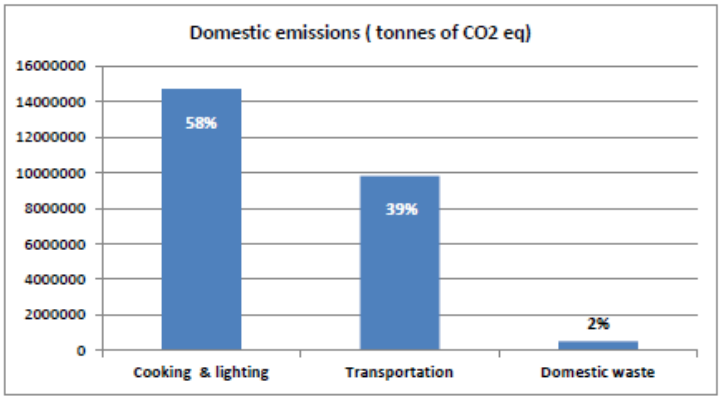


Figure 53: Urban sector GHG emissions from cooking, waste generation and transportation (pertaining to year 2005-06)

12.3.2 URBAN WATER DEMAND

The water use is lifestyle linked and directly proportional to the economic status of household, hence the water demand in urban localities is slated to go up considerably in coming years. The economic development will not only improve household's economic conditions but also attracts people towards cities; resulting in steep rise in urban water demand.

With increasing household income and increasing contributions from the service and industrial sectors, the water demand in the urban and industrial sectors could increase substantially. At the country level, it is projected that average urban water demand would increase from 85 liters per capita per day (lpcd) in 2000, to 125 and 170 lpcd by 2025 and 2050, respectively (Amarasinghe, Shah, & Anand).

The same estimations are used to develop water demand scenarios for the state of Jharkhand considering BAU with low and high demand estimations. It should be noted that the urban water demand also includes the water use of livestock management.

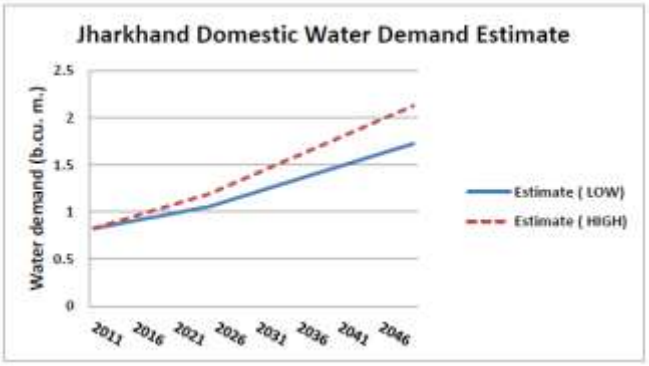


Figure 54: Estimated water demand for urban sector- Jharkhand[60]

12.4 CLIMATE CHANGE IMPACT ON URBAN SECTOR

Climate projections for India (Table-42) show significant rise in annual temperature of India and an increase in annual precipitation.

[60] Based on national estimations (Mall, Gupta, Singh, Singh, & Rathore, 2006)

Table 42: Climate change projections based on four GCM outputs for India (Agarwal and Lal (2001) cited in Revi (2008))

Year	Temperature Change (°C)			Precipitation Change (%)		
	Annual	Winter	Monsoon	Annual	Winter	Monsoon
2020s	1.36±0.19	1.61±0.16	1.13±0.43	2.9±3.7	2.7±17.7	2.9±3.7
2050s	2.69±0.41	3.25±0.36	2.19±0.88	6.7±8.9	-2.9±26.3	6.7±8.9
2080s	3.84±0.76	4.52±0.49	3.19±1.42	11.0±12.3	5.3±34.4	11.0±12.3

Provisioning of amenities such as water, food, energy and sanitation is going to become complicated under these changing climate scenario. The climate extremes can have significantly large negative impact on urban centres because of greater concentration of population, building and infrastructure in urban areas.

12.4.2 HEAT WAVES AND RISING TEMPERATURE

Increase heat waves and temperature would also increase the use of air conditioning which might increase energy shortage. Increased use of air conditioners can also add more greenhouse gases to the atmosphere since most electricity is currently produced by burning fossil fuels. The impact of rising temperature on power situation is discussed in Chapter on Power.

In Jharkhand, 30 percent of the urban population do not have access to clean water which increases their vulnerability towards water scarcity and pollution. 22.2 percent population does not have good quality of wall material while the households with low grade of roof material are very high.

Table 43: Household conditions in urban regions of Jharkhand (Census, 2011)

Type	Total Urban HHs	% HHs with lower grade material	Remarks
Material of roof	1495642	3.8	Households with roof material Grass/Thatch/Plastic/Polythene/
Material of wall	1495642	22.2	Households with wall material Grass/Thatch/Plastic/Polythene/Mud/Un-burnt Brick
Source of drinking water	1495652	30.5	Tap water from untreated source/uncovered well/spring/canal/river/tank/pond/lake/

Jharkhand has witnessed weather anomalies in recent past. Jharkhand experienced the highest number of heat waves in 2000-2010 mainly affecting the urban poor. In addition there were instances of flash flood and heavy rains.

Table 44: Recorded Heat Waves in Jharkhand (Jharkhand Disaster Management Plan, 2011)

Year	March	April	May	June	Mar-June
2004	16	6	4	3	29
2005	12	1	8	20	41
2010	15	19	4	12	50

A large population in the state are not well equipped or do not have access to resources and services that can protect them from natural furies and weather anomalies.

12.4.3 CLIMATE CHANGE AND RISK OF FLOOD

Many cities in Jharkhand have faced flood or flood like situations in resent past. Year 2008 witnessed heavy rainfall and 1,00,000 people got affected in the cities of Ranchi and Jamshedpur alone. During the monsoon season, rivers Damodar, Kharkai, and Suvarnarekha – received water exceeding their capacity thus increased

flood threat to Ranchi and Jamshedpur cities[61]. In 2008 Jamshedpur got flooded due to heavy rains in the adjoining regions Orissa[62]. During the monsoon in 2011, low lying areas of Ranchi, Gumla, Loharanga, Simdega, East and West Singhbhum and Saraikela-Kharsawan got inundated completely disturbing the economic routine of the individuals, institutions and industries[63]. Nature's fury was repeated in September 2012 and city of Bokaro got flooded due to heavy rains[64].

The draft State Disaster Plan 2011 has listed 11 districts of the state which are vulnerable to floods.

Table 45: Projected climate change during the next century over India (Mall, Gupta, Singh, Singh, & Rathore, 2006)

Region	Climate change	Rainfall
All India	• Increase in winter temperature by 1–4°C with increased CO2 concentration	• Precipitation increase of approximately 20% • Increase in heavy rainfall days during the summer monsoon period and an increased inter-annual variability
All India	• Average temperature change is predicted to be in the range of 2.33 to 4.78°C, with a doubling in CO_2 concentration	• Increase in frequency of heavy rainfall events
All India	• Area-averaged annual mean surface temperature rise is projected to range between 3.5 and 5.5°C by the end of the century • More warming in winter season	• Increase of about 7 to 10% in annual mean precipitation • Decline of 5–25% in winter precipitation • Increase in monsoon precipitation is 10–15% • Monsoon season over northwest India – increase of 30% or more in rainfall by 2050 • Western semi-arid regions of India could receive higher than normal rainfall in a warmer atmosphere • Decrease in winter precipitation between 10 and 20% over central India by 2050

All the three climate change linked projections predict that the precipitation will increase significantly as temperature rises as warmer climate will accelerate the hydrologic cycle and alter rainfalls trends, also the spread of rainfall will change and monsoon rains will increase. Most importantly, frequency of heavy rainfall events will increase.

Heavy and intense rainfall can cause urban flooding and infiltration of logged water into groundwater. These events could add to the functioning of Urban Local Bodies and revised urban planning with high premium might be required to incorporate climate change into their decision making leading to additional costs. This could also affect the transportation system by damaging roads and pavement, disrupting traffic by creating congestion, road blocks due to landslides and mudslides and also affect emergency evacuation operations.

Jharkhand which is already vulnerable due to flooding (and flash-floods), will increasingly be exposed to nature's fury due to climate change. The state's infrastructure and city designs have no provisions for planned water drainages systems[65], the rainfall pattern changes will affect the economic performance of the state as cities life and other communication infrastructure will increasingly face disruptions due to rainfall and flooding.

[61] http://www.hindustantimes.com/News-Feed/Archived-Stories/Jharkhand-blames-Orissa-for-flood-calls-out-army/Article1-318309.aspx
[62] http://www.hindustantimes.com/News-Feed/Archived-Stories/Jharkhand-blames-Orissa-for-flood-calls-out-army/Article1-318309.aspx
[63] http://articles.timesofindia.indiatimes.com/2011-09-24/ranchi/30197677_1_danger-mark-flash-floods-low-lying-areas
[64] http://ibnlive.in.com/news/heavy-rains-lash-jharkhand-bokaro-flooded/289122-3-233.html
[65] Jharkhand Disaster Plan 2011

Table 46: Vulnerable urban infrastructure and impacts of climate parameters (Source: Regmi and Hanoka 2009)

Vulnerable Infrastructure	Bridge	Drains	Rail tracks	Pavement	Culvert	Side slopes	Airport	Road Signs
Temperature	✓		✓	✓			✓	
Precipitation								
Winter	✓	✓	✓	✓	✓	✓	✓	✓
Summer	✓	✓	✓	✓	✓	✓	✓	✓

12.5. ISSUES AND CHALLENGES: URBAN SECTOR AND TRANSPORTATION

Urban sector: According to the National Sample Survey Organization (NSSO), 13.2 lakh persons comprising 20.2 per cent of the state's urban population live below poverty line[66].

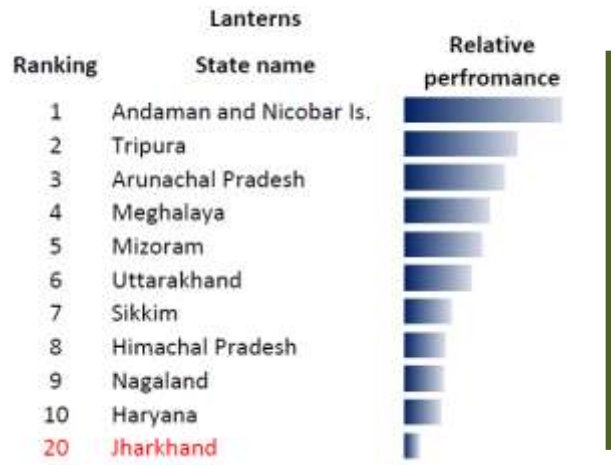
An analysis of migration history for the sample, however, suggests that as many as 60 percent of the households have recorded livelihood migration over the 20-year period between 1985 and 2005. Of these, about 4 percent moved to a different district within the state and another 4 percent to a different state, indicating that most of the migration has taken place within the same district[67].

Apart from migration, Jharkhand remains among the most food-insecure states in the country[68].

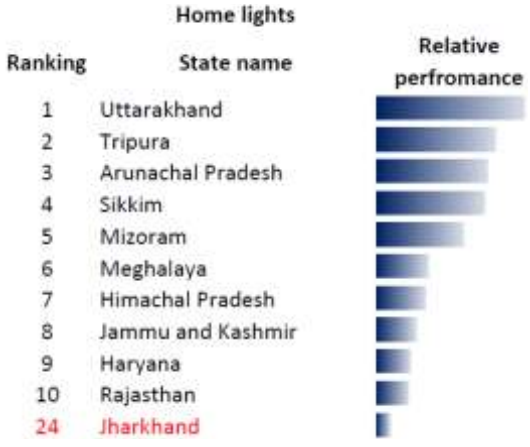
Estimates based on NSS data suggest that household access to electricity at 11 percent is extremely low in rural Jharkhand, compared to 48 percent for rural India (the only state that has a lower access rate than Jharkhand is Bihar).

The penetration of clean energy options is low in Jharkhand. An analysis based on the World Energy Council report suggests that the penetration of solar photo voltaic (SPV) technologies in Jharkhand is one of the lowest when compared to other states in the country.

Status of installation of domestic/ urban SPV systems

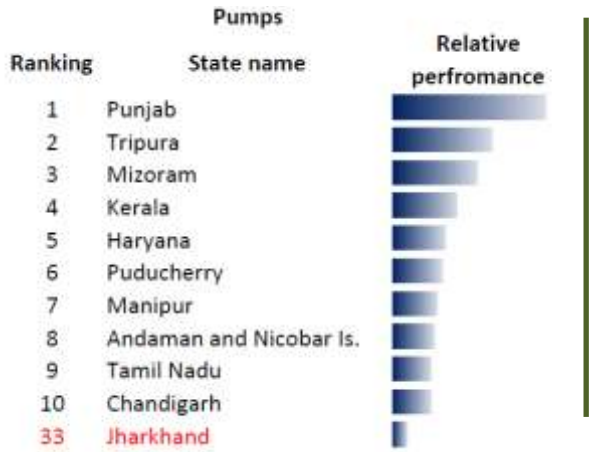


Household SPV lantern: Relative performance of Jharkhand

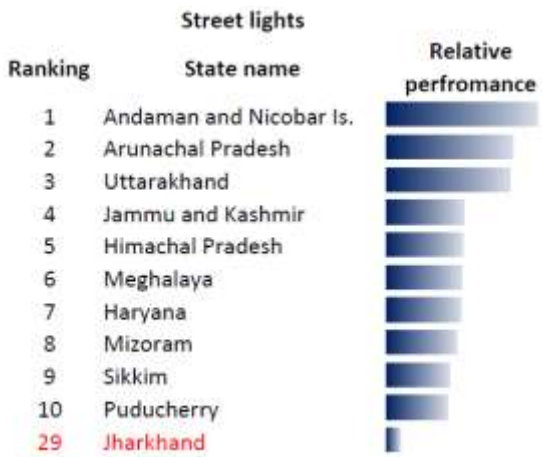


Household SPV Home Lights: Relative performance of Jharkhand

[66] http://www.uhrc.in/downloads/Jharkhand_wall_chart.pdf
[67] http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1181699502708/ch3.pdf
[68] http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1181699502708/fullreport.pdf



Household SPV Pumps: Relative performance of Jharkhand



Household SPV Street lights: Relative performance of Jharkhand

Figure 55: SPV energy solutions for domestic sector: Relative ranking of Jharkhand (as on Jan 2011)

Domestic penetration of solar PV based devices is low in Jharkhand. Compared to other states/UTs the per capita solar PV energy devices is among the lowest in the country[69] for all the appliance categories. Comparing the state's performance with that of neighbouring Bihar and Orissa too displays a very grim picture. Among all the SPV appliance categories, SPV lanterns enjoy the best percolation whereas there have been no taken of the SPV based water pumps in the state.

Table 47: SPC Appliance Penetration-Performance of Jharkhand

State/UT	Solar photo voltaic system				Percentage of SPV w.r.t. all India total			
	Lanterns	Home lights	Street lights	Pumps	Lanterns	Home lights	Street lights	Pumps
Jharkhand	16374	4905	620	0	2.0%	0.7%	0.5%	0.0%
Bihar	50297	3170	955	139	6.2%	0.5%	0.8%	1.9%
Orissa	9882	5156	5819	56	1.2%	0.8%	4.7%	0.7%
INDIA	**817549**	**669805**	**122697**	**7495**	**100%**	**100%**	**100%**	**100%**

***(as on Jan 2011)**

Transport sector: Only 36 percent of villages in the state have immediate access to all-weather roads compared to the all-India average of 57 percent[51].

[69] Relative ranking is developed based on SPV numbers from India Energy Book 2012 (World Energy Council - Indian Member Committee, 2012) and census of India 2011 survey (The Registrar General & Census Commissioner, 2011)

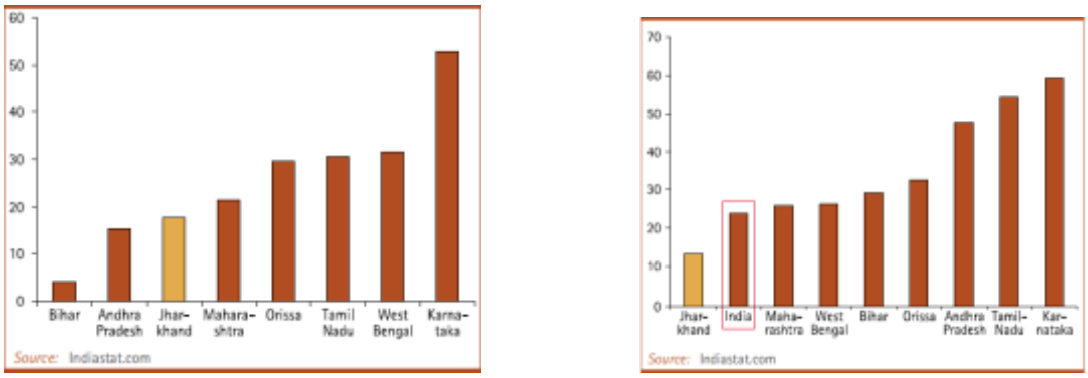


Figure 56: Comparative analysis of Road density (left) and Percentage of surface roads (right) in Jharkhand (Poverty Reduction and Economic Management-India Country Management Unit, 2007)

A large number of vehicles in Jharkhand support the industries and mining sector. Most of the times these mines and industries operate in hinterland, poor road conditions not only increases the wear and tear of the vehicles but also reduces the fuel efficiency of the vehicles (increasing GHG emissions).

Jharkhand has one of the poorest road connectivity among all the Indian states. In terms of road density, the state rank is poor, it's better than Bihar and AP but worse than the neighbouring states of Orissa and West Bengal. In terms of the proportion of surfaced roads in total road length, the state ranks the lowest among the sample states (see exhibit 102) (Poverty Reduction and Economic Management-India Country Management Unit, 2007).

12.6 ADAPTATION STRATEGIES

Adaptation is considered a vital response for urban systems to build resilience to predicted climate change impacts. The resilience can be developed through:

Infrastructure development:

1. Upgrading the existing infrastructure especially robustness of water and power supply: Most of the existing water supply schemes in the cities were designed and installed decades earlier and are now highly inadequate to meet the challenges of climate change. Cities should have adequate mechanism for the timely removal of wastes and treatment of wastewater would solve the problem of urban water logging caused by careless disposal of solid wastes which obstructs water flow in the drainages.
2. Programmatic approach to develop and promote quality housing solutions for urban and rural poor. Using indigenous techniques low cost housing options can be designed that provide safety against heavy rains and heat.
3. Infrastructure development for urban waste collection, segregation and safe disposal. Waste to energy program.

Urban planning:

1. Urban risk assessments: Regional spatial planning and urban design can help to reduce the vulnerability of urban system by checking misdirected urban sprawl.
2. Emergency preparedness and establishment of early warning system should be designed and implemented to ensure safety of urban dwellers (especially prone to flooding).
3. Innovative and cost-effective methods should be employed in urban water purification, storm-water harvesting and storm-water treatment. Wells, ponds and incoming canals to cities should be protected to maintain water quality and water availability.
4. Better institutional capacity and good governance: Planners should be able to foresee the changes in land-use, population and climate in coming decades and include all social classes for a robust decision making process.

5. Creation of more green spaces and increased tree cover to reduce the urban island effect.
6. Increased absorption capacity of soil (to absorb rain water thus reducing pressure on city drainage system) by reducing cemented space (wherever possible).
7. Improving urban microenvironment by identification and closure of clandestine/unauthorized operations in urban centres and compliance to standards in diesel generator sets used by the households and the small industries. In addition measures specific to the transportation sector may include:
   - Notification of vehicle emission norms in accordance with the road map proposed by the expert committee on Auto Fuel Policy. Introduction of clean fuelled vehicles (running on CNG/LPG/Hybrid Battery etc) in major urban centres.
   - Upgradation of PUC checking system, anti adulteration drives, improvement of mass transport system, infrastructure development for traffic decongestion, implementation of better traffic management options like regulation of traffic in peak hours at major traffic intersections& Restriction on movement of trucks and carrier vehicles in urban areas.
   - Strict regulation of vehicles on industrial operations to discourage overloading (to avoid damages to roads).
   - Mandatory yet incentivized pollution checking centres for all type of vehicles.
8. Reduce the ecological footprint of urban centres by improving energy performance of the households and institutions:
   - Programmatic approach development for replacement of incandescent light bulbs with energy efficient lighting solutions.
   - Programmatic approach (PPP model) to replace energy inefficient appliances (e.g. old refrigerators, air conditioners etc) with energy efficient options.
   - Regulatory measures to promote use of energy efficient appliances in government buildings and government supported institutions.

12.7 SECTORAL ACTION PLAN AND BUDGET

For Urban and Transportation sector action plan and budget please refer to Section C: Sectoral Action plans.

Chapter 13

WATER RESOURCES AND CLIMATE CHANGE

Jharkhand is landlocked and depends heavily on rainfall for its water requirement. The state receives majority of rainfall during the four months of monsoon starting second week of June, the winter season precipitation is meagre and also fluctuates heavily. The average rainfall ranges between 1200-1600 mm per year[70].

Currently, nearly 90% of the water supplied to rural areas is from ground water sources whereas about 30% of the water supply in the urban areas comes from ground water sources and the rest from over ground reservoirs and rivers. The rural Jharkhand too has witnessed a change in the water source, during last 3-4 decades the villages have shifted to the utilization of water from surface water to ground water through wells and hand pump for domestic purposes.

13.1 WATER SECTOR OVERVIEW

13.1.1 SURFACE WATER RESOURCE

The availability of water recourse in the state is 327790 lakhs m^3, out of which 275280 lakh m^3 is from surface water and remaining 52510 lakh m^3 is from ground water (Report of Central Ground Water Board , 2004).

Considering average annual rainfall of 1200 mm, the state receives 95,652 MCM rain water annually. However, as per Second Bihar irrigation Commission's Report (1994), total availability of water in the state of Jharkhand is 32,779 MCM, including downstream discharge from the basins.

Table 48: Surface Water Snapshot of Jharkhand

Surface Water Information of Jharkhand	
Average annual rainfall	1200 mm
Total average annual precipitation	95652 MCM
River Basin Area	79,262 sq km
Surface water availability	27,528 MCM
Surface water usage	6,965 MCM

The entire state is drained out by sixteen river basins into the Bay of Bengal. The position of each river basin, their drainage pattern, etc., is displayed in the river basin map (see map below).

13.1.2 GROUND WATER RESOURCES

Groundwater constitutes a major and widely used resource in Jharkhand for drinking and domestic purposes. However, it is not uniformly distributed due to the varied hydrogeology of the state. About 20% of the available ground water is used for irrigation mainly from privately owned dug well or shallow tube wells. District-wise groundwater balance data indicate high levels of ground water abstraction in certain urban agglomerations where groundwater potential developed is only a tenth of the utilizable reserves.

The annual replenishable ground water resource in the state has been established at 5.58 bcm (billion cubic meters) and net annual ground

[70] The details of rainfall its nature , distribution, changing trend is described in 'Climate Change in Jharkhand' section of the report

water availability is estimated to be 5.25 bcm (Central Ground Water Board, 2006). Altogether, the state puts to use 21% of its ground water resources.

Table 49: Groundwater Status and availability in Jharkhand (Central Ground Water Board, 2006)

	Annual Replenishable Ground water resource				Total (bcm)	Natural loss of ground water (bcm)	Net annual ground water availability (bcm)
	Monsoon Season		Non-monsoon season				
	Recharge from rainfall (bcm)	Recharge from other sources (bcm)	Recharge from rainfall (bcm)	Recharge from other sources (bcm)			
Jharkhand	4.26	0.14	1.00	0.18	5.58	0.33	5.28
All India	248.01	69.59	41.85	73.19	433.02	33.77	399.25

The low dependency of state on ground water is easily understood by the water pump distribution map (see below), compared to Gangetic plains, high intensive agriculture belt of Madhya Pradesh, Maharashtra and dry regions of Gujarat, the number of borewells in the state is very low (Shah, 2009).

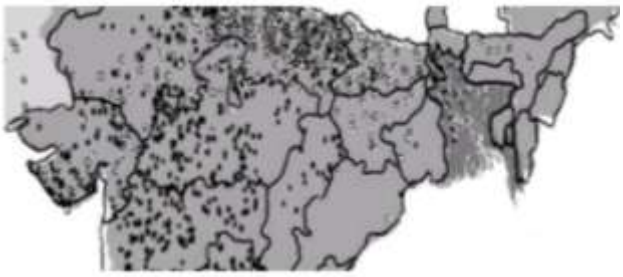


Figure 57: Distribution of electric and diesel pumpsets in India (each dot represents 5000 borewells) (Shah, 2009)

13.2 WATER SECTOR ISSUES & CHALLENGES

Despite the fact that the state receives good rainfall, surface water availability in the state is not sufficient due to inadequate storage facilities. Also the topography, soil and rock formations do not support water storage. High rain variability coupled with monsoon rains, low moisture holding capacity of soils, absence of developed aquifers due to the hard rock substrate and high run-off due to the undulating terrain results in water deficiency in the state[71].

About 60 percent of the rainy days have rainfall below 2.5 mm. On about 40 percent rainy days, evaporation level is more than 2.5 mm per day. As per estimates out of the average annual precipitation of 10 million hectare meter in the state about 20% is lost in the atmosphere, 50% is lost due to surface runoff and balance 30% gets soaked into the ground as soil moisture and ground water.

The major water sector issue faced by the state include:

i. In Jharkhand, most of the major and medium irrigation projects were implemented during 1970-80. The capacity of all the old projects has reduced significantly over the period of time.
ii. During the last decade, there has been a substantial increase in water draft from ground water sources in the state.
iii. Prevalence of high concentration of iron in mining belts (mainly in granitic terrain), municipal and industrial pollutants poses serious threats to the ground water quality.
iv. Erratic rainfall in the state needs attention for conjunctive use of surface and ground water. Post-monsoon flow in most rivers is used for irrigation which further reduces their flows in lean season.

[71] As per the categorization by Indian Meteorological Department, Jharkhand figures in the "drought corridor" of the country.

v. Water use efficiency in irrigation as well as in domestic water supply is generally very low and more importantly there is lack of scientific monitoring and surveillance.

vi. In area under mining, significant water gets stored or is being stored in open mining pits and is not being put to any use.

13.2.1 GROUND WATER ISSUES

The natural process of ground water recharging in the state is slow, also artificial ground water recharging facilities are undeveloped in the state the result is that water table in the plateau is going down (Department of Agriculture and Sugarcane Development , 2011).

Over-Exploitation of Ground Water has rendered several areas devoid of ground water in peak summer, resulting in drying up of dug wells and tube wells. Excessive withdrawal of ground water by industrial units has created adverse effect on its quantity also (Water Resources Department, 2011).

Table 50: Groundwater availability, utilization and stage of development in Jharkhand (Central Ground Water Board, 2006)

	Net annual ground water availability (bcm)	Annual Ground Water Draft			Projected demand for domestic and industrial usage (upto 2025) (bcm)	Ground water availability for future irrigation (bcm)	Stage of ground water development (%)
		Irrigation (bcm)	Domestic and Industrial (bcm)	Total (bcm)			
Jharkhand	5.25	0.70	0.38	1.09	0.56	3.99	21
All India	399.25	212.51	18.09	230.62	29.17	162.29	58

Ground water scenario in the state can be better understood from the Gravity Recovery and Climate Experiment (GRACE) satellite mission. Based on subtle variations in the pull of Earth's gravity by using microwaves, GRACE estimated a falling water table across the northern Indian subcontinent. The GRACE-determined depletion rate implies that groundwater was being pumped out 70% faster in this decade than the Central Ground Water Board of India estimated it was in the mid-1990s. The apparent surge in withdrawal would have been large enough to turn a once-stable water table into a falling one that demands ever-deeper wells and bigger pumps. (Tiwari, 2010)

As displayed in following figure, the ground water in the southern districts of the state has been rising overtime, whereas in the northern districts it has been depleting fast.

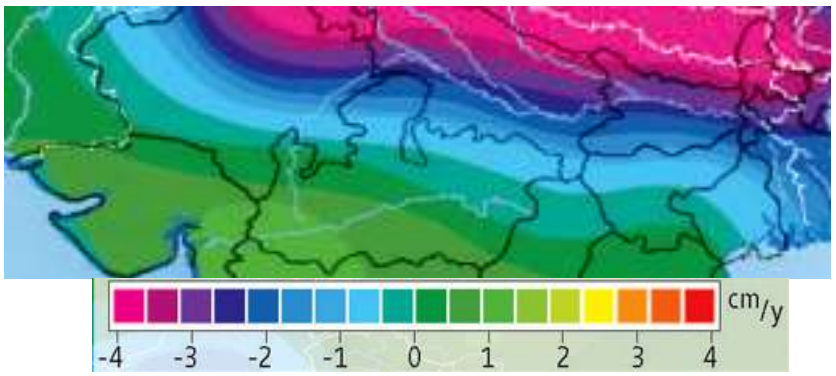


Figure 58: Ground water depletion in Jharkhand (depletion in cm/year) (Tiwari, 2010)

Some districts in Jharkhand have already witnessed sharp fall in ground water table, there are districts where during last three decades (1980-2010) the water table drop is between 1-4 meters. Water table drop is important as below a certain level it becomes infeasible to extract water and farmers have to invest in more

expensive technologies (Sekhri, 2012). Apart the trend is dangerous as Jharkhand does not have deep aquifers as found in the Gangetic plains, and the existing ones in the rocky terrain are porous and theoretically they can soon become dry due to overexploitation.

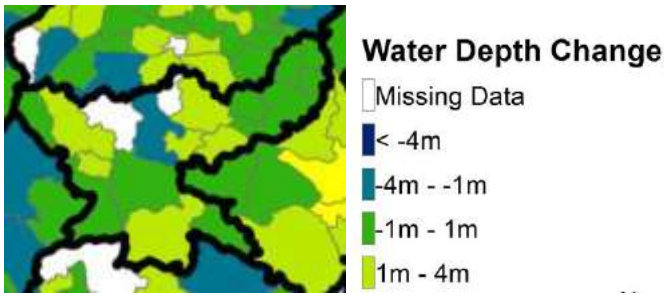


Figure 59: Water depth change in Jharkhand during 1980-2010 (Sekhri, 2012)

Impact of industry on ground water: Industrial pollution has reduced the fresh water available for domestic and economic purpose, large tract of fresh water streams are polluted and also domestically produced polluted water is reducing availability of clean surface water.

For example, in Jharkhand, 75 per cent of sponge iron plants the industries use ground water. Sponge iron industry although is relatively less water intensive but the impact is high as most of the water is sourced from aquifers. Excessive extraction of ground water leads to reduction in the ground water table and affects the availability of water in the surrounding areas[72] (Bhushan & Juneja, 2011). As per 'Block-wise Dynamic Ground Water Resource Estimation', till 2009, the water quantity in 17 blocks has reached sub-critical state, whereas water table in 5 blocks was in critical state and in another 5 blocks ground water aquifers had been overexploited because of unregulated water extraction.

Further, the minerals from mines also leach into the aquifers, thus water from a large number of aquifers is unsuitable for drinking purposes. Following table provides a list of districts that suffer from fluoride, nitrate and arsenic pollution.

Table 51: Districts affected by dissolved chemicals

Dissolved chemicals	Affected districts
Fluoride (F>1.5mg/l) in groundwater (Kamyotra, 2011)	Bokaro, Giridih, Godda, Gumla, Palamu, Ranchi
Nitrate (>45mg/l) in Ground Water (Kamyotra, 2011)	Chatra, Garhwa, Godda, Gumla, Lohardega, Pakur, Palamu, Paschimi Singhbhum, Purbi Singhbhum, Ranchi, Sahebganj
Arsenic pollution (Sources: DW & S Deptt.)	27 villages are affected in the district of Sahebganj

13.2.2 SURFACE WATER ISSUES

Waste water generated by urban habitats is another big pollution source. With rise in economic activities and expanding population the water requirement of the urban habitations shoots up, which results in waste water generation which when left untreated spoils the quality of surface water and ground water. Based on the numbers and estimations available for the country, state specific waste water numbers are generated for the urban sector. From the projections it can be inferred that although water use efficiency may go up considerably but the overall burden of waste water generated by urban areas is going to be huge. If the water efficiency of the state is increased by 100% still the growing urban population will release close to twice the waste water as it is generating today.

[72] http://cseindia.org/userfiles/sponge_iron_layout.pdf

Table 52: Waste water generated by urban settlements

	INDIA (Kamyotra, 2011)			JHARKHAND* (estimations)		
Year	Urban Population (million)	Wastewater Generation (Litres/Capita/ Day) (lpcd)	Gross Wastewater Generation (mld)	Urban Population (million)	Wastewater Generation (Litres/Capita/ Day) (lpcd)	Gross Wastewater Generation (mld)
1977-78	72.8	116	7007	3.2	5.09	308
1989-90	122.7	119	12145	4.46	4.32	441
1994-95	151.6	130	16662	5.13	4.4	564
2009	316.15	121	38255	7.09	2.71	858
2051 (Projected)	*1000*	*121*	*120000*	*12.50*	*1.51*	*1500*

*National average of waste water generated is used to estimate waste water numbers for Jharkhand

13.3 WATER SECTOR VULNERABILITY TO CLIMATE CHANGE

Impact of climate change on rainfall: Climate change is expected to significantly alter India's hydroclimatic regime over the 21st century. It is widely agreed that parts of the Indo-Gangetic basin may receive less rain than in the past; but the rest of India is likely to benefit from greater precipitation. According to IPCC (2001), most Indian landmass below the Ganges plain is likely to experience a 0.5–1^0 C rise in average temperatures during 2020–2029 and 3.5–4.5^{0}C rise in 2090–2099. Many parts of peninsular India, especially the Western Ghats, are likely to experience a 5–10% increase in total precipitation (IPCC 2001); however, this increase is likely to be accompanied by greater temporal variability. Throughout the sub-continent, it is expected that 'very wet days' are likely to contribute more and more to total precipitation. This is likely to mean higher precipitation intensity and larger number of dry days in a year.

Climate change impacts on groundwater: Various climate change model predict increased temporal variability for rainfall, this translates to intense and large rainfall events in short monsoons followed by long dry spells. Evidence suggest that groundwater recharge through natural infiltration occurs only beyond a threshold level of precipitation; however, it also suggests not only that runoff increases with precipitation but the run-off coefficient (i.e. run-off/precipitation) itself increases with increased rainfall intensity (or precipitation per rainfall event) (Carter 2007).

Increased frequency of extremely wet rainy seasons (Gosain and Rao 2007) is also likely to mean increased run-off; compared to 1900–1970, most of India is likely to experience 5–20% increase in annual runoff during 2041–60[73]. Higher variability in precipitation may thus negatively impact natural recharge in general.

Climate change and increased water demand for agriculture: The rainfall pattern in Jharkhand will be affected due to change in climate, the net impact on a given location will depend upon the change in both the total precipitation and the variability of that precipitation. From agriculture point of view this will be disastrous for Jharkhand as the state is mostly dependent on rainwater for irrigation. Hence managing groundwater storage will acquire greater significance for the state than ever before. However, besides groundwater demand, climate change is expected to impact groundwater supply too in direct and myriad ways.

Climate change and increased water demand by thermal power plants: As explained in the 'Chapter on Power Sector' of the report, the rise in stream temperature due to climate change will result in reduced efficiency of the thermal power plant which uses water for cooling purpose. The rise of stream water temperature can be

[73] Rainfall pattern shift is descibed in 'Climate Change in Jharkhand' chapter of this report

compensated to a certain extent by increasing water intake to dissipate the generated waste heat to a larger quantity of water.

Based on the international experience, it's clear that the rise in water temperature results in excess intake of water by the thermal plants to ensure that the efficiency of the power plant is maintained. It's estimated that for one degree rise in atmospheric temperature, the water demand goes up by 10%. One result of the analysis reveals an increase by up to 30% in water demand during the summer month to compensate for an average increase of 2.1°C (Held, Strepp, Patt, Pfenninger, & Lilliestam, 2012).Hence for years 2025 and 2050, water requirements for one degree and two degrees rise in ambient temperature is translated into excess water requirement of the thermal power plants.

Water availability and impact on hydro electric plants: The hydro-electric plants, whether based on run-of-the-river and reservoir technology will suffer due to water shortages. Long dry spell may reduce the water availability and bring down the electricity output of the hydro-electric plants.

Climate change and water demand projections: An assessment of the availability of water resource in the context of future national requirements taking particular account of the multiplying demands for water and expected impacts of climate change and variability is critical for relevant national and regional long-term development strategies and sustainable development.

McKinsey study shows that India water demand will grow at 2.8% CAGR and reach 1,498 billion cubic meters (BCM) in 2030 (India's current water supply is 740 BCM) in Business-as-Usual scenario. With increase in regional mean temperature, water demand will further rise (as already discussed in the chapter). Another business-as-usual scenaioro puts India's water demand at 833 BCM in 2025 and 900 BCM in 2050 (Amarasinghe, Shah, & Anand, 2010).

Figure 60: National water demand-supply estimation

Table 53: National water demand estimation for Irrigation, domestic and industrial purpose

Sector	2000		2025		2050	
	Total	% groundwater	Total	% groundwater	Total	% groundwater
	Billion cu. Meters	%	Billion cu. Meters	%	Billion cu. Meters	%
Irrigation	605	45	675	45	637	51
Domestic	34	50	66	45	101	50
Industrial*	42	30	92	30	161	30
Total	680	44	833	43	900	47

*Industrial water demand includes water requirement in thermal power plants (for cooling purposes)

Water projections for domestic, industrial and agriculture sector: National level water demand projection studies were analyzed to generate water demand estimations for the state of Jharkhand. Growth rate estimations for each category are used to derive the appropriate rate for Jharkhand and the same was suitably adjusted to generate sectoral projections for water demand for Jharkhand.

Water usage and projections for power plants in Jharkhand- A study by NGO, Centre for Science and Environment has estimated the volume of water used in thermal power plants is to the tune of 35,157.4 million cubic metres (MCM) annually which constitute 87.8 per cent of the total industrial water use. A similar study using the Central Pollution Control Board (CPCB) data has observed that the total wastewater discharged by all major industrial sources is 83,048 million litres per day (mld).

Thermal power plants in India use an average of 5 cubic meters of water for each mega watt of power produced. Based on the annual power generation of the thermal power plants in Jharkhand, the annual water demand for the power plants is calculated in the following table. Also a projected water requirement for the years 2025 and 2050 in business-as-usual scenario is calculated for the state of Jharkhand.

Table 54: Projected water demand for Jharkhand

	Domestic water demand	Industrial water demand	Thermal power plant water demand
Base year	**2010**	**2010**	**2010**
Demand growth (annual)	2.7% p.a. during 2010-25 and reduced to 1.7 % p.a. during 2025-50 (due to rise in efficiency and decrease in population growth)	3.2% p.a. during 2010-25 and reduced to 2.3% p.a. during 2025-50 (due to stagnation in industrial growth and increase in efficiency)	For year 2010 and till 2015, per MW water consumption is taken as 5 $m^{3,}$, beyond 2025, its considered as 4 m^3 per annum for each MW of power generated
Base year water demand (actual)	1244 Million Cubic Meters	4338 Million Cubic Meters	-
2025(projected)	1748 Million Cubic Meters	6420 Million Cubic Meters	-
2050(projected)	2492 Million Cubic Meters	10111 Million Cubic Meters	-

13.4 SECTORAL RESPONSE

13.4.1 SECTORAL VISION AND COMMITMENT

The JAPCC recognizes the critical importance of water resources to the state and the need to safeguard these through a comprehensive multi-pronged response process. As such, it is committed to taking the necessary steps to examine all related issues through a consultative process.

13.4.2 STRATEGIES

JAPCC recognizes that climate change impacts on water sector will be widespread, combating climate change will require a combination of short term reactive and long term anticipatory adaptation strategies.

Planned long term adaptation

Policy measures: Developing an integrated water resource management policy for the state is suggested to bring all the water resources of the state under one department for sustainable management of water resources. State level polices from conservation to better management of current water resources are required to maintain a desired state of the water resource.

Improved water management supply for urban areas for augmenting the availability and meeting the increased demand in irrigation, domestic and industrial sectors. Replenishable groundwater too needs to be augmented to meet the domestic, irrigation and industrial demand through techniques like rain water harvesting. This accompanied by conservation measures and an improved water management supply will further work towards security a sustainable water supply in the future. In the long term, effective water policies to promote

conservation, management and enhancement would complement the short-term plans in designing an effective water adaptation strategy.

In this regard, JAPCC suggests for expediting the formation of Water and Land Management Institute (WALMI) Jharkhand, which is expected to be the back bone of participatory irrigation management (PIM). The JAPCC also suggests to promote a Water Resource Regulatory Authority (with jurisdiction over all types of water resources) to develop a comprehensive water sector response.

Regulatory measures:

Water use regulations need to be developed in consultation with the water users. The regulations need to cover agriculture, industrial and domestic water use to control use of water and to promote water use efficiency, water recycling and water harvesting.

- Role of *panchayats* in managing groundwater use in rural areas (for consumption, irrigation and industrial use)
- Mandatory metering of ground water
- Water pricing
- Regulations to facilitate use of water efficient appliances

The 'Water Resource Regulatory Authority' as suggested by the JAPCC can be housed in water resource department or it can operate separately to fulfil following:

- Facilitate real time database of all the water resources available to the state. Assisted by a powerful web enabled platform, the authority will keep track of all the water bodies (surface, subsurface) in the state. The authority will need to map all the water bodies, catchments and also measure the water use in respective mini/micro water catchments.
- The authority will review the water sector data quality and parameters currently collected by various departments. The authority will also review the scale, periodicity and data flow processes.
- Additional data requirement needs to fill in information gaps
- Setting up of weather stations, monitoring
- Develop 'situation reports' and periodic 'sectoral review reports' to communicate with the stakeholders in government and public on the status and health of the water resources. These reports can form the basis of state actions.
- Facilitate sectoral water audits. These audits will be mandatory in nature and will help the authorities to check the water consumption pattern against the sectoral water usage standards.
- Measure and report sectoral water efficiency actions

Detailed water sector database creation: The adaptive mechanism will depend on climate change and its impact on water sector. The very basic information on water i.e. water availability in the state had been worked out by the 2nd Bihar Irrigation Commission (1994). Since then, no further assessment was carried out to plan out a detailed water development approach for the state of Jharkhand. Institutionalized approached for climate change study on water sector, including rainfall variability, sedimentation loads and its' rate in rivers, discharge of river, water quality of rivers including data on water pollution in basins need to be followed for effective climate change planning.

The above information will be critical to design an appropriate and accurate state response towards climate change. This would require:

- Review of the performance of hydrological observation stations required for the state
- Review of the numbers and network of automatic weather stations and automated rain gauge stations;
- Review of gaps in the existing hydro-meteorological and hydrological data from climate change monitoring and assessment perspective. Appropriately address the gaps overtime.
- Similarly, Water assessment map for the state need to be developed. The water assessment should be designed to collect data and trends on:
    - Ground and surface water status
    - Ground and surface water capacity

- Ground and surface water trends
- Yield from ground water and
- Replenishment capacities of ground and surface water bodies

- There is also need for a water resource management study for areas under **severe water stress**. This would require exploring technologically advance options to develop water sources for the extremely critical zones. Artificial ground water recharging, cloud seeding, river linking and exploring very deep water aquifers to manage water demand in the regions under extreme water stress

Reactive/ anticipatory adaptation: Since it's clear that rainfall will increase over time but number of rainy days will go down. Hence it's necessary to create a water use efficiency and recharge strategy for the state.

Water use efficiency enhancement: The current water use efficiency parameters and approaches are inadequate. It is suggested to develop water use efficiency mechanisms for all the sectors. Technology centric and economic tools should be put to use to promote water use efficiency in the state. This may include

i. All water conveyance channel may be lined in phased manner in order to minimize conveyance loss
ii. Agriculture department may be asked for promotion of sprinkler irrigation system in *rabi* field crops and drip irrigation for fruits and vegetable crops where discharge is limited
iii. In deficit basis/ sub basin area industries may be asked to treat the domestic waste water and use the same in their production processes.
iv. Drinking water Sanitation department may look into minimizing water conveyance and distribution losses
v. Industrial water use reduction, reuse and recycling measure

Rain Water Harvesting and Management: Decentralised Rain Water Harvesting for augmenting the availability and meeting the increased demand in irrigation, domestic and industrial sectors may be facilitated to mitigate effects of climate change. In villages, farmers may be made aware and encouraged to harvest rain water in-situ, in their fields by ways of various traditional methods. Such methods and technologies may be strengthened, further developed and extended under Integrated Watershed Management Project (IWMP). Enhancing the capacity of old reservoirs (whose capacity has been reduced over a period of time) by de-silting and other repair works may increase the overall availability of water in the state. In phased manned all the water bodies and harvesting structure may be repaired to regain its' full capacity and further operation and maintenance. Water stored in mining pits may be analysed and brought for used after making any necessary treatment, if required.

Water management in mining areas: A stormwater management plan at the mine site should be put in place and provide for the collection, storage and disposal of water. Site drainage should also aim to separate natural runoff from water generated by mining and processing operations minimizing the amount of water that needs to be treated or retained. In Jharkhand, multiple agencies have taken initiatives to managing water in their mines. The Eastern Coalfields Limited, a subsidiary of Coal India Limited ECL had undertaken a unique aquaculture pilot Project in an abandoned open cast mine. This abandoned open cast mine had turned into a permanent water reservoir fed by rainwater, ground water and surface runoff. Private Players like Tata Steel have constructed Check Dams to arrest surface run off.

Ground water management: Jharkhand has observed significant reduction in ground water level in recent past, especially nearby industrial enclaves such as Ranchi, Dhanbad, Bokaro etc. This is because of excessive withdrawal from ground water and poor recharge. Considering the dependency of domestic water requirement from ground water sustainable use of ground water becomes paramount for the state.

The Ground Water Directorate may be strengthened and engaged with Central Ground water Board in carrying out study of static and dynamic nature of ground water. Recommendation of the study may be implemented in phased manner. Some known mechanism such as roof top rain water harvesting may be taken on all institutional, Public sector undertaking and Government buildings and the water so harvested may be guided for the artificial recharge of ground water. High altitude / hill top villages prevailing in *Santhal Pargana* region and other places may harvest rain water, store them and after basic treatment used for drinking water. Adaptable models of artificial recharge of ground water may be developed, piloted and implemented in large scale.

Convergence of efforts: In order to arrive at sustainable use of water in irrigation, domestic, industrial, environmental and other uses, an inter departmental high power committee or some other mechanism which would develop sector wise water requirement and plan to fulfil the same and would facilitate all possible required actions including the measures of climate change impacts. The proposed mechanism needs to have clear annual active plan with budget may be drawn from all the department pertaining to water sector, implement the same on timely, monitor the progress and suggest feedback for further improvement in plan and entire mechanism.

Since the state receives a reasonable amount of rainfall and has undulating topography, there are opportunities to arrest run off losses by creating water retention structures. This will not only check erosion of surface soil leading to siltation of the dams/water reservoirs but will also increase irrigation potential and increase sub-surface moisture, which is essential for good agriculture in the state.

Water use efficiency of thermal power plants- Another measure to improve water-efficiency in power plants could be the reuse of secondary-treated municipal waste water, as well as passively treated coal mine drainage, and ash pond effluent. Further it is recommended to enable power plants to produce some of their own water, i.e. by using the thermal discharges to desalinate water (if such contaminated water is available close to power plant).

To counter the risks from climate change (in the form of erratic rainfall and increased water demand across sectors), the most suitable adaptation measure is to increase the reservoir`s net storage volume. Increased reservoir capacity will also have a significant role in flood control situations or drought like situations.

Awareness generation:

Awareness is key to water resource management. The awareness measures should be designed to:

- Conservation of existing water resources
- Conservation of aquifers and water bodies
- Plastic waste management
- Reduction, recycling, reuse of water

Awareness programs for policy makers: Training programs targeting government officials, political leadership should be designed to familiarize the highest decision makers on impact of climate change on water resources in the state and also to communicate the severity of the imminent problems.

Awareness programs for service providers: The municipal bodies should be exposed to the water situation in the state and familiarize them with the outcomes of various climate change models in order to make them aware of the micro and macro water scenario in the state to facilitate water conservation measures at the municipal level.

Awareness programs for end users: Water use efficiency and conservation requirement and techniques (processes, technology and other options) should be shared with end users (initial focus on highly inefficient sectors) through appropriate and smart communication medium.

13.5 SECTORAL ACTION PLAN AND BUDGET

For water sector action plan and budget please refer to Section C: Sectoral Action plans.

Chapter 14

KNOWLEDGE MANAGEMENT ON CLIMATE CHANGE

Climate change action planning is a long term dynamic and process, a cross sectoral micro level (district and block level) inventory of information is a desired condition to make climate change planning possible and relevant. The climate change associated uncertainties and ever improvising adaptation mechanisms ensure that the climate change adaptation process always remains dynamic reacting to the feedback system that communicates the performance of the activities implemented as part of plan.

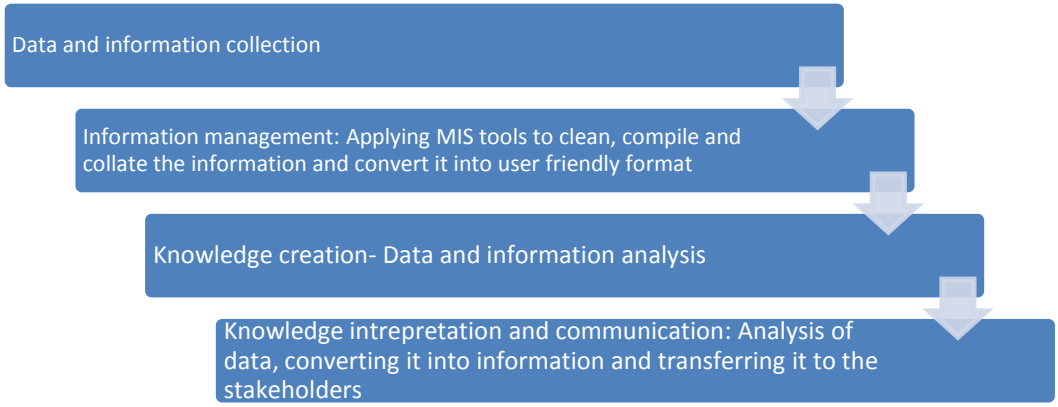
During the course of JAPCC development, it became clear to the engaged stakeholders that to develop an accurate and effective climate change action plan, a knowledge and information management system will be required. The current practices of data collection and interpretation will require significant alterations to fit into the new climate change management regime proposed for the state to plan for and ensure timely appropriate responses. A knowledge management system that will be dedicated to management of information linked to climate change aspects for mitigation and adaptation is suggested for the state. Such system will help identify and focus the resources towards the (prescribed) appropriate responses making the whole process of 'defining and designing climate change actions' scientific, accurate, acceptable and resource efficient.

14.1 KNOWLEDGE MANAGEMENT- REQUIREMENT OF JHARKHAND

During the process of development of JAPCC, it was realized that there is lack of systematic data collection and management is problem common to most of the state departments, most of the departments don't maintain information systems that are required to capture or communicate the climate change linked data. The information management systems followed by the departments are not integrated with IT interfaces of the departments thus data compilation and collation is difficult; result is that information is not easily/readily available to the decision makers.

It is highly recommended to design, develop and establish a state level information management system that will hell equip the policy makers, subject experts and execution focused entities with relevant and timely information.

The broad conceptual framework of knowledge management should be based on four pillars of information **collection**, information **management**, knowledge **creation** and **communication**.



Information collection:

Timely and precise information availability is one of the necessary conditions to develop an appropriate adaptation strategy for the state. Particular to Jharkhand, various state departments collect regular information under various domains to measure performance of various governments actions as well as to design new policies and programs.

Globally as well as locally mitigation and adaptation options are available and under trial phases, but the state may not be in position to fully utilize learning from such interventions unless the state has developed a cross sectoral clear understanding on the climate change status, sensitivity and capacity.

The existing information available with the state on climate change aspects is clearly not adequate. A significant effort is required to capture regional climate change information and put it to use by developing empirical models that support decision making. For relevant yet comprehensive data collection, it will be required to map the existing data management approaches, create inventory of data that already exists and identify:

1. What new set of data need to be collected,
2. At what level (micro or macro) data need to be collected and
3. What should be data collection frequency

Data collection requirement and need should be clearly identified and acted upon.

Knowledge creation' i.e., analyzing information on climate change aspects that are crucial for decision making and implementation actions in the state. The existing information collection and management tools are not designed keeping in mind the climate change planning and performance of the state, hence there exist crucial knowledge and data gaps in certain areas.

Climate change and knowledge vacuum:

Table 55: Projected water demand for Jharkhand

Sector	Data and information requirements	Rationale
Agriculture and livestock	Study on Agro ecological zone wise cropping pattern and productivity levels for various crops Research on micro climatic impacts on the major crops in Jharkhand Capacity assessment of surface water and aquifers in the state **Long term plans:** Development of geospatial based irrigation planning tool Inclusion of livestock productivity in livestock-census Socio economic data pertaining to rural development and agriculture sector; including financial inclusion, existing market interfaces and feedback mechanisms	The data collection will help understand the impact of climate change on agriculture sector The data collection will help map the opportunities available The data collection will help identify the potential activities that can be carried out to reduce vulnerability and enhance the efficiency of the agriculture sector
Forests and biodiversity	Impact of climate change on vegetation Impact of precipitation change on biodiversity Phenological shifts: Altered productivity; Shifts in species distributions; Shifts in composition; Stress-induced mortality; Extirpations and extinctions; Susceptibility to pests and pathogens Erosion, sedimentation; Water balance; Species composition; Shading, stream ; Temperature; Productivity Invertebrates Exotic species	The data collection will help understand the impact of climate change on biodiversity Data collection and analysis will help identify problems that need priority action

Sector	Data and information requirements	Rationale
Energy sector	Detailed studies to map off-grid renewable and waste to energy options Study to understand energy saving potential for: MSME sector, public sector building and households. Sample surveys are recommended to derive at energy baselining and energy saving potential.	Long term dependency on dirty energy (coal fuel) restricts the options available to the state for reducing GHG emissions. Hence demand side efficiency management can be an effective short term strategy that can be adopted as the starting point activity. Renewable energy options are a necessity due to environmental and regulatory reasons. Not only such options are relatively clean (although costly) but due to central government's commitment to introduce renewable energy in the energy portfolio of industries it will be necessary to promote renewable options in immediate future.
Health sector	Health risk mapping for disease linked with climate change (i.e. vector borne diseases, water borne diseases)	Identifying regions with high vulnerability to vector borne diseases
Water sector information	Data collection on water levels, water discharge from water bodies and reservoirs Data on aquifers: Aquifer type, capacity, depth, recharge Water use and water replenishment data	The water sector data will be an important input to agriculture sector analysis The data will help identify the water demand-supply gaps
Socio-economic data	Data collection on parameters that help identify: 1. Coping capacity of the households (i.e. income, physical assets, access to services and facilities etc) to measure the resilience of the households. 2. Vulnerability of households: The data collection should focus on parameters and proxies that can quantify the risk exposure of the households towards changes in climate.	Vulnerability assessment and mapping of the state is necessary for resource allocation. Large tribal and poor population of the state and resource crunch makes this exercise compulsory to justify investments.

14.2 DATA COLLECTION AND INFORMATION MANAGEMENT REQUIREMENT

The data collection and its analysis is an immediate requirement for the climate change planners. It will not only help understand and quantify the short, medium and long term impact of climate change on various sectors but will help develop a plan of action to contain the climate change impact.

Climate change vulnerability assessment and strategies for better preparedness in the state - The immediate aim of data collection will be to develop a cross-sectoral adaptation strategy for the state based on the analysis of the projected climate change impacts and the assessment of vulnerability for the selected sectors.

Understanding low carbon development pathways- There is need to develop future scenarios on the basis of using an optimization energy environment modelling framework. This will facilitate in long-term planning in identifying technological and policy choices that would result in sustainable low carbon high growth development in Jharkhand.

Increasing the scale and distribution of the data- This will aim to enhance the quality of resolution of Meteorological, hydrological and land use data that are essential to run and validate climate change models to reduce uncertainty and error of the interpretation. This will enable research to responds to the demands of policy making more effectively.

1. Vulnerability assessment and strategies development: The overall aim will be to develop a cross sectoral strategy for the state. The strategy will be based on the climate change impact as projected for the state and identification of risk exposure and vulnerabilities of various identified sectors (viz. Agriculture, forestry, water, health, mining, power, urban and transport).
2. Data quality enhancement: The current climate change projects for the state are either based on meteorological, hydrological data at low resolution and from limited observation centres. In order to increase accuracy of the observation and the projections it will be required to generate information at the micro levels.

The climate data creation has to be followed by strategies that may wed by creation of a robust yet dynamic data management and sharing platform.

Knowledge management: The climate change information availability is either scarce or coarse. The information on rainfall changes and temperature shifts generated from climate change simulations is available at scales as micro as district level, but the information required for adaptation and mitigation decisions is either not available or outdated or is available in forms that simply does not support information integration or analysis. It is suggested to develop information and knowledge management systems that are able to organize information from multiple sources and assess them to generate meaningful and easy to understand outputs. The information technology options can be put to maximum use to generate, share and analyze information.

14.3 CURRENT STATUS OF INFORMATION AND KNOWLEDGE MANAGEMENT

In Jharkhand, the Directorate of Economics and Statistics is entrusted with the responsibility of collection, compilation, tabulation and analysis of various types of statistical data required by the state government and other institutions. Various types of data collected by the Directorate include agriculture sector statistics, vital statistics, price and other socio-economic statistics. Agriculture survey wing brings out reports on Agriculture Production, district wise crop yield, reports for agriculture insurance schemes and different use of land etc. Vital statistics wing is mainly entrusted with the work of registration of births and deaths. State income wing of the Directorate brings out data on subjects like State Domestic Product, Capital Formation etc. In addition operating under the NSSO, the National Sample survey wing of the directorate conducts surveys on selected themes.

There are multiple research and education institutions that cater to research requirement of the state. In the agriculture sector there are important universities like Birsa Agriculture University (Ranchi), also a network of 22 *Krishi Vigyan Kendras* caters to the agriculture sector scientific research and extension work in Jharkhand.

University level institutions like, Indian School of Mines-Dhanbad and Birla Institute of Technology-Ranchi are equipped with state of the art resources and can contribute to scientific research in the state.

There are a few research institutions in the state which are purely engaged in variety of primary research work. These include;

- The Central Fuel Research Institute, based in Dhanbad focuses its research in the field of the fuel resources particularly lignite and coal resources.

- The National Metallurgical Laboratory, Jamshedpur, is involved in various kinds of work associated with technological and scientific research to facilitate the industrial development of the state, especially in the areas of minerals, metals and another type of elements called the advanced materials.
- The Central Institute of Mining and Fuel Research focuses on research in the field of mining to facilitate the mining work and reduce the expenses of the mining industry.
- Central *Tasar* Research and Training Institute (Ranchi) and Indian Lac Research Institute (Ranchi) are dedicated resource centres available to the state for research on issues closely linked with the livelihood of the rural communities,
- Specialized institutions like State Institute of Rural Development (SIRD), Jharkhand is the Apex Institute for Training & Research in Rural Development and Jharkhand Tribal Welfare Research Institute (TRI-Ranchi).

14.4 STRATEGIES FOR KNOWLEDGE MANAGEMENT

Action point 1: A comprehensive interdepartmental data need assessment through stakeholder consultation depending on requirements of climate change linked actions.

Action point 2: A web enabled tool to be developed for collating, synthesizing and delivering knowledge products to decision makers on climate change. The endeavour will link various data across sectoral interests that are important and relevant to climate change actions and policy decisions.

Action point 3: Identifying institutions in the state and outside that can be used for information management and knowledge creation. E.g. BIT Mesra has a established centre for climate studies. Such centre for excellence can be roped in when designing knowledge management strategies for the state.

Action point 3: Inventorizing information on community vulnerability and resilience towards climate change. The baseline clubbed with climate exposure can be used to develop a relative index for identifying communities and allocating resource.

Ex, tribal and other rural communities in Jharkhand have practised and developed multiple traditional knowledge systems that may contribute to the strategy-mix to be developed for the agriculture and forestry sector.

Action point 4: Designing communication tools, awareness generation, capacity building- The climate change actions will require mainstreaming of the climate change concerns into outreach and other programs of the government. The information dissemination will be required at every level, starting from policy makers, program designers, implementation agencies and the general public.

The tool and interface used in outreach/communication will need to be designed keeping in view the target audience. Some indicative stakeholders include:

1. *Awareness and capacity building programs for policy makers and senior officials*- The top echelons in the state with need to develop long term clarity on climate change and its impact on the state economic and social well being. The goal of the awareness program for the policy and program designers will be to develop cross sectoral dynamics of climate change issues. Departments covering all major sectors (covered in this plan) need to be engaged for mitigation and adaptation linked awareness programs.
2. *Awareness and capacity enhancement programs for implementing agencies*- Agencies responsible for implementing climate change action plan will have to be equipped with capacity to comprehend available information and climate models; design and implement micro and macro level plans that are relevant, acceptable and effective. Awareness programs followed by capacity building activities are required for the mid and field level human resources.
3. *Awareness programs for public*- The citizens of the state need to participate in the climate change actions required, understanding of the community on climate change issues need to be developed and so should be the clarity on the actions required and planned for the state.
    a. Farmers and farm sector: Agriculture sector strategies will need to be piloted, field tested and shared with the communities through extensive agriculture extension network of the state.

Decision of selection of extension medium (e.g. audio, video, print) need to be decided on case to case basis.

b. Industries: SMEs as well as heavy industries need to be made aware on the benefits from operational efficiencies. In addition regulatory and support mechanism existing in the state and outside need to be shared with the industrial players.

c. Students and scholars: In order to achieve long term buy-in for climate change actions, state should direct resources focusing on developing understanding of the students on climate change problems, issues and options.

Chapter 15

INSTITUTIONAL MODEL FOR STATE ACTIONS ON CLIMATE CHANGE

A state wide implementation of the state climate change action plan is only possible through highest order of convergence. The commitment from the highest echelon is required and will have to be translated into sector wide short, medium and long term program development and its implementation.

In this section of the report, an institutional arrangement is suggested for implementation of the state climate action plan. The overall institutional arrangement has been designed in order to streamline and strengthen state's actions in response to reducing state's vulnerability to climate change. The five principles on which the action plan implementation is based upon include-

1. Mainstreaming climate change actions into policies, strategies and programs at the state level and respective department level
2. Generating revenues and leverage central, bi-lateral, multi-lateral and private funds for implementing actions
3. Strengthening the knowledge base on the climate change linked localized impacts, vulnerabilities vis-a-vis local adaptation capacity
4. Developing and identifying best practices and translating it into local action
5. Developing a future course of action for a more resilient Jharkhand at industry, community and natural stock level

15.1 INSTITUTIONAL STRUCTURE OF THE CLIMATE CHANGE ACTION

The implementation of climate change action plan will be a state wide activity spread across sectors, hence an inter-departmental institution headed by Department of Environment and Forests and supported by other sectors is suggested.

Developed on the lines of SAPCC, it is suggested that a **governing body** with senior officers from all the concerned departments and sector experts as representatives of civil society and academia be formed. The governing body will be the highest authority that will ensure that the state actions are in line with the national missions and actions. Further, the governing body will have to ensure that the state mission as pronounced under SAPCC is not compromised and funds are invested in an equitable manner.

For the action plan implementation, an autonomous and highly dynamic **executive body** is suggested for the state**.** Functioning under the guidance of governing body, the executive body will be housed in the Department of Environment and Forests and will be responsible for execution of climate change program. Registered as a 'non-profit society', the executive body will be headed by a Secretary level officer and will function under the guidance of the Principal Secretary of the Department of Environment and Forests.

It is suggested that the executive body has several task forces which are headed by directors for specialized tasks; each execution arm or task force should be supported by professionals drawn from various departments and assisted by subject area experts. Since climate change is a dynamic activity, hence the executive body will require support of autonomous institutions that help develop the relevant programs for the state, ensure inter-departmental coordination and most importantly identify and generate funds required for the pilot, research activities and also for program implementation.

The suggested structure of the implementation agency for Jharkhand Climate Change Action is described in following figure. The command chain is represented using arrows.

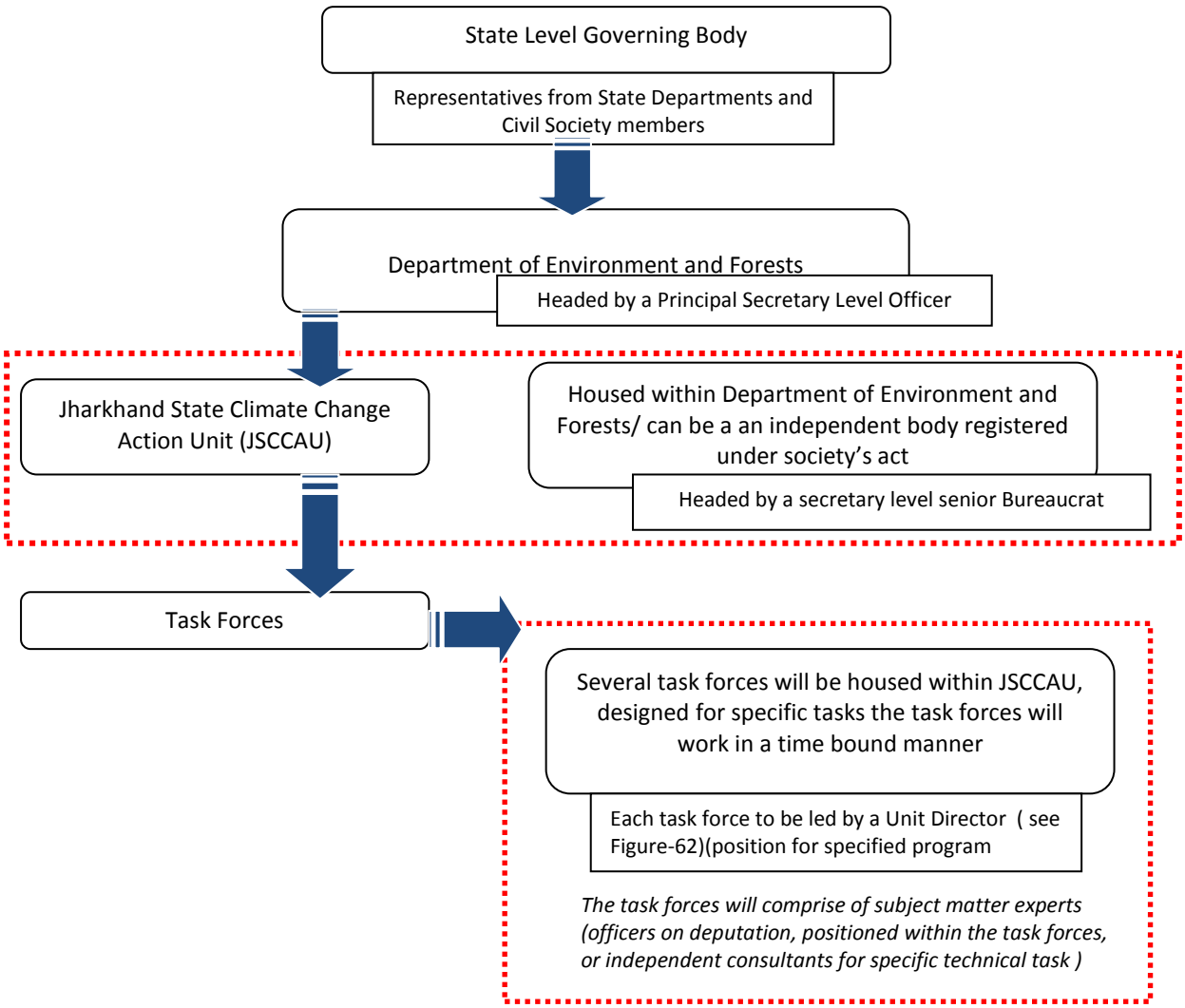


Figure 61: Suggestive Institutional Structure for Jharkhand Climate Change Action Implementation

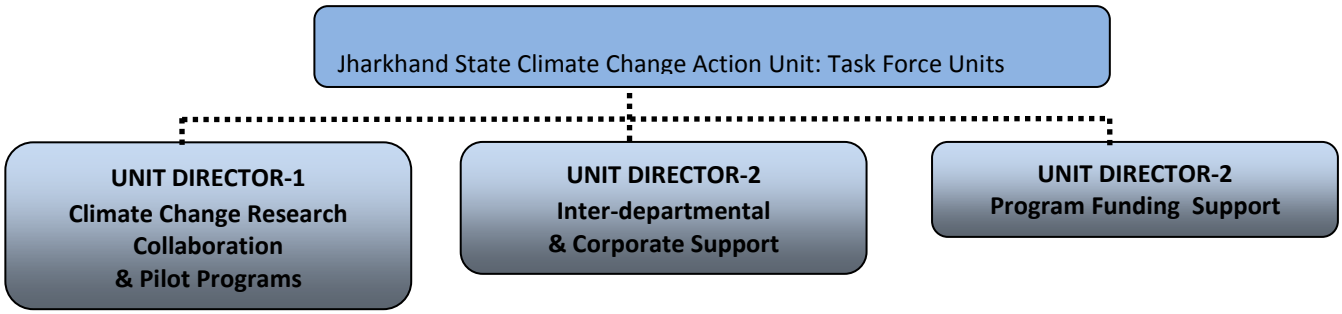


Figure 62: Suggestive list of Directors with respective responsibilities

15.2 KEY AREAS OF POTENTIAL FUTURE WORK

To develop the institutional framework for climate change action implementation, the state will have to devote resources to establish and streamline a structure that is 'acceptable', 'influential', 'capable' and 'effective' to help the state achieve the desired goals outlined in the state climate change action plan.

The key areas of action to establish such a mechanism are

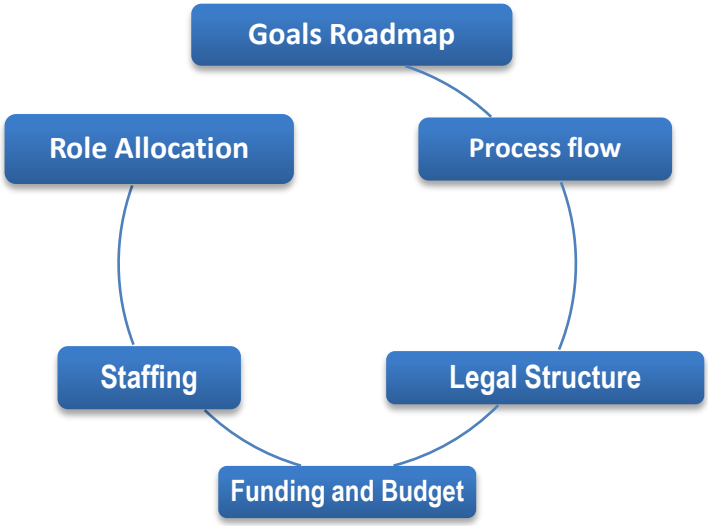


Figure 63: Key areas of action to establish Climate Change Action Unit

A. **Goals Roadmap:** Before finalizing the structure of the State Climate Change Action Implementing Agency, the state should clearly define the future roadmap based on the current understanding of the problem and anticipated actions as prescribed in the SAPCC document. The Goals roadmap will help identify the roles of various departments (sector wise action required) in short-medium and long term and will also help map the resources available to the state and the resources that will be required in the future.

B. **Process flow analysis:** The understanding of actions expected from various sectors will indicate the processes that need to be put in place to ensure timely resource identification and allocation. The process flow mapping is highly applicable identifying as well as developing protocols for inter-departmental collaboration and communication.

C. **Legal Structure:** The goals roadmap and the process flow (as identified) will become the basis for the legal structure of The Climate Change Action Unit. It is suggested that 'the unit' can be made part of the Department of Environment and Forests, headed by the Principle Secretary of the department the unit will have to be equipped with administrative powers to perform its functions as described in the State Climate Change Action Plan.

D. **Funding and Budget:** The Climate Change Action Unit will require funds for three sets of activities:
   i. Meeting operational expenditures
   ii. Research and piloting: Conducting state specific research to measure and develop state and sectoral response for climate change. Develop and demonstrate pilot activities for different sectors.
   iii. Awareness generation: The Climate Change Action Unit will have to engage its resources to develop awareness of state bodies, institutions, administrators, policy makers and public in general.

The funding requirements of the Climate Change Action Unit can be met through multiple sources:

Dedicated funds: Special taxes/levies on ecologically damaging activities (i.e. mining, thermal power plants) can be used to generate funds for the climate action

Program funding: The central government has allocated funds for various missions under the NAPCC. The state can tap such funds by developing appropriate programs under SAPCC in line with the NAPCC.

Multi/Bi-lateral funds: The state can approach various funding agencies and get a buy-in for its projects/programs under such funds.

Annual state funding: The state action plan budget can be tied with the state budget cycle, a state wide fund can be created for initial years when the budgetary demand will be high.

E. **Staffing and role allocation:** The key positions of the implementation unit will be filled by the state bureaucracy. The senior positions in the Climate Change Action Unit can be filled by getting subject matter experts from various departments on deputation or through direct hiring. Full time recruitments for the managerial posts and support staff can be done.
The staff requirement will depend upon the execution style of 'the unit'.

SECTION C: SECTORAL ACTION PLANS

Climate Change Action Plan (Sector-wise)

1. STRETEGIC APPROACH FOR AGRICULTURE SECTOR (2013-18)

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation Horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term[74]	Medium term[75]	Long term[76]				
AG1. Research and development-Research to ascertain impact of climate change in Jharkhand	Establish a dedicated Centre and network of weather stations for research on climate change and its impact on Agriculture sector in Jharkhand	Agriculture and Sugarcane Development (ASD)	Bi- / multi-lateral agency	✓	✓			4		✓
	Climate change vulnerability mapping	ASD		✓				2.5		✓
	Development of a state level climate impact mode-for agriculture sector	ASD		✓						✓
	Development of controlled experiments to understand impact of climate change on native/other farm species of Jharkhand	ASD		✓	✓					✓
	Exploring opportunities to reduce impact of climate change considering indigenous agriculture practices as well as international experiments	Agriculture and Sugarcane Development (ASD)		✓	✓			18.3		✓
AG2. Increasing climate resilience of agriculture sector	Mission approach to promote agriculture sector research work through network of agriculture universities in collaboration with ICAR and other universities.	ASD	Multi- / Bi-lateral agency	✓	✓			6.1		✓

[74] Short term: 1-2 years
[75] Medium term: 3-5 years
[76] Long term: 5-10 years

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation Horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term[74]	Medium term[75]	Long term[76]				
	Infrastructure promotion to support agriculture economy (including rural go-downs, cold storage facilities)	Agriculture and Sugarcane Development (ASD)			✓			48		✓
AG3. Exploration of carbon mitigation options	Research on exploring potential of carbon sequestration in agriculture sector	ASD	Multi- / Bi-lateral agency		✓			3	✓	
	Promotion of agricultural waste and residue management practices to reduce CH_4 emissions	Agriculture and Sugarcane Development (ASD)			✓			12		✓
	'Agriculture Waste to Energy' option promotion				✓			30		✓
	Promotion of use of organic manure	ASD			✓			20		✓
AG4. Increasing resource base	Program to enhance productivity of waste and barren land through soil management practices	Agriculture Development	Multi- / Bi-lateral agency		✓			60	✓	✓
	Promotion of cultivation of horticulture species (similar to NABARD's WADI Project)	Agriculture Development			✓			30	✓	✓
	Promotion of on-farm water conservation practices	Agriculture Development	Multi- / Bi-lateral agency		✓			90	✓	
AG5. Smart water management	Promotion of practices to minimize water logging in fields and surroundings	Agriculture Development		✓	✓			30	✓	✓
	Promotion of water use efficiency (micro irrigation, efficient water management)	Agriculture Development		✓	✓			120	✓	
	Water cascading and land levelling measures through MGNREGS	Agriculture Development								
AG6. Vulnerability reduction measures	Strengthening and establishment of weather monitoring network	Agriculture Development	Multi- / Bi-lateral agency	✓				2.4	✓	
	Weather based Agromet advisory services for the agriculture community in the state	Agriculture Development		✓				7.2	✓	
	Development of insurance products for poor, lower middle class households to protect households assets natural perils	Agriculture Development			✓			0	✓	
	Development of crop and cattle insurance products for poor and lower middle class farmers	Agriculture Development			✓			0	✓	
AG7. Awareness generation on Climate	Awareness programs to improve understanding of policy makers	Agriculture Development		✓	✓			1	✓	

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation Horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term[74]	Medium term[75]	Long term[76]				
Change	Awareness programs to improve understanding of agriculture sector researchers	Agriculture Development		✓	✓			1	✓	
	Awareness programs to improve understanding of agriculture sector extension workers/ farmers/ panchayat functionary etc.	Agriculture Development		✓	✓			24	✓	
AG8. Capacity building for sustainable agriculture	Capacity building of agriculture sector planners, department officials on climate change and its impact on agriculture sector	Agriculture Development	Multi- / Bi-lateral agency	✓				1	✓	
	Human resource development/Capacity building (institutional and personnel) on climate change concerns & planning, weather monitoring and weather services	Agriculture Development		✓	✓			0.5	✓	
	Capacity building of agriculture extension workers, farmers on climate proofing and sustainable agriculture	Agriculture Development		✓	✓			7.2	✓	
5-year budget estimate								**518.2**		

2. STRATEGIC APPROACH FOR FORESTRY SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
FD1. Research and development- Research to ascertain impact of climate change on forests of Jharkhand	Establish a dedicated *Research Centre* for *Climate Change* research	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	4		
	Document impact of climate change on forests, wildlife and biodiversity	Forest Department	USAID	✓	✓		HIGH	6	✓	
	Develop controlled environment state of art facilities to understand impact of climate change on native forest species of Jharkhand	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	10	✓	
	Exploring opportunities through field trials to reduce impact of climate change considering indigenous silviculture practices as well as international forestry experiments	Forest Department	Multi- / Bi-lateral agency		✓	✓	HIGH	20	✓	
FD2. Development of climate change resilient forest management plans	Develop a long term Climate Change Mitigation plan for forestry sector	Research Centre on Climate Change	USAID		✓	✓	HIGH	2.5	✓	
	Develop responses to climate change (projected and actual) impacts.	Research Centre on Climate Change			✓	✓	HIGH	1.5	✓	✓
	Integrate responses in forest management plans	Forest Department		✓	✓		HIGH	-	✓	✓
FD3. Rural energy management	Programs for promotion of energy efficient cooking systems in rural Jharkhand	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	30.6	✓	
	Programs for promotion of clean energy options in urban and rural areas	Forest Department		✓	✓		HIGH	72	✓	
FD4. Increasing economic efficiency of the forest resources	Development of programs to improve financial returns from the forest dependent's economic development activities	Forest Department	Multi- / Bi-lateral agency		✓	✓	MEDIUM	24	✓	
	Training of communities dependent on forests on sustainable use of forest resources (i.e. wood fuel, fodder, MFP, others)	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	12	✓	
FD-5. Out of forest tree cover enhancement	Promotion of urban forestry, community forestry, social forestry, agro forestry	Forest Department		✓	✓	✓	HIGH	72	✓	
	Development of village forests with focus on wood fuel	Forest Department		✓	✓	✓	HIGH	120	✓	
FD-5. Forest Biodiversity	Comprehensive documentation of biodiversity in the state	Forest Department	Multi- / Bi-lateral agency	✓			HIGH	12	✓	

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
management	Study of impact and response of climate change on biodiversity of the state	Forest Department		✓	✓		HIGH	5	✓	
	Response plan to accommodate biodiversity in case of climate change induced migration	Forest Department					HIGH	2	✓	
	Development of state biodiversity action plan (with inclusion of climate change response)	Forest Department					HIGH	2	✓	
FD-7. Capacity building/ Awareness generation	Introduction of climate change adaptation and mitigation in the state forest department coursework	Forest Department	Multi- / Bi-lateral agency	✓			HIGH	2	✓	
	Departmental awareness on climate change and its impact on forests and biodiversity	Forest Department		✓			HIGH	9.6	✓	
	Community awareness generation in regions where pressure on biodiversity is imminent	Forest Department		✓	✓		MEDIUM	9.6	✓	
	Capacity building of forest officials to integrate climate change concerns into forest planning and actions	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	4.8	✓	
FD-8. institutional arrangement on climate change and mitigation	Aligning state forest policies with the Green India Mission	Forest Department	Multi- / Bi-lateral agency	✓	✓		HIGH	0.5	✓	
FD-9. Action to reduce damage to forest property from mining activities	Clear demarcation of boundary of mining activity using sophisticated techniques	Forest Department		✓			HIGH	5	✓	
	Guidelines to cover exposed soil with vegetation (or other suitable means) within a prescribed timeframe	Forest Department		✓			MEDIUM	0.5	✓	
	Guidelines for transportation of minerals from forested areas (to minimize spill over of minerals in surrounding areas)	Forest Department		✓			HIGH	1	✓	
	Site specific guidelines for use of explosives to control noise pollution depending on the biodiversity (fauna) in the region	Forest Department		✓	✓		MEDIUM	1	✓	
FD-10. Exploration of carbon mitigation options	Identify and develop carbon mitigation strategies to enhance carbon sequestration	Forest Department			✓		MEDIUM	1	✓	
	Explore revenue options and design appropriate carbon sequestration projects	Forest Department		✓	✓		MEDIUM	6	✓	
FD-11. Forest fire	Development of early warning system for forest fire detection and its integration with existing GIS	Forest Department		✓			HIGH	6		

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
management	Introduction of modern forest fire management systems in existing sanctuaries and national park	Forest Department			✓		HIGH	54		
5-year estimated budget								**496.6**		

3. STRATEGIC APPROACH FOR HEALTH SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
HLT-1. Research and data collection	A detailed study on the climate sensitivity of diseases break with focus on both vector borne and water borne diseases	Medical and Public Health	Multi- / Bi-lateral agency	✓	✓		High	3		✓
	Identify communities and regions that fall under the most vulnerable category	Medical and Public Health	Multi- / Bi-lateral agency	✓	✓		High	-		✓
	Identify data gaps in the present disease management plan	Medical and Public Health		✓	✓		High	-		✓
HLT-2. Developing and establishment of an (early) warning system	Development of a state level disease warning system and integrating it with national/regional level systems	Medical and Public Health	Multi- / Bi-lateral agency	✓			Medium	4.8		✓
	Protocol development to identify and respond to a disease of concern	Medical and Public Health		✓			Medium	-		✓
	Define protocol to ensure time-bound action in response to reporting of a disease	Medical and Public Health		✓			Medium	-		✓
HLT-3. Monitoring, evaluation and feedback system	IT and spatial presentation enabled surveillance system to capture information on vector borne and other diseases	Medical and Public Health	Multi- / Bi-lateral agency	✓			Medium	7		✓
HLT-4. Awareness on climate change and health issues	Targeted awareness programs to help communities and health facilitators understand impact of climate related diseases	Medical and Public Health	Multi- / Bi-lateral agency		✓		Medium	25		✓
	Specially designed training programs for regions which are not affected currently but under potential threat of vector borne diseases	Medical and Public Health			✓		Medium	-		✓
HLT-5. Quick response mechanism	Establishment of a state wide system to develop a quick response to any disease outbreak or health disaster	Medical and Public Health	Multi- / Bi-lateral agency		✓		Medium	24	✓	✓
	A dedicated response mechanism for rural areas (including PRIs, SHGs and other village institutions)	Medical and Public Health			✓		Medium	-	✓	✓
HLT-6. Institutional arrangement	Sensitization and capacity building for state health department officials	Medical and Public Health	Multi- / Bi-lateral agency	✓	✓		Medium	1.5	✓	✓
	Integration of health sector concerns for the state in health policy and planning document	Medical and Public Health			✓		Medium	0.5	✓	✓

	Aligning the state plans with the NAPCC	Medical and Public Health			✓		Medium	0.25	✓	✓
HLT-7. Health insurance for the poor	100% coverage of poor under the *Rashtriya Swasthya Bima Yojana*	Medical and Public Health			✓		Medium	350		✓
	Developing a special health insurance product for the tribal regions	Medical and Public Health			✓		Medium	-		✓
HLT-8. Partnership with private sector	Mobilizing private funds for promotion of rural health programs	Medical and Public Health			✓	✓	Medium	36		✓
	Engaging corporations in systematically developing health infrastructure in underdeveloped regions	Medical and Public Health			✓	✓	Medium	0.45		✓
5-year budget estimate								**452.5**		

4. STRATEGIC APPROACH FOR INDUSTRIAL SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
IND-1. State GHG mitigation approach development	GHG inventorization of big industries	Industries	EESL		✓		Medium	1		
	GHG inventorization of MSME sector		EESL		✓		Medium	1		
	Technology inventorization for priority (high impact) sectors		EESL	✓			Medium	1.5		
	Green growth planning (with focus on GHG emission)		EESL / BEE	✓			Medium	0.5		
IND-2. Infrastructure planning and development	Inclusion of risk assessment and vulnerability studies in infrastructure planning				✓	✓	High	1		
	Involving industries in energy planning			✓			High	1.5		
	Redefining standards for new infrastructure to make it more resilient			✓			High	0.5		
IND-3. Promotion of green energy options	Fiscal measures to support low carbon energy options		EESL / BEE	✓	✓	✓	Medium	32		
	Infrastructure and procedural support to promote green energy options		EESL / BEE	✓	✓		Medium	2.5		
IND-4. Industrial Efficiency improvement	Development of a MSME sector efficiency improvement strategy aligning it with ongoing efficiency improvement programs of financial institutions and bi-multi lateral institutions		BEE / EESL	✓	✓		Medium	1		
IND-5. Exploring carbon revenue options for industrial efficiency	Developing a carbon revenue centric revenue support mechanism for financing of industrial efficiency financing				✓		Medium	0		
	PoA, sectoral NAMA app, approaches for MSME sector				✓		Medium	1.5		
IND-6. Industry specific adaptation strategies	Broadening of the manufacturing base (beyond mineral & mining)						Medium	0		
	Revision of environmental performance standards of industries						Medium	0.5		
	Develop infrastructure to support industrial supply-chains			✓	✓		Medium	12		

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
	Conducive environment for market-based financing of SMEs			✓			Medium	1.5		
	Monitoring, evaluation and communication system for environmental performance of industries			✓	✓		Medium	5		
	Monitoring, evaluation and communication system for environmental performance of SMEs			✓	✓		Medium	5		
5-year budget estimate								**68**		

5. STRATEGIC APPROACH FOR MINING SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs in crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
IND-1. State Level Mining Sector Inventorization	Detailed inventorization of the mining activities in the state (i.e. Area under mines, annual production etc) 1. Area under open cast mines 2. Underground Mining 3. Abandoned Mines	Mining	Multi- / Bi-lateral agency	✓			Medium	5		✓
	Calculation of annual GHG emissions from the mining sector	Mining		✓			Medium	0.5		✓
IND-2. Green growth planning (with focus on GHG emission)	GHG inventorization of all the big mines	Mining	Multi- / Bi-lateral agency	✓			Medium	3		✓
	Efficiency standards/ guidelines for mining sector operations	Mining	EESL	✓			Medium	0.5		✓
	Afforestation and back-filling plans for abandoned mines	Mining/Forest	Multi- / Bi-lateral agency	✓			Medium	3		✓
IND-3. Infrastructure planning and development	Development of rail/ road network to improve connectivity of mines to ease out mineral transportation	Mining/Railways	-		✓	✓	Medium	300		✓
	Reducing pressure on rural roads due to mineral transport activity	Mining/Railway			✓		Medium	-		✓
	Standards for transport of minerals focusing on reducing spill over of minerals	Mining	Multi-/ Bi-lateral agency	✓			Medium	1		✓
	Guidelines on conveyer based transportation of minerals wherever feasible to reduce spill over	Mining		✓			Medium	2		✓
IND-4. Water management in Mining areas	Use of abandoned mines for water harvesting	Mining	Multi- / Bi-lateral agency		✓		High	-		
	Water cascading measures in mining operations	Mining			✓		High			
	Water efficiency measures for mining operations	Mining	Multi- / Bi-lateral agency		✓		High			✓
	Rainwater harvesting and ground water recharging guidelines in mining locations	Mining		✓	✓		High	12		✓
	Guidelines on effluent discharge from mining areas (into water bodies)	Mining	Multi- / Bi-lateral agency		✓		High	1		✓

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs in crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
IND-5. Control measures to reduce water contamination due to mining activity	Guidelines on creating physical boundaries to control wash out of minerals into water bodies during extremely rainy days	Mining		✓			Medium	1		✓
	Erosion management in mining areas to reduce run-off of minerals and top-soil	Mining	Multi- / Bi-lateral agency		✓		Medium	-		✓
5-year budget estimate								**326**		

6. STRATEGIC APPROACH FOR POWER SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
PWR-1. Defining Low emission path for the power sector	GHG inventorization of the power generation facilities	Energy	CenPEEP	✓				0.5		✓
	GHG mitigation (efficiency improvement) plan	Energy	CenPEEP	✓				0.25		✓
	Renewable energy and energy efficiency plan for the state	JREDA	EESL					1		✓
PWR-2. Enhancing energy efficiency in electricity generation	Assessment of financial and technical viability to improve efficiency of power plants (switching towards super critical boilers)	Energy	CenPEEP / NTPC	✓				1		✓
	Designing fiscal incentives to promote energy efficiency in power plants	Energy	CenPEEP / NTPC	✓				0		✓
PWR-3. Promotion of distributed power generation facilities	Develop a state policy to promote small scale power generation facilities		Multi-lateral agencies	✓				0.25		✓
	Dedicated centre to extend technical support to small scale decentralized power generation units	JREDA	As above	✓				5		✓
PWR-4. Demand side management for improving energy use efficiency	Estimation of T&D losses, development of and implementation of a T&D approach that reduces losses and thefts	Energy	BEE / EESL	✓	✓			1		✓
	Subsidy mechanism to promote adoption of Energy Efficiency options in urban sector	Energy	BEE / EESL	✓	✓			150		✓
	Subsidy mechanism to promote adoption of Energy Efficiency options in SME sector	Energy	BEE / EESL		✓			90		✓
	Promotion of energy efficient technological measures to reduce power consumption in street lighting, government building and other installations	JREDA, Municipal Corporations	BEE / EESL		✓			0		✓
	Regulatory measures to promote energy efficiency-							0.5		✓

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
	mandatory energy audits for selected establishments									
PWR-5. Energy efficiency approaches	Develop PPP model for introducing EE in urban sector	Energy, Urban Development	BEE / EESL		✓			0.5		✓
	Develop programmatic EE approach for MSME sector in Jharkhand		BEE / EESL		✓			0.5		✓
PWR-6. Awareness generation	Awareness generation on efficient use of energy		BEE / EESL	✓				25		✓
	Awareness generation on process and technological options to reduce energy use		BEE / EESL	✓				25		✓
PWR-7. Harnessing renewable energy potential of the state	Promotion of renewable energy options in villages close to forests	Jharkhand Renewable Energy Development Agency (JREDA)	BEE / EESL	✓				12		✓
	Mapping of villages not connected to grid and develop lighting programs with focus on micro hydro power generation as off-grid lighting solutions for villages close to water streams	JREDA	BEE / EESL	✓				1		✓
	Development of programmatic approaches to attract carbon revenue for RE projects							0.25		
PWR-8. Institutional mechanisms	Awareness generation and capacity building of office bearers	Energy, JREDA	BEE / EESL	✓	✓			1		
	Aligning state's plans with that of National Plans (National Solar Mission and National Mission on Enhanced Energy Efficiency)	Energy	BEE / EESL		✓			0.25		✓
PWR-9. Transmission and distribution loss reduction	Stringent laws to discourage theft of power	Energy	BEE / EESL	✓	✓			0.25		✓
	Technology options to reduce theft of electricity	Energy	BEE / EESL		✓			20		✓
	Modernization of substations	Energy	-		-			-		✓
5-year budget estimate								**333.25**		

7. STRATEGIC APPROACH FOR URBAN AND TRANSPORT SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
U&T-1. Urban water use management	Development of operational standards for water sector utilities (High Priority)	Urban Development Department (UDD) andULBs	Multi- / Bi-lateral agency / ICLEI		✓		HIGH	0.5	✓	
	Adoption of water efficient devices in government owned/supported institutions (High Priority)	UDD & ULBs	Multi- / Bi-lateral agency		✓		HIGH	15	✓	
	Regulations for use of water efficient devices in buildings and other urban settlements (High Priority)	UDD & ULBs	Multi- / Bi-lateral agency		✓		HIGH	0.25	✓	
U&T-2. Rainwater management	Increase in the absorption capacity of urban spaces (High Priority)	UDD & ULBs	Auroservice d' Auroville		✓		HIGH	72	✓	
	Scientifically developed rainwater drainage systems for all the major cities (High Priority)	UDD & ULBs	Auroservice d' Auroville			✓	HIGH	50	✓	
	Enact laws to avoid potential encroachments of water drainage channels (High Priority)	UDD & ULBs	Auroservice d' Auroville		✓		HIGH	-	✓	
	Revive lost glory of city lakes and use them as sinks to capture rain water (High Priority)	UDD & ULBs	Auroservic e d' Auroville		✓		HIGH	60	✓	
U&T-3. Reducing carbon footprint of urban sector	Regulation for energy audits of commercial and state owned buildings (Medium Priority)	UDD; Building Dept, Industry Dept	EESL		✓		MEDIUM	0.25	✓	
	Develop urban energy guidelines in line with BEE supported Municipal DSM program (Medium Priority)	UDD & ULBs	EESL		✓		MEDIUM	3		✓
	Development of programmatic energy efficiency approaches for urban water pumping and sewerage disposal (Medium Priority)	UDD & ULBs	EESL		✓		MEDIUM	36		✓
	Lighting, cooling and heating centric energy saving options for bigger buildings (Medium Priority)	UDD & ULBs	EESL		✓		MEDIUM	1		✓
U&T-4.Solid Waste management	Waste management vision for the state of Jharkhand (High Priority)	UDD & ULBs	Multi- / Bi-lateral agency / ICLEI	✓			HIGH	0.5	✓	
	Development of integrated municipal waste management (High Priority)	As above	-		✓		HIGH	Include	✓	

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
								d above		
	Capacity building of rag-pickers on waste segregation and valuation to improve waste to resource recovery (High Priority)	As above	-		✓		HIGH	0.5	✓	
U&T-5. Waste water management	Segregation of water at the household level (a pilot project can help develop a programmatic approach) (Medium Priority)	UDD & ULBs	Auroservice d' Auroville		✓		MEDIUM	2	✓	
	Water reuse, reduction and recycling promoted at all levels (Medium Priority)	As above	Auroservice d' Auroville		✓	✓	MEDIUM	2	✓	✓
	Implementation of wastewater to resource projects on pilot basis- waste to energy, waste to fertilizer (Medium Priority)	As above	Auroservice d' Auroville		✓	✓	MEDIUM	2	✓	✓
U&T-6. Promotion of sustainable urban habitats	Develop an urban development plan to promote climate smart cities on pilot basis (Medium Priority)	UDD & ULBs	Auroservice d' Auroville		✓		MEDIUM	1.25	✓	✓
	Inculcate environmental sustainability practices in citizens (through sensitization programs) (Medium Priority)	As above	Auroservice d' Auroville		✓	✓	MEDIUM	7.5	✓	
	Promote green cities (components including plans to increase green cover, efficient transport sector, water storage and management planning) (Medium Priority)	As above	Auroservice d' Auroville		✓	✓	MEDIUM	6	✓	
	Development of quality standards for water supplies, and power distribution(Medium Priority)	As above	Auroservice d' Auroville		✓	✓	MEDIUM	1	✓	
U&T-7. Transport sector management	Control in the sales of adulterated fuel (Medium Priority)	UDD & ULBs			✓		MEDIUM	0.5		✓
	Pollution standards for urban as well as rural areas (Medium Priority)	As above	Multi- / Bi-lateral agency		✓		MEDIUM	0.25		✓
	Network of vehicle pollution testing laboratories (Medium Priority)	As above			✓		MEDIUM	24		✓
	Implementation of IT enabled inter-city public transport service, including a fleet of buses to reduce use of personal vehicle (Medium Priority)	As above	Institute of Urban Transport (IUT)/World Bank		✓		MEDIUM	30		✓

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium term	Long term				
	Transportation standards for spill free movement of minerals through road/rail (Medium Priority)	As above			✓		MEDIUM	1		✓
U&T-8. Promotion of eco-friendly commuting options	PPP model to promote eco-transportation mechanism (Medium Priority)	UDD & ULBs	IUT/World Bank		✓		MEDIUM	5		✓
	Making cities pedestrian and cycling friendly (Medium Priority)	As above	IUT/UNDP		✓		MEDIUM	6		✓
	Town planning to address traffic plans in order to reduce congestion (Medium Priority)	As above	IUT		✓		MEDIUM	1		✓
	Smart traffic management to optimize traffic speed as well as reduce waiting time on traffic lights (Medium Priority)	As above	IUT/World Bank		✓		MEDIUM	1		✓
5 year budget estimate								**329.50**		

8. STRATEGIC APPROACH FOR WATER SECTOR

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium Term	Long term				
WAT-1. Policy measures	Water Resource Regulatory Authority to regulate whole of water resources in the state	Water Resource Department / Command Area Development			✓	✓		2	✓	
	Stakeholder consultation to decide jurisdiction of Water Resource Regulatory Authority	WRD		✓				1	✓	
	Appropriate policy to streamline water resource management strategies	WRD		✓				0.25	✓	
	Appropriate policy to create space for Water Resource Regulatory Authority	Water Resource Department		✓				incl. above	✓	
	Developing a state policy for drought management	WRD		✓				0.25	✓	
	Regulation for rainwater harvesting: 1. Rainwater harvesting in cities/ selected zones in cities 2. Rainwater harvesting in government staff colonies, offices 3. Rainwater harvesting in educational institutions (size limitation to be considered) 4. Rainwater harvesting in industrial zones/ SEZs	Water Resource Department (WRD)		✓				0.25	✓	
WAT-2. Groundwater management with focused attention on over exploited areas	Creation of water retention structures	WRD			✓			360	✓	
	Rain Water Harvesting and Management:	WRD; Urban Development Dept			✓	✓		36	✓	
	Ground Water Management	WRD			✓	✓		36	✓	
WAT-3. Detailed water sector Research and Development	Water management assessment map of the state	WRD; MID		✓				2	✓	
	Designing a separate study for areas under severe water stress	WRD, MID		✓				0.5	✓	

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium Term	Long term				
WAT-4. Enhancing preparedness for drought monitoring, drought mitigation and development of early warning system	Establishment of a drought monitoring and management mechanism, that culminates into an early warning system for drought/ drought like situation	WRD		✓	✓	✓		15	✓	
WAT-5. Testing and promotion of technology based water management options	Invest in R&D for water and soil moisture conservation	WRD		✓	✓			0.25	✓	
	Facilitate real time database of all the water resources available to the state	WRD			✓			0.25	✓	
	Review the water sector data quality and parameters	WRD			✓	✓		0.25	✓	
	Additional data requirement needs to fill in information gaps	WRD			✓			-	✓	
	Setting up of weather stations, monitoring systems	WRD			✓	✓		Incl in WAT-4	✓	
	Periodic reporting system	WRD			✓	✓		-	✓	
WAT-6. Awareness generation	Awareness programs to improve understanding of policy makers	WRD			✓			0.6	✓	
	Awareness programs to improve understanding of industrial department and industries on impact of CC on water resources	WRD and ID			✓			0.6	✓	
	Awareness program for farmers to promote adoption of water smart agriculture.	WRD, MID, ADD			✓			11	✓	
WAT-7. Water management in mining areas	A mining sector guideline for collection, storage and disposal of water	Mines and Geology Dept		✓				0.3	✓	
WAT-8. Water use efficiency measures in industrial sector	Water use efficiency planning for mining sector	Mines and Geology Dept	EESL	✓				0.5	✓	
	Water use efficiency planning for industrial sector	WRD and Industries Development (ID)	EESL	✓				0.5	✓	
	Development of water use efficiency standards for selected 'high impact' sectors/subsectors	WRD and ID	EESL	✓				incl above	✓	
	Introduction of water audit system for industrial plants	WRD and ID		✓	✓			0.5	✓	
WAT-9. Improving Water	Creation of water retention structures in rural and urban areas	WRD and MID			✓	✓		40	✓	

Strategies	Proposed activities	Responsible department/s	Implementation Support	Implementation horizon			Level of priority	Cost (Rs crores)	Adaptation Measure	Mitigation Measure
				Short term	Medium Term	Long term				
Use Efficiency in urban/rural settlements	Strategies to reduce conveyance losses in water channels	MID			✓	✓		0.25	✓	
	Promotion of sprinkler irrigation system in *rabi* field crops and drip irrigation for fruits and vegetable crops	Agriculture Development Dept			✓	✓		120	✓	
	In deficit basins/ sub basin areas industries may be asked to practices water swapping in PPP mode for treatment of domestic waste water and use it in the production process	WRD and Industries Dept			✓	✓		25	✓	
	Drinking water Sanitation department may look into minimizing water conveyance and distribution losses	Drinking Water and Sanitation Dept			✓	✓		0.5	✓	
WAT-10. Payment for Ecosystem Services option as conservation tool	Testing of PES option water conservation between community-community PES based revenue transfer mechanism And Community-Industry PES revenue transfer mechanism				✓	✓		1	✓	
5-year budget estimate								**654.75**		

APPENDIX

ANNEXURE 1

The eight different "National Missions" are:-

- National Solar Mission: It 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 options. The plan includes:
    - Specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishments;
    - A goal of increasing production of photovoltaic to 1000 MW/year;
    - A goal of deploying at least 1000 MW of solar thermal power generation. Other objectives include the establishment of a solar research center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.
- National Mission for Enhanced Energy Efficiency: Current initiatives are expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:
    - Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
    - Energy incentives, including reduced taxes on energy-efficient appliances
    - Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.
- National Mission on Sustainable Habitat: To promote energy efficiency as a core component of urban planning, the plan calls for:
    - Extending the existing Energy Conservation Building Code;
    - A greater emphasis on urban waste management and recycling, including power production from waste;
    - Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles;
    - Incentives for the use of public transportation.
- National Water Mission: With water scarcity projected to worsen as a result of climate change, the mission sets a goal of a 20% improvement in water use efficiency through pricing and other measures.
- National Mission for Sustaining the Himalayan Ecosystem: The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.
- National Mission for a "Green India": Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.
- National Mission for Sustainable Agriculture: The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms and other appropriate agricultural practices.
- National Mission on Strategic Knowledge for Climate Change: To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling and increased international collaboration. It also attempts to encourage private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

Other Programs

The NAPCC also considers the other ongoing initiatives, which may contribute to climate change which include:

- Power Generation: The government is mandating the retirement of inefficient coal-fired power plants and supporting the research and development of IGCC and supercritical technologies.
- Renewable Energy: Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions should ensure purchase of certain percentage of grid-based power from renewable sources.
- Energy Efficiency: Under the Energy Conservation Act 2001, large energy-consuming industries are required to undertake energy audits and an energy labelling program for appliances has been introduced.

(Source: Prime Minister's Council on Climate Change, 2008)

ANNEXURE 2

GHG emissions (Garg & Shukla, 2002)

	CO2 (MT)		CH4 ('000 tons)		N2O('000 tons)		NOX('000 tons)		SO2('000 tons)		Total for district (MtCO2e)	
	1990	**1995**	**1990**	**1995**	**1990**	**1995**	**1990**	**1995**	**1990**	**1995**	**1990**	**1995**
Deoghar	0.2	0.17	18.7	18.7	0.08	0.08	1.3	1.3	1.4	1.2	0.61	0.6
Dhanbad	3.03	3.03	132.6	132.6	0.5	0.5	13.7	13.7	29.8	29.8	6.03	6.03
Dumka[ŧ]	0.21	0.16	34	33.5	0.12	0.14	1.8	1.9	1.7	1.3	0.97	0.92
East Singhbhum	10.24	11.64	39.1	40	0.24	0.27	21.4	24.2	49.2	56.9	11.13	12.58
Giridih	18.49	21.21	49	47.7	0.37	0.42	39.8	46.3	82.8	96.3	19.63	22.36
Godda	0.1	0.09	17	25.9	0.05	0.06	1	1.3	0.8	0.8	0.47	0.67
Gumla[Ŧ]	0.13	0.08	35.2	34	0.11	0.13	1.2	1.2	1.1	0.9	0.91	0.85
Hazaribagh[¥]	3.68	3.14	67.2	75.7	0.38	0.42	14.7	13.5	24.3	23.1	5.23	4.89
Lohardaga	0.06	0.05	7.6	7.4	0.07	0.09	0.5	0.4	0.4	0.3	0.24	0.23
Palamu[†]	0.34	0.24	39.1	39.9	0.41	0.46	3.1	3.1	2.7	2.1	1.28	1.24
Ranchi[ϒ]	1.06	1.11	58.4	56.7	0.62	0.73	5.6	6.1	6.5	6.8	2.48	2.56
Sahebganj	0.18	0.13	27	26.8	0.11	0.12	1.4	1.4	1.4	1.1	0.78	0.74
West Singhbhum[ƀ]	1.19	1.56	39.7	39.5	0.08	0.08	4.9	5.6	7.5	8.2	2.04	2.44
TOTAL											**51.8**	**56.11**

[ŧ] Jamtara's emissions are included in district Dumka's emissions

[Ŧ] Simdega's emissions are included in district Gumla's emissions

[¥] Ramgarh, Koderma and Chatra's emissions are included in district Hazaribagh's emissions

[†] Garhwa's emissions are included in district Palamu's emissions

[ϒ] Khunti and Latehar's emissions are included in district Ranchi's emissions

[ƀ] Kharsawan 's emissions are included in district West Singhbhum's emissions

ANNEXURE 3

Calculation of Climate Change vulnerability Index

Component	Aspect	Calculation description
Exposure	Precipitation variance (projected rainfall w.r.t. current average rainfall)	Normalized values for all the mentioned parameters are generated for each district. A composite category index number is developed by taking an average of the normalized values generated.
	Temperature variance (projected temperature w.r.t. current average temperature)	
	Sex Ratio	
	Percentage of ST population	
	Child population (0-6 years)	
	Decadal Population Growth	
	Percentage of Population below poverty line	
Sensitivity	Dense forest	Normalized values for all the mentioned parameters are generated for each district. A composite category index number is developed by taking an average of the normalized values generated.
	Open forest	
	Scrub	
	Land put to non-agricultural use	
	Barren & unutilised land	
	Permanent pasture and other grazing land	
	Cultivable wasteland	
	Land under miscellaneous trees	
	Other than current fallow(2-5years)	
	Current fallow land	
	Net sown agriculture area	
	Area sown more than once	
	Area under paddy cultivation	
	Area under wheat production	
	Area under vegetable production	
	Area under spices production	
	Area under horticulture plantation	
Adaptive capacity	Livestock population	Normalized values for all the mentioned parameters are generated for each district. A composite category index number is developed by taking an average of the normalized values generated.
	Literacy rate	
	Percentage of household having toilet	
	Percentage of household having TV	
	Percentage of household having motor vehicle	
	Percentage of household having electricity	
	Credit/Deposit ratio	
	Household having concrete roof	
	Number of agricultural Worker	
	Health Facilities (hospital, PHC, APHS, HCS etc.)	
	Number of School and College	

The vulnerability index is calculated using the formula: { **(Exposure-Adoptive Capacity)* Sensitivity** }

ANNEXURE 4

Calculation of agriculture sector Vulnerability Index

	Parameter	Formula
	Climate vulnerability	Rainfall Variance and temperature variance are indexed. One reading for average rainfall, two readings for projected temperatures (year 2030 and year 2080) and one reading for changes in minimum temperatures are used to develop respective indexes. A simple average of the four indexes is taken as the category index.
	Demographic features	**1.** Decadal population growth for the district **2.** SC, ST population in the district **3.** BPL Population in the district **4.** Rural population per unit area Four different normalized indexes are developed. A simple average of the four indexes is taken as the category index.
	Agriculture productivity	Horticulture sector productivity (fruits, vegetable and specie) and farm sector productivity (Maize, paddy, wheat, gram, *arhar* and *sarso*) is used to develop a composite index for the agriculture sector productivity of the state.
	Stock and Capacity indexing	Number of electrified villages in the district, availability of credit and saving services in rural areas is used to develop the capacity in rural areas.
		Agriculture area available in each district, area sown annually and area sown more than once is used for developing agriculture sector stocks and capacity.

Each aspect of the determinant has been converted to a normalized index value. Each normalized index value of the aspects has been aggregated to obtain the determinant value and these determinant values have been again aggregated into an overall index. The procedure for normalization is as follows:

= (Value of District – Minimum Value of the District)/ (Maximum Value of the District – Minimum Value of the District)

Composite index for Agriculture sector vulnerability=

(Agriculture sector productivity normalized value+ Stock and Capacity Normalized Value)-
(Normalized value for rural demography+ Normalized values for Climate Sensitivity)

ANNEXURE 5

Calculation of forestry sector Vulnerability Index

	Parameter	Formula	Weightage assigned
1	Forest cover status	(1- Forest area/ District Area)	25%
2	Wasteland Status	Wasteland land in the districts	25%
3	Forest vulnerability to climate change	Forest Vulnerability to Climate Change (whether vegetation in the district will get affected due to climate change). Value of '1' is assigned to districts that will get negatively affected due to climate change, else the value is '0'	25%
4	Scheduled or not	Value of '1' is assigned to districts is listed as Scheduled area else the value is '0'	12.5%
5	SC, ST population	Percentage of SC, ST population in the district comparison to the rural population	12.5%

Each aspect of the determinant has been converted to a normalized index value. Each normalized index value of the aspects has been aggregated to obtain the determinant value and these determinant values have been again aggregated into an overall index. The procedure for normalization is as follows:

= (Value of District – Minimum Value of the District)/ (Maximum Value of the District – Minimum Value of the District)

Composite index= (index of 'Forest cover status')*0.25+ (index of 'Wasteland Status')*0.25 + (index of 'Forest vulnerability to climate change')*0.25+ (Index of 'district listed as scheduled or not')*0.125+ (Index of SC, ST population in the district)*0.125

ANNEXURE 6

Captive power plants in Jharkhand

	Company Name	Project Name	Location	Type	Capacity (MW)
1	ACC Ltd	Chaibasa CCP	Chaibasa	Thermal	15
2	Adhunik Thermal Energy	Phase 1	Kandra	Thermal	30
3	Adhunik Thermal Energy	phase 2	Kandra	Thermal	30
4	Aditya Birla Chemicals Ltd	Thermal Power plant		Thermal	30
5	Bimaldeep Group	Bimaldeep steel CPP	Jamshedpur	Thermal	8
6	Bimaldeep Group	Bimaldeep steel CPP	Jamshedpur	WHR	4
7	JSPL	Patratu CPP	Patratu	Thermal	1320
8	JSPL	Patratu CPP	Patratu	Process flue gases	180
9	JSPL	Godda CPP	Godda	Thermal	1320
10	Hindalco	Sonahatu CPP	Sonahatu	Thermal	900
12	Abhijeet Infra	CPP	Saraikela	WHR	90
13	Abhijeet Infra	CPP	Saraikela	Coal fired	30
14	Usha Martin	CPP	Ranchi	Coal based	20
15	Usha Martin	Jamshedpur CPP	Jamshedpur	WHR	29690
18	Pawanjay Steel & Power Ltd	CPP	Lohardaga	Thermal	24
20	Divine Vidyut Ltd	CPP	Saraikela	Thermal	20
21	Praneet Ispat Udyog Pvt Ltd	CPP	Hazaribagh	Thermal	9.8
22	Shivam Iron & Steel Co Ltd	CPP	Giridih	Thermal	12
Total capacity					33732.8

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